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Cutting-Edge Business Technologies in the Big Data Era

Proceedings of the 18th SICB
"Sustainability and Cutting-Edge
Business Technologies" Volume 1

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Editor

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Volume 1

Editor

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Preface

Cutting-edge technologies (CETs) are having an increasingly profound impact on business and management. As emerging, advanced, and innovative digital technologies, CETs have many potential applications for business. They are producing exciting added value in the way firms manufacture, produce, and deliver goods and services. As artificial intelligence technologies, CETs support management to reduce risk, pull insights out of oceans of data, and make strategic decisions.

This book presents original research papers that address issues related to CET questions, implications, possible adoption and use, opportunities, and challenges rising from the interaction of CETs and management. In this book, we combine cutting-edge technologies and business analytics in the context of the big data era.

Cutting-edge technologies have been used in various business applications such as cloud computing, the Internet of Things, blockchain, virtual, augmented, and hybrid reality, edge computing, big data analytics, business analytics, business intelligence, deep learning, and artificial intelligence.

Crucial knowledge is scattered along the value chains and hidden in huge raw and unstructured data; without the aid of big data analytics and deep learning algorithms, we will not be able to discover hidden value in complex and nonlinear and multidimensional datasets in order to drive insight, knowledge, and wisdom.

This book is divided into two volumes. The first volume contains contributed research papers on emerging cutting-edge technologies. The second volume contains research papers on the adoption and use of CETs and their impact on innovation performance, competitive intelligence, and strategic decisions.

Covering numerous emerging technologies, tools, techniques, and disruptive digital innovation, this book supports scholars, researchers, managers, and decision-makers to gain deep knowledge and insight to effectively leverage cutting-edge technologies into business intelligence.

The contributed research papers reflect a wide and diverse team of scholars and researchers from the UK, Poland, USA, Denmark, India, Kosovo, Jordan, Moldova, Indonesia, India, Iraq, Palestine, Vietnam, Spain, Malaysia, Turkey, Romania, Australia, Bahrain, Algeria, Oman, Norway, UAE, Egypt, Trinidad and Tobago, Canada, Namibia, Albania, Bulgaria, and Uzbekistan.

This book is about cutting-edge technologies and their applications, challenges, and opportunities in the context of big data era and business analytics. It explores diverse emerging advanced technologies, tools, paradigms, and disruptive innovation.

In conclusion, today if we ask ourselves, “Quo Vadis” cutting-edge business technologies in the big era? What could be the answer?

To answer Quo Vadis is to make radical customization, smart digitization, mass mobility, and novel business models. To answer Quo Vadis is to make a prediction. As Ophelia stated in Shakespeare’s play Hamlet, “We know what we are, but know not what we may become.”

We believe that this book will serve as a knowledge source for researchers, professors, students, managers, business leaders, and decision-makers. Finally, we would like to thank all the authors for their valuable contributions to this book.

Saad G. Yaseen

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Bagging vs Boosting Ensemble Classifiers in Predicting Companies' Financial Status

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Abstract. Nowadays, predicting companies' financial status became an essential part of the researchers' interest, given its importance and impact on several parities (i.e., stockholders, banks and workers). In this work, we propose ensemble bagging and boosting algorithms for predicting companies' financial status. In addition, real vastly imbalanced Polish companies' dataset considered to train and test the classifiers. SMOTE and SMOTE ENN balancing techniques used to solve the data imbalanced distribution problem. Accordingly, the ensemble boosting classifiers outperform the bagging classifiers in predicting companies' financial status.

Keywords: Economic forecasting · Ensemble classification algorithms · Bagging classifiers · Boosting classifiers · Data balancing

1 Introduction

Bankruptcy has been an appealing domain to predict a company's financial failures. Therefore, bankruptcy prediction has been extensively studied in the domain of finance and economics [8]. Bankruptcy prediction is a vital issue that can be provided for companies to cut back on risk and take early action. Depending on the bankruptcy prediction the financial decisions are being conducted. Early warnings of insolvency help policymakers in the company motivate reaction to minimize the impact of bankruptcies.

The effectiveness of bankruptcy in a company has a major impact as they influence a large number of stakeholders, including creditors, workers, creditors and suppliers, and maybe even countries [3]. In the early model researchers like Beaver in 1966 [7], Altman in 1968 [5], Williams and Goodman in 1971 [21], and Sinkey in 1975 [20] have used discriminant analysis in bankruptcy prediction. Artificial neural networks have been adopted for years as a significant technique to predict bankruptcy [1, 2].

Nowadays, machine learning algorithms have acquired more interest from researchers in the finance area, especially for bankruptcy prediction using financial ratios.

This paper is a further step of our previous work in forecasting companies' financial status. In [14], several simple resampling approaches were used to solve Spanish companies dataset balancing problem. Then, three well-known classical machine learning algorithms were used to anticipate the companies' financial status. Moreover, in [4],

eleven advanced balancing techniques have been adopted to balance a vastly imbalanced dataset for Spanish companies. C4.5 classifier used to forecast companies' financial failure. Thus, the superior balancing technique that allowed the c4.5 classifier to obtain the least type I error was SMOTE ENN.

In addition, in [19], in order to improve the performance of several classifiers, they combined with simple deterministic Delay Line Reservoir (DLR). The combination shows an enhancement in the performance of the classifiers.

In this work, we propose an ensemble implementation of three well-known standard classification algorithms, namely: Naïve Bayes [18], Support Vector Machine (SVM) [11] and K-Nearest Neighbor (KNN) [12], using bagging ensemble creation technique to anticipate Polish companies financial status. In addition, two boosting classifiers, namely: AdaBoost [13] and XGBoost [10] have been adopted as well. Furthermore, real vastly imbalanced Polish companies' dataset used to train the ensemble bagging and boosting classifiers, which create a major challenge faced the classifiers and dramatically affect their performance. Thus, two well-known data balancing techniques adopted to address the issue of data imbalanced distribution and improve the classification performance which are SMOTE [9] and SMOTE ENN [6]. In addition, while the accuracy doesn't provide a reliable evaluation for the classifiers performance, four other evaluation metrics have been adopted, which are: recall, specificity, type I error, and type II error.

The remainder of the work has been organized as follows. Section 2 presents the Problem description. In Sect. 3, a brief description for the methodology used in this paper. Section 4 discusses the experimental results obtained from the classifiers. Lastly, Sect. 5 concludes the work.

2 Problem Description

The dataset used in this study is obtained from Emerging Market Information Service (EMIS) for companies in Poland. The main problem in that dataset is the imbalance distribution. In other words, the Polish companies' dataset is vastly imbalanced; it contains 10000 records for companies, of which 203 records are for bankrupt companies, whereas the remaining 9797 are for solvent ones. In addition, it consists of 64 numerical variables. Accordingly, this extremely imbalanced distribution of the financial data makes it a challenge for any classifier in predicting companies' financial status. Furthermore, the Polish companies' dataset considered in this work in order to measure the performance of bagging and boosting ensemble classifiers concluding the best type to solve companies financial status forecasting problem.

3 Methodology

Basically, the classical machine learning algorithms can be categorized into two broad groups, which are standard classifiers and ensemble classifiers. Thus, the standard classifier is defined as a single stand-alone machine learning algorithm that is devoted to solving various types of classification problems and can handle different types of data (i.e., Numerical and categorical) [16]. On the other hand, more recently, the researchers

realized that dividing the problem into several subproblems and using a combination of classifiers (i.e., ensemble classifiers) to solve them obtains considerably better results than the standard single classifiers [15]. In other words, the ensemble classifiers consist of several single classifiers, each one of those classifiers used to solve a part of the classification problem, finally, the results would be a combination of the outputs yielded from every classifier. Moreover, there are two major ensemble classifiers creating techniques, which are: bagging and boosting [15]. More details about them are in the following subsections.

3.1 Bagging Ensemble Classifiers

Also known as bootstrapping, is an ensemble classifier-creating technique which splits the original dataset into several subsets (bootstraps), then train and test the base learners using each one of those subsets parallelly. Finally, obtain the results from the ensemble by aggregating the yielded results by each of the base learners.

In this paper, three well known classifiers considered as bagging ensembles have been utilized to predict Polish companies' financial status.

Ensemble Support Vector Machine (SVM) [11] is a powerful popular machine learning algorithm, adopted to solve binary classification problems. The main procedure of SVM is to find the hyperplane that maximizes the margin between the binary classes in the feature space. **Ensemble Naïve Bayes** [18] is a classical well-known probabilistic classification algorithm. Naïve Bayes considers the probability of each attribute in the feature space is detached from the others, and use those independent probabilities in order to assign the class attribute for the test instances. **Ensemble K Nearest Neighbors (KNN)** [12] is a simple straight-forward classifier, based on the distribution of the training dataset, its simplicity came as a reason of its requiring to a little or no prior knowledge about the distribution of the data. KNN keeps the training dataset as it is and calculate the all distances between each record in it and each record in the test set, then assign each test set instance class depending on the majority voting of the nearest samples in the training dataset. In other words, the KNN classifier is based on the nearest instances classes, each instance in the test set assign the class of nearest instances in the training set depending on the value of K. Thus, if the value of $K = 1$, the class of the nearest instance will assign to the required record, also, the value of K must be odd to avoid the problem of the equality of the instances amount labeled with the same class.

3.2 Boosting Ensemble Classifiers

It is the other major ensemble classifier creating technique. Basically, it is a sequential approach that set initial weights for the whole instances in the dataset, and use this dataset to train and test the base classifier. Furthermore, the weights of the misclassified instances will be increased to give the classifier a higher ability in the next stage of the approach to recognize the potential classification mispredictions, thus, avoid them in the next classification cycle. The final results are normally obtained using weighted majority voting [13].

Accordingly, two boosting ensemble classifiers have been devoted in this work to anticipate Polish companies' financial status. **Adaptive Boost (AdaBoost)** is a boosting

ensemble classification algorithm. The base learner in AdaBoost is the decision tree algorithm. In the first iteration, the weights are equally assigned to each instance in the dataset, and then it will gradually increase for the misclassified instances in the remaining iteration [13]. **Extreme Gradient Boosting (XGBoost)** is a new powerful ensemble machine learning algorithm. Classification and Regression Trees (CART) are used as base learner. In addition, the sum of all CARTs score is considered as the final result [10].

4 Experimental Results

This section discusses the approaches devoted to predicting Polish companies' financial status, i.e., ensemble KNN, ensemble NB, ensemble SVM, AdaBoost, and XGBoost). As stated before, the Polish companies' dataset is vastly imbalanced, which affects the behavior of the classifiers in solving the problem; the classifier will constantly predict the solvent companies and avoid the bankrupt ones. But despite this, the accuracy metric value obtained from the classifiers will be very high, which means that the results are not reliable. Thus, to avoid the inconsistent data distribution, two advanced data balancing techniques adopted to process the dataset before utilizing to train and test classifiers, namely:

1. Synthetic Minority Oversampling TEchnique (SMOTE)[9]: it is an oversampling technique that generate new synthetic minority samples depending on the existing ones.
2. Synthetic Minority Oversampling TEchnique with Edited Nearest Neighbor (SMOTE-ENN) [6]: it is a hybrid (Oversampling-Undersampling) technique uses SMOTE to generate new synthetic minority instances, and ENN to eliminate the groups of instances that contain one instance belonging to the minority class, and the majority of its neighbors belonging to the majority class.

Moreover, as aforementioned, the accuracy metric does not provide a considerable measure of the classifiers' real performance in processing the imbalanced datasets. Accordingly, more metrics are adopted to evaluate the performance of the classification algorithms stated as follows [3]:

- Recall: shows the performance of the classifiers in predicting bankrupt companies.
- Specificity: shows the performance of the ensemble classifiers in predicting the solvent companies.
- Type I error: shows the performance of the classifiers in mispredicting the solvent companies.
- Type II error: shows the performance of the classifiers in mispredicting the bankrupt companies.

Furthermore, scikit-learn [17] library used in python to implement the bagging and boosting machine learning algorithms with 10-fold cross-validation.

4.1 Bagging Ensemble Classifiers with Advanced Data Balancing Techniques

As the data imbalanced distribution problem leads the classifiers to proceed undesirable behavior, which is predicting always the solvent companies and ignoring the bankrupt

one, SMOTE and SMOTE-ENN adopted to process the dataset before using it to train the classifiers. As shown in Table 1, the ensemble NB classifier performs very poor performance in anticipating Polish companies financial status; it tends to predict the bankrupt companies at the expense of solvent ones. Furthermore, all of the other ensemble classifiers yields very good accuracy and excellent recall values, which means that all of them show a great performance in forecasting bankrupt companies. KNN-SMOTE ENN is the superior in forecasting bankrupt companies with the highest recall and lowest type II error value. However, there is a noticeable variance between the approaches performance in predicting solvent companies. SVM-SMOTE performs the worst performance according to specificity and type I error values. Moreover, KNNSMOTE ENN obtains the optimal performance in forecasting solvent companies.

Accordingly, with respect to the results obtained from the bagging approaches, we can conclude that almost all of the approaches show a great performance in anticipating the financial status of Polish companies; KNN-SMOTE ENN is the best, whereas NB-SMOTE is the worst.

Table 1. Bagging ensemble classifiers results.

Classifier	Accuracy	Recall	Specificity	Type I error	Type II error
NB_SMOTE	0.5531	0.953	0.1532	0.8468	0.047
NB-SMOTE ENN	0.5799	0.9555	0.1517	0.8483	0.0445
SVM-SMOTE	0.8654	0.9683	0.7625	0.2375	0.0317
SVM-SMOTE ENN	0.9015	0.9838	0.8076	0.1924	0.0162
KNN-SMOTE	0.945	0.9996	0.8904	0.1096	0.0004
KNN-SMOTE ENN	0.9724	0.9999	0.941	0.059	0.0001

4.2 Boosting Ensemble Classifiers with Advanced Data Balancing Techniques

As stated in the previous section, SMOTE, and SMOTE ENN have been used used to process the dataset as a preprocessing stage before using it to train and test boosting classifiers (i.e., AdaBoost and XGBoost). As shown in Table 2, all of the boosting approaches obtain outstanding results in anticipating the financial status of companies. The accuracy of all of them is greater that 96%. Moreover, XGBoost-SMOTE ENN is the superior boosting approach in anticipating the financial status of companies compared to the other boosting approaches; it shows the most favorable performance in predicting bankrupt companies (highest recall), and solvent companies (the least type I error). However, AdaBoostSMOTE shows the lowest performance regarding predicting companies financial status; it attains the lowest accuracy, recall, specificity, and the highest type I and II errors compared to the other boosting approaches.

Table 2. Boosting ensemble classifiers results.

Classifier	Accuracy	Recall	Specificity	Type I error	Type II error
ADABOOST-SMOTE	0.9638	0.9781	0.9495	0.0505	0.0219
ADABOOST-SMOTE ENN	0.9732	0.9846	0.9603	0.0397	0.0154
XGBOOST-SMOTE	0.9876	0.9988	0.9765	0.0235	0.0012
XGBOOST-SMOTE ENN	0.9897	0.9989	0.9822	0.0207	0.0011

4.3 Bagging Ensemble Classifiers vs Boosting Ensemble Classifiers

Based on the previous sections, it is not hard to recognize the type of ensemble machine learning algorithm that shows better performance in anticipating the financial status of Polish companies. Figure 1 illustrates the accuracy metric values obtained by the bagging and the boosting classifiers. As shown in the figure, bagging Naïve Bays approaches shows very poor performance in anticipating the financial status of Polish companies. However, all of the remaining bagging and boosting approaches obtain excellent accuracy values, thus, yielding great performance in predicting Polish companies financial status with the superiority for boosting approaches. More precisely, Fig. 2 illustrates the performance of bagging and boosting classifier in predicting solvent and bankrupt companies individually. Thus, it is obvious that all of the boosting and bagging ensemble classifiers yield very significant performance in predicting Polish bankrupt companies with superiority for boosting ones. On the other hand, it is not the same regarding forecasting solvent companies. As shown in Fig. 3 there is an obvious difference between bagging and boosting classifiers with respect to the solvent companies mispredicting

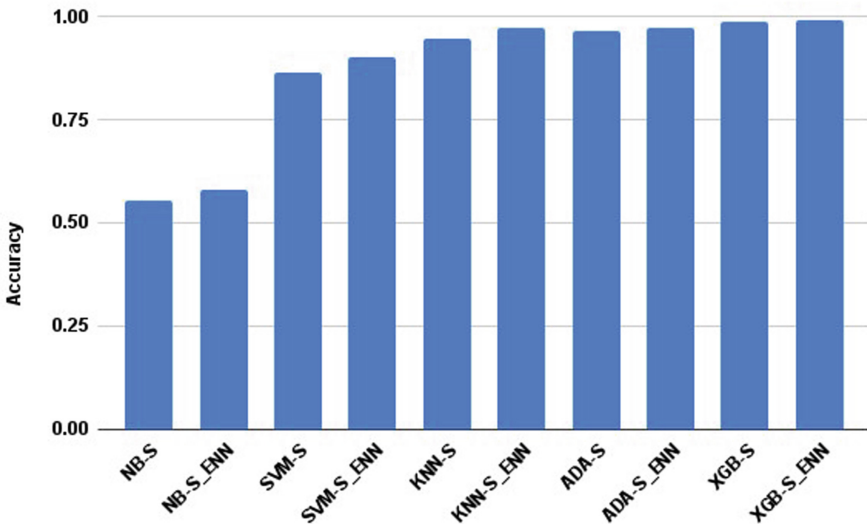


Fig. 1. Accuracy obtained by bagging and boosting classifiers.

rate. Here the boosting classifiers show noticeably better performance in anticipating the financially stable Polish companies.

Accordingly, a firm inference extracted from the boosting and bagging classifiers applications on the data of Polish companies, boosting classifiers (i.e., AdaBoost and XGBoost) outperform the bagging classifiers (i.e., Ensemble NB, ensemble SVM, Ensemble KNN) with respect to predicting Polish companies financial status.

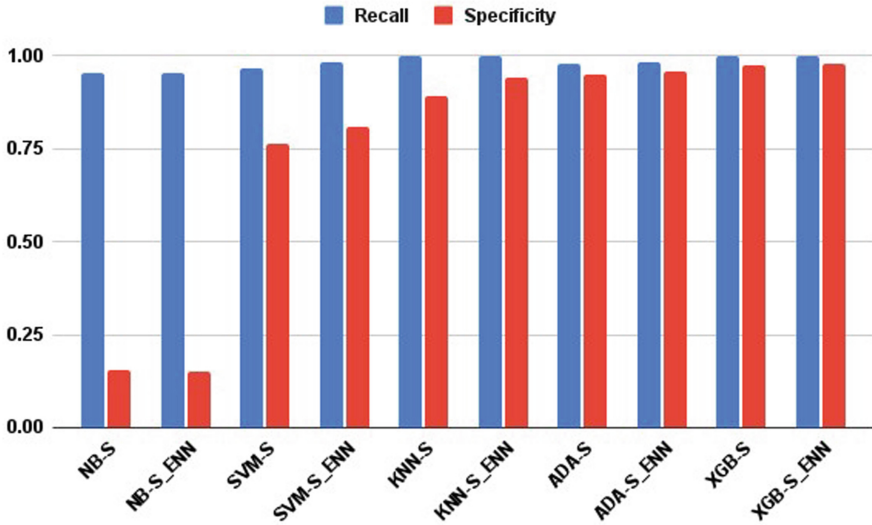


Fig. 2. Recall and Specificity obtained by bagging and boosting classifiers.

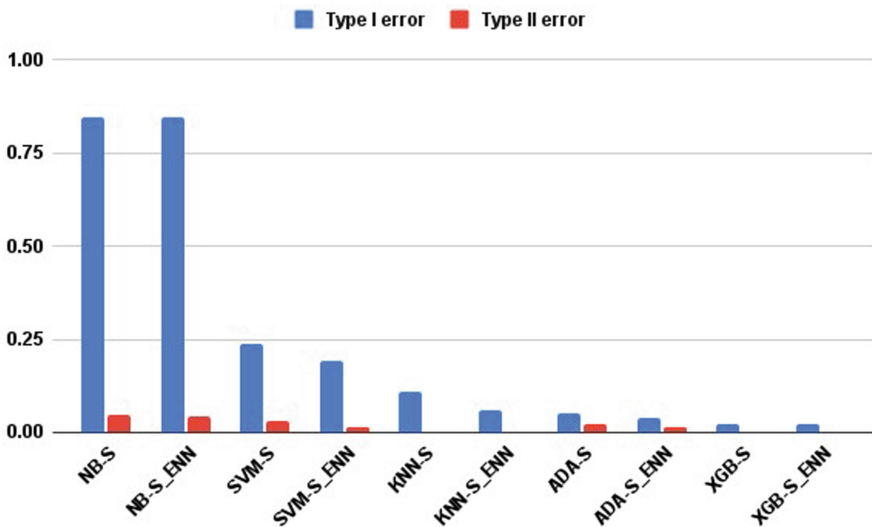


Fig. 3. Type I and type II errors obtained by bagging and boosting classifiers.

5 Conclusions and Future Work

In this work, three bagging classifiers (i.e., ensemble SVM, ensemble Naïve Bays and ensemble KNN) and two boosting classifiers (i.e., AdaBoost and XGBoost) have been devoted to forecast the financial status of Polish companies. Moreover, the real Polish companies' dataset considered in this work is extremely imbalanced; 98% of its records are for financially sound companies. Thus, to address the issue of data imbalanced distribution, two advanced data balancing methods have been used (i.e., SMOTE and SMOTE ENN). Furthermore, while the accuracy doesn't provide a reliable evaluation for the classifiers in processing imbalanced data, four other metrics were adopted (i.e., recall, specificity, type I error and type II error). Accordingly, as stated in the evaluation metrics values, each and every bagging and boosting ensemble classifier show a strong success in predicting the bankrupt companies, but with superiority for the boosting classifiers. However, regarding to predicting the financially sound companies, Naïve Bayes show very poor performance compared to the other bagging classifiers.

In addition, XGBoost-SMOTE ENN outperformed all of the other bagging and boosting classifiers in predicting Polish companies' status. In other words, the boosting approaches provide a robust alternative to predict companies' financial status in data with an extremely imbalanced distribution. In future work, deep learning algorithms can be considered as ensemble models, and used to predict companies' financial status. In addition, more real datasets can be considered in order to present a more realistic and precise evaluation of the ensemble classifiers.

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The Effect of Automated Teller Machines and Broadband on Bank Profitability: Evidence from Southeast European Countries

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Abstract. The rapid expansion of information technology – (IT) has affected the dynamism of all activities in every sphere, where even the financial industry is accommodating their services efficiently. Therefore, the focus of this research is to investigate in an econometric sense the factors of IT and certain specific factors of the banking industry, and how they influence the profitability of banks for the countries of Southeast Europe - (SEE). To overcome these challenges, the study used a hybrid technique, employing Random, Fixed, and Arellano-Bond estimations on panel data for 13 countries from 2006 to 2021. The findings confirm that automated teller machines (ATM), broadband subscriptions (BBS), telephone subscriptions (TS), and capital adequacy ratio (CAR) have a strong positive effect on bank profitability in SEE economies, while non-performing loans (NPLs) have a negative significant effect. The novelty and scientific contribution of this research is that it comprises data from recent years, an econometric approach, and a variable combination that differs significantly from previous studies.

Keywords: Banks’ indicators · broadband · telephone subscription · GMM

1 Introduction

Performing business in today’s dynamic global economy and the expanding trend of information technology needs appropriate international capabilities. Against this dynamic situation, the banking industry has not been able to be indifferent and act with the services of traditional banking, but this industry has reacted proactively by integrating its products and services through strategies that they have designed to be in trend with the development and to be in step with the global competition. The competitive environment in all areas, particularly the banking industry, has stimulated management and leadership structures to recognize the importance of innovations, particularly technological features and the application of their advantages in banking management. Commercial

banks can improve conventional banking operations by transitioning to modern banking, offering innovative products and services, reducing operating costs, and improving service efficiency by utilizing financial technology [22]. To effectively integrate these innovations, banking institutions should establish a credible management system with competent human capital to design and implement transformation strategies through the use of sophisticated information technology such as ATMs, e-banking services, etc. The architecture known as information networks, broadband, and telephone subscription must also be provided to perform modern banking services. Koutroumpis [14] discovered that the implementation of information networks has a direct effect on the performance of activities in the modern economy, where businesses utilize them to enhance services effectively.

As a consequence, the core aim of this study is to recognize the effect of the variables automated teller machines, broadband & telephone subscription, capital adequacy, and NPLs on bank profitability in SEE economies. A priori, in pursuit of this objective, the study has outlined a few research problems, such as: a) does the setup of ATMs influence bank profitability, b) fixed broadband subscription has an advantageous influence on bank profitability, c) does telephone subscription positively influence profitability, d) did capital adequacy requirements affect bank profitability and e) did NPLs harm bank effectiveness. This study intends to contribute to the development of new quantitative evidence for SEE economies by taking a unique approach to the treatment of bank profitability. The research methodology also employs a unique econometric approach with panel data for SEE economies, combining random, fixed, and Arellano-Bond estimation throughout the period 2006–2021. The dynamic panel data model is inspired by the author's Le and Ngo, [15], as well as Shuli, Yangran, and Yong, [19]. The research is conceptualized, beginning with the background of the literature, and moving on to econometric analysis, findings, and conclusions.

2 Theoretical Background and Hypotheses of the Study

This section will explicitly concentrate on evaluating extensive research on the domain of financial innovations. Throughout recent years, the expansion of sophisticated fintech has transformed into a serious challenge in the offering of banking services at the global level, including for SEE economies. The examination and measurement of profitability in the financial industry are tightly regulated by guidelines and special regulatory requirements proposed by the Bank for International Settlement, as well as directives issued by the European Central Bank, as given by the Central Banks within the country that oversees the safety and stability of this industry through net interest margin (NIM), return on equity (ROE), and return on assets (ROA). In the framework of scientific research, practically all of them have employed proxies such as NIM, ROE, and ROA research, which is regarded as the most accepted measure of bank profitability [1, 4, 6, 10] and [20].

From an academic perspective, numerous research has attempted to determine the influence of IT-based banking services on profitability and have initially found ambiguous evidence of their effect. Certain of the early research throughout this context argued for a positive association [7, 23], although there is research that challenges the arguments

for a negative association [2, 18]. The justification for promoting the application of IT in these services lies in the fact that investments in IT provide moderately low risk, also a high return in ROA. As a result, several revisions on the effect of ATMs on bank performance have already been conducted. Holden and El-Bannany [12] used data from banks in the United Kingdom of England to reveal that the utilization of ATMs by banks had a positive influence on ROA. Similarly, the researchers Valverde and Humphrey, [21] found that ATMs and electronic payments had a beneficial association in decreasing operating expenses by more than 30 % compared to their asset value in examining 11 European economies. In support of these arguments, the installation of ATMs, as well as other connecting products such as points of sale (POS) significantly affect profitability [15]. Towards the vein of previous research, our investigation proposes the following hypothesis:

H₁: The installation of ATMs from banks positively affects the return on assets.

On the other side, the infrastructure required for the digitalization of services, especially broadband and telephone subscriptions, is essential. Those authors who strongly support the outlook and argue that fintech boosts bank productivity and reduces overhead costs are [9, 23] and [8]. Those arguments are indeed reinforced by the scholars Iddrisu, Yindenaba, and Banyen, [13], who identified the components of broadband and mobile phone as Fintech₁ and Fintech₂, where based on their findings a strong connection between them is argued. In light of these discoveries, the research paper proposes two additional hypotheses:

H₂: Broadband subscription positively affects the return on assets.

H₃: Telephone subscription positively affects the return on assets.

In the context of this study, the factors considered particularly towards banks were capital adequacy and NPLs. Spahiu [20] determined that the quantity of capitalization has a major favorable influence on the stability and profitability of banks after evaluating the context of capital requirements and compliance with the legislative acts that supervise this matter. Inappropriate risk assessment of placements might result from NPLs. Non-performing loans harm a bank's profitability in this context. The latest study by Phung, Van Vu, and Tran [16] examining banks in the United States from 1994 to 2018 discovered an adverse connection between bank efficiency and non-performing loans.

3 Econometric Analysis

Our sample size for the study covers thirteen (13) Southeast European economies (Albania, Kosovo, Moldova, Bulgaria, Croatia, Hungary, Bosnia and Herzegovina, Montenegro, Greece, North Macedonia, Slovenia, Romania, and Serbia), with an aggregate of 208 observations throughout 2006 until 2021. The data utilized in this investigation include panel information (e.g., 13 SEE economies) from respectable databases such as the World Bank, Economic Research Source, and the International Monetary Fund. The data is processed and formatted as coefficients before being employed in the econometric technique via RE, FE, and Arellano-Bond. Model construction or modification is regarded as one of the most difficult challenges for academics, we constructed our version of the authors [15] and [19]. As a result, the applied empirical evidence is combined, with a particular emphasis on individual effects due to our panel data. Thus, the focus

is on understanding the impact of ATMs, broadband, telephone subscriptions, as well as bank-specific factors on ROA. The presentation of the RE and FE equations, in our instance, the reason for the scope of the paper, in the editing rules, will be incorporated into the Arellano-Bond paradigm, thus the basic equation is as follows:

$$Y_{it} = \sum_{j=1}^r \varphi_j Y_{i,t-j} + X_{i,t} \beta_1 + w_{it} \beta_2 + \pi_i + \epsilon_{i,t} \quad (1)$$

Considering our scenario, the equation is expressed as:

$$\text{ROA}_{i,t} = \varphi + \mu(\text{ROA})_{i,t} + \beta_1(\text{ATM}_{i,t}) + \beta_2(\text{BBS}_{i,t}) + \beta_3(\text{TS}_{i,t}) + \beta_4(\text{CAR}_{i,t}) + \beta_5(\text{NPL}'_{s_{i,t}}) + \pi_i + \epsilon_{i,t} \quad (2)$$

4 Econometric Findings

The following part will go over the initial results, beginning with descriptive statistics and advancing to correlation analysis. The very first results of this research back up the hypothesis that all SEE countries have a financial system, specifically a banking industry, with a positive return on assets. This is confirmed by the fact that the mean value of the ROA is 0.79 %, with a standard deviation of 1.33 %. The variable automated teller machine (ATM), which has been recognized as innovative in the banking industry, has a mean coverage value of 60.48 per 100,000 inhabitants in the SEE countries. The variation between minimum and maximum cover spans from 6.74 to 156.79 ATMs per 100,000 inhabitants. Meanwhile, two other variables that are crucial for the development and promotion of electronic banking broadband subscription and telephone subscription have an average value of 19.18, respectively 28.23 per 100,000 inhabitants. The mean capital adequacy ratio in SEE economies is 9.69 %, with a standard deviation of 2.39 %. This indicates that banks are adequately funded, and the latest variable non-performing loans had an average value of 10.69% of total loans with a standard deviation of 7.51%. This conclusion suggests that banks should focus on tighter credit risk management (see Table 1).

Table 1. Descriptive statistics

	ROA	ATM	BBS	TS	CAR	NPL's
Obs	208	208	208	208	208	208
Mean	0.794	60.484	19.182	28.234	9.697	10.689
Std.D	1.332	28.106	9.582	11.529	2.391	7.511
Min	-9.530	6.746	0.329	6.109	-1.261	1.064
Max	4.638	156.797	41.562	55.166	16.261	45.572

Source: Author's calculations

Taking into consideration that the data used in this analysis are cross-sectional (panel statistics) for 13 SEE countries with a total of 208 observations, it is necessary to perform some preliminary tests before performing the econometric approaches. The multicollinearity was examined employing correlation breakdown, followed by an additional test via the vector inflation factor. Correlation measurement was used to determine the level of correlation across ROA as a predicted variable and ATM, BBS, TS, CAR, and NPLs as independent variables.

Table 2. Correlation matrix

	ROA	ATM	BBS	TS	CAR	NPL's
ROA	1.0000					
ATM	0.3161	1.0000				
BBS	0.1171	0.3840	1.0000			
TS	-0.3706	0.4432	-0.2244	1.0000		
CAR	0.3891	0.1174	0.0617	-0.2361	1.0000	
NPL's	-0.3399	-0.0098	0.1369	0.2392	0.0593	1.0000

Source: Author's calculations

Table 2 reveals that ROA has a favorable interaction with ATM, BBS, and CAR. Nevertheless, there is an inverse association between TS and NPLs. Furthermore, the interactions between the variables are shown in Table 2. In terms of multicollinearity, it is noticed that no variable included in the research has a value of more than 0.5, providing adequate proof that the data is not concerned with multicollinearity [17]. This argument is confirmed by the VIF outcome, which has an arithmetic mean of 1.31. The Hausman test was employed to choose from RE and FE based on the model's validity and stability. The premise (H_0) according to this assumption is that if the ρ -value is important ($\rho = 0.01$), then the adequate model is a RE, if the ρ -value is greater ($\rho \geq 0.01$) then (H_a) is used, which means that the adequate model is a FE. Hence based on a value of $\chi^2(2) = 17.49$ with $\rho = 0.1870$, the acceptable model is a FE.

Upon the selection of the model, the F -test value is computed, which based on the FE model is $F = 13.45$ with probability $\rho = 0.000$, indicating that all of the variables employed in the research have constants less than 10, which is a supplementary diagnostic on the analysis's stability. In our scenario, R^2 has a coefficient of 0.5301 or is articulated differently than the variables involved in the model, which explains 53.01 % of the return on assets, although the remaining portion is explained by variables that weren't included in the research. As well, to discover whether the panel data is concerned about heteroscedasticity, the Breusch-Pagan/Cook-Weisberg test was used, and the output of this testing, $\chi^2 = 0.1103$, provides sufficient evidence that the data do not have problems with heteroscedasticity. The Arellano-Bond model was employed as the third model to evaluate the degree of effect of the predictor variable on the return on assets for the SEE banking system. The outcome of wald $\chi^2(2) = 131.37$, with $\rho = 0.000$, indicating that the examination using this approach is sufficient. The Sargan J -test was employed to

analyze the validity of the instruments, and the probability value is $\rho = 0.1604$, proving that if the value is insignificant, the instruments in this evaluation are appropriate (see Table 3).

Table 3. Empirical results

	Random Effect		Fixed Effect		Arellano-Bond	
	β	Sig.	B	Sig.	β	Sig.
ATM	.01671	0.000	.00814	0.009	.04008	0.000
BBS	.00609	0.552	.02550	0.080	.00292	0.043
TS	.00227	0.843	.00044	0.983	.04205	0.028
CAR	.28168	0.000	.34156	0.000	.42897	0.000
NPL's	-.06804	0.000	-.07141	0.000	-.07113	0.000
_cons	-.14596	0.795	-.78469	0.382	-1.3855	0.082
Screening tests						
F-test	“_”	“_”	13.45	0.0000	“_”	“_”
Wald chi2	87.78	0.0000	“_”	“_”	131.37	0.0000
R-sq	0.6817	“_”	0.5301	“_”	“_”	“_”
χ^2 -test	41.50	0.1103	“_”	“_”	“_”	“_”
VIF Mean	1.31	“_”	“_”	“_”	“_”	“_”
Sargan J- test		“_”	“_”	“_”	76.786	0.1604

Source: Estimates by the author's

Employing ROA as a profitability metric, the outcomes provided in our scenario reveal that ATMs proved to have a significant positive influence on the profitability of the banking system for SEE economies in both simulations. The threshold of statistical significance is 1 %, which implies that for every increase in the number of ATMs, the degree of profitability increases by 0.81 percentage points based on FE and 4 percentage points based on the Arellano-Bond estimation. This finding confirms the first hypothesis and is consistent with the research's expectations. The outcomes of this study are in light of the study performed by [15] which investigated 23 economies from 2002 to 2016 using GMM estimation. Their results suggest that ATMs and points of sale (POS) influence bank improvement and profitability. Similarly, research conducted in the UK banking system by authors Holden and El-Bannany, [12] reveals that the installation of ATMs by banks has a positive effect on their profitability. In a similar vein, Valverde and Humphrey, [22] discovered, after researching 11 European countries, that ATM and electronic payments have affected up to 30 % of bank operational cost reduction, which is reflected in better financial performance.

The next variable examined in this study is BBS, which is considered to be vital in terms of the expansion of information technology, and this component has proven to be positively significant at a level of 1 % to the predicted variable return on assets

for SEE economies. These data validate hypothesis 2. Through both simulation models, the implications effect was represented with a coefficient of .02550 in FE and .00292 in Arellano-Bond. Therefore, this indicates that each increase in the BBS variable increases ROA by 25.5 percentage points according to FE and 2.92 percentage points according to Arellano-Bond. The study's results are supported by those of the authors Shuli *et al.* [19], who contended that the rapid expansion of information technology has a positive influence on bank profitability by analyzing China's banks. Koutroumpis, [14] discovered from an analysis of OECD countries that information networks have a positive influence on the modern economy, where the financial industry leads to an improvement by integrating their services. However, telephone subscription has resulted in a significant positive effect with a significance level of 1 % in the ROA ratio, and that only according to the Arellano-Bond evaluation, while in the fixed effect regression, it has proven to be insignificant. Based on Arellano-Bond, the outcomes of the third examined variable validate and confirm the third hypothesis. This result corresponds with the findings of a study conducted by authors Del Gaudio, Porzio, Sampagnaro, and Verdoliva, [3], who explored 28 EU countries and discovered that technology communication tools (telephone, ATMs, and ICT diffusion) affect bank profitability and stability over the period 1995–2015. Bank capital is one of the key arteries for providing efficient funds, and regulatory authorities focus attention on it. CAR in our scenario paradigm had a significant positive influence on the two applied measures (FE and Arellano-Bond) with a significance level of 1 %. As indicated by the coefficients ($\beta = .34156$ FE and $\beta = .42897$ Arellano-Bond). The outcomes of this study are consistent with predictions thereby verifying the hypothesis stated, they are also consistent with the findings of the author Chandrasegaran, [5] who contends that CAR has a constructive influence on bank profitability.

In addition, as demonstrated by the coefficients ($\beta = -.07141$ FE and $\beta = -.07113$ Arellano-Bond), the last variable, NPLs, has exerted a considerable negative influence on ROA. This indicates that any increase in this proportion has a detrimental influence on the profitability of SEE banks. This outcome is constant with the stated premise and expectations.

5 Conclusion

The investigation concentrates on the opportunities presented by the advancement of IT, as well as certain special factors of the banking business, and the influence they have on the bank's profitability in SEE economies. The uniqueness of this research is that it presents the treatment problem in the context of explicit factors that affect aspects of IT and examines their influence on the banking sector. Additionally, the study covers 13 SEE economies from 2006 to 2021 and employs a hybrid technique in terms of variable composition as well as an econometric approach using RE, FE, and Arellano-Bond estimation.

The current findings contend that the banking systems of SEE economies are appropriately financed and have an average positive return. Nevertheless, in terms of IT innovation adoption, all countries have a reasonable level of coverage with ATMs, broadband, and telephone subscriptions, which are innovations and have been officially declared

Fintech innovations. Based on the offered hypotheses, all hypotheses were validated at a 1 % significance level, arguing that: a) ATMs, BBS, TS, and CAR had a positive effect on bank effectiveness in SEE economies, b) whereas NPLs have a significant negative effect. In light of these findings, it can be concluded that regulatory authorities as well as financial industry management should focus their attention on the issue of credit risk and capital management, whereas governmental regulatory authorities might also focus on the maintenance and expansion of continuous infrastructure for investments in information technology.

Finally, since this investigation is particularly important for the banking industry, it does not preclude non-financial companies from using the findings to implicate their products and services. It is proposed that in future research, more factors connected to IT be used, as well as some more advanced econometric methodologies.

The STUDY's Research Implications

Based on the study's findings, we can conclude that policy-making mechanisms can benefit significantly, implying policy redesign by the regulatory authority and the banks themselves. Supervisory bodies and the banking sector should develop policies that provide customers with efficiency, cyber security, and time management, which is considered very important when compared to traditional services. Additionally, reforms in the financial system should be created, such as infrastructure development for the entry of international financial institutions, which can bring new practices and approaches.

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Business Sustainability in Hypercompetitive Contexts

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Abstract. Markets are evolving from high competition to hypercompetitive formats, which means that competitive advantages are quickly engulfed by competitors and disseminated worldwide. Nonetheless, there is a source strong enough to create added value with a sustainable degree of lasting customer acceptance. However, to be able to exploit that source of competitiveness, it is necessary to change the current economic paradigm; it is indispensable to overcome the rational phase and work within the affective phenomena sphere. That is because both the goal businesses need to reach (becoming consumer's preference) and the elements to achieve it can only be found in what we know as the emotional dimension of life. Once that first premise has been accepted, it is necessary to establish the methodology to convert something not measurable by nature into something else manageable and able to be quantified objectively. After more than 20 years of research and empirical testing, the proposed model (Expansive Emotional Influence) has been able to help grow several businesses from different countries without the need for e-commerce, even in contexts such as the World Financial (2008) and the COVID-19 crisis.

Keywords: competitiveness · hyper-competition · emotion management · prestige · broad-listening

1 Introduction

The first step to facing the challenges of hypercompetition is to set the ultimate goal the enterprise has to reach. Once the *what* is set, it is necessary to determine the way it will be achieved; the *how*.

1.1 Ultimate Goal

The sole focus of an enterprise's brand is to work to become and remain a market reference. However, a brand must be the consumers' preference to do so. Therefore, once accepted that premise, the next step is to define how to reach the status of consumer preference. The durability factor deserves separate consideration, which is how long we want to maintain as a preference.

1.2 The How

Personal preferences¹ are part of the sphere of affective phenomena, which are radically opposed to rational phenomena. We are, therefore, under the dynamics of sentiments, emotions, which means that a brand will need to arouse the appropriate emotions in consumers to become their preference for which a brand has to generate a higher level of satisfaction than the competition.

Expectations. The first step in generating a high level of customer satisfaction is understanding the difference between needs and expectations (see Fig. 1: emotional Perception Scale.)

Once working with expectations and not only with needs is understood, enterprises face the real challenge because expectations are rarely made explicit. Contrary to needs, everything the customer specifies (rationally) expectations are what the customer really wants but does not make explicit. That is where the real difficulty of generating appreciated added value lies: how to know, in a systemic way, what is not made explicit.

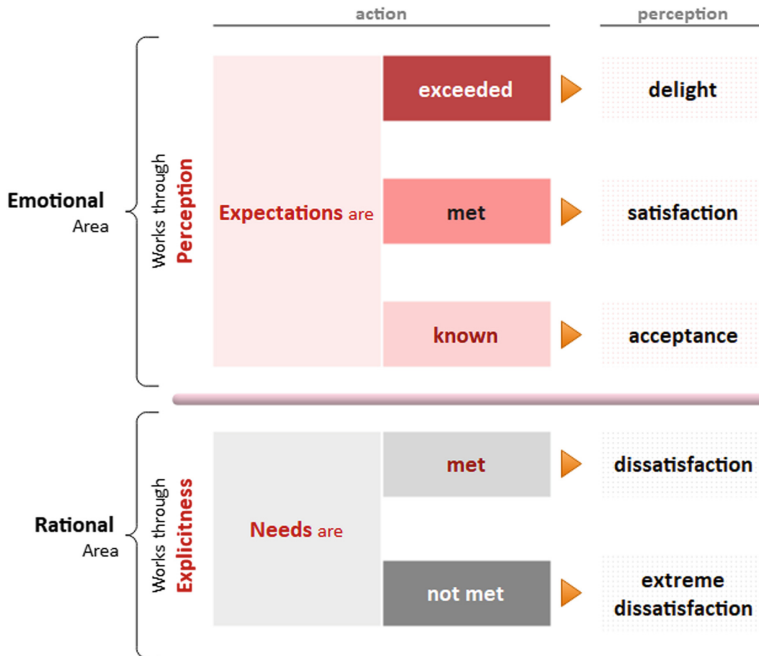


Fig. 1. Emotional Perception Scale

Beyond generating added value that is appreciated by consumers, if a brand wants to remain a benchmark in the long term, it must be able to create genuine emotional bonds with its consumers, which, in turn, will also require knowing their expectations.

¹ A preference is considered, according to K.R. Scherer, as “the stable evaluative judgments in the sense of liking or disliking a stimulus, or preferring it or not over other objects or stimuli.”.

2 Substantiation

The first ingredient of a customer's high satisfaction is the appealing capacity of the product offered by a brand. The foundations of product attractiveness are the following outcomes:

1. Competitive Costs—Ability to keep costs low compared with the competition.
2. Substantive Features²—Implies knowing customer expectations³ with the consequent innovation and the ability to introduce utilities,⁴ which have to be, at the very least, unique.

Hence, the *substantiation* method will consist of the ability to satisfy/exceed customer expectations⁵ by maintaining low costs.

In this article, I will focus on the systemic ability to know customer expectations and turn them into unique and strongly appreciated utilities.

2.1 Broad Listening

There are two ways to reach the real desires (expectations) of customers, data mining from metadata (or big data,) and listening to them (customers) in a broad sense.

Large corporations that can afford the cost of the first option may not need the second. But small and medium-sized enterprises that cannot afford the costs of managing meta-data need to work on the second alternative: broad listening.

In any case, the level of competitiveness that can be achieved by knowing the expectations of each customer in particular rather than the general way obtained from meta-data is significantly higher.

The broad listening option is the one we take for this study. To do so, we will develop a series of questions:

1. What is broad listening?
2. Do we need it?
3. Can we manage it?

What is Broad Listening? Broad listening is defined as a bi-directional one-to-one process of emotional nature aimed at becoming aware of an Individual's expectations managed by the person who wants to know the expectations of another, which is driven and constrained by the mutual perception of the people who interact.

Do We Need It? The listening process we use in everyday life—much less extensive and more simplified— does not allow people to get to know the expectations of the person with whom they are interacting, simply their needs. Consequently, a broader listening ability is necessary to get to know another Person's expectations, e.g., a Company's customers.

² When we refer to something “substantive” (in the context of this article), it is aligned to actual desires to make it profoundly and constantly appreciated by consumers.

³ According to the Emotional Perception Scale, expectations—the emotional area— must be differentiated from needs, which correspond to the rational area.

⁴ A utility is “a feature that serves to get something the customer wants.”.

⁵ The constant evolution of individuals' expectations is the primary reason for innovation.

Can We Manage It? The *broad listening* process can hardly be managed successfully⁶ if several premises are not met, such as (Fig. 2):

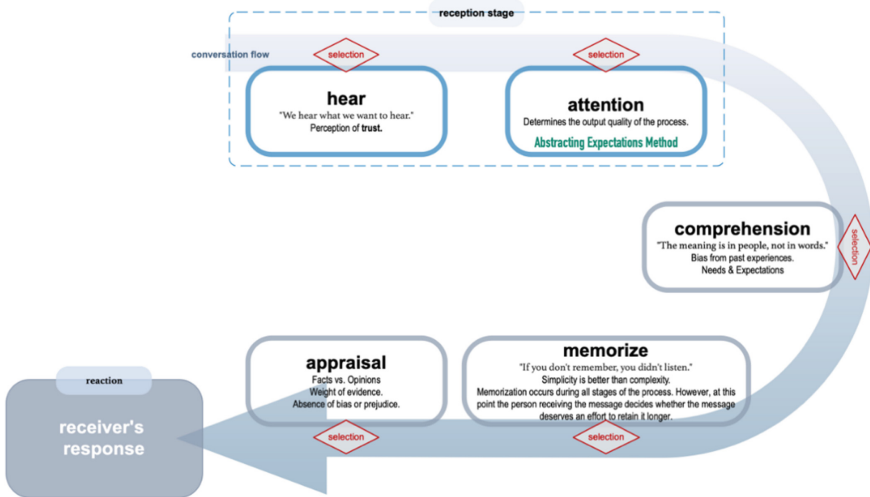


Fig. 2. Steps of the broad listening process.

1. Proper execution of all the steps of the process, which we often ignore.
2. Generate a sufficient perception of trust.

Learning all the steps of *broad listening* and executing them properly should not be a significant problem. However, generating a sufficient perception of trust is a major challenge for most people. That is because both the process and perception (trust) correspond to the emotional area, which means that specific behaviors are required from the person interested in knowing others’ expectations to produce that perception (of trust). Hence, it is necessary to design a specific method to effectively manage the *broad listening* process.

2.2 Broad Listening Engineering

We already know the steps of *broad listening*, so now we need to:

1. establish what is considered a correct execution of these steps, and
2. identify what individual qualities are required to generate a perception of trust, so the corresponding behaviors can be adopted.

Once the corresponding correlation matrix is built, it will be possible to determine the capacity to know the customers’ expectations (*bl*) (Table 1).

⁶ A successful management of the broad listening process occurs when the receiver’s response is an expectation.

Table 1. Correlation matrix to determine the broad listening capability.

<i>Lc & Tc</i>		Range of Values	
Low		1	
Medium		3	
High		9	
Listening Characteristics [Lc]	Lc Level	Tc Level	Trust Characteristics [Tc]
Hear [1]	<i>Lc1</i>	<i>Tc1</i>	Positivity [1]
Attention [2]	<i>Lc2</i>	<i>Tc2</i>	Primary Balance [2]
Comprehension [3]	<i>Lc3</i>	<i>Tc3</i>	Self-control [3]
Memorize [4]	<i>Lc4</i>	<i>Tc4</i>	Self-confidence [4]
Appraisal [5]	<i>Lc5</i>	<i>Tc5</i>	Broadmindedness [5]

$$bl = \frac{(\sum^L c + \sum^T c)}{90}$$

The sender's capability to perform the broad listening process is measured by means of two variables: Listening Characteristics and Trust Characteristics. The value of Listening Characteristics (*Lc*) will be the addition of the *Lc* value for each step of the process. The value of Trust Characteristics (*Tc*) will be the addition of the *Tc* value for each characteristic.

The sender of a broad listening (*bl*) interaction is the person who wants to know other's expectations; hence, the one who steers the process and, consequently, the person who "sends" the emotional energy to the interlocutor (receiver,) generating a perception of trust.

The broad listening (*bl*) capability will be a ratio, where 1 is the superior value.

Knowing a person's ability to execute the *broad listening* process (*bl* index), we can determine the quality of the characteristics obtained and, thus, the level of the substantive feature generated and, therefore, the level of customer satisfaction able to be achieved.

Abstracting Expectations. The "voice of each customer," from which we will extract the expectations, will be processed in a format that allows further analysis.

The below table shows the column EPW, which indicates the *emotional perception weight* of the customer's voice. Adding the values assigned to each expectation will allow us to know the emotional weight of each expectation, from which we will be able to order them according to their relevance (Table 2).

Below are two examples of the action of *broad listening* (Table 3).

People with a *broad listening* ability (*bl*) of 0.10 were able to extract the expectations and utilities shown below (Tables 4 and 5).

Table 2. Model of data gathering to deploy the *broad listening* method.

Attending	Age	Year	Month	Origin	Request	Extended	EPW	Expectation
Patri	35–47	2020	1	Alcoy	Información de comunión,		9	información efectiva
Patri	35–47	2020	1	Alcoy	Queremos unas cuantas fotos de comunión, para tener el recuerdo, algo sencillo	hemos mirado la web aunque solo hemos visto bodas	9	información efectiva
Patri	35–47	2020	1	Alcoy	Quiero información para las fotos de comunión de mi hija,	cuando mi hijo fuimos a Agres (con otro fotógrafo) y me gusta como queda en exterior, pero me da igual el sitio,	9	información efectiva
Patri	< 35	2020	1	Miramar	Para sesión de new born, queremos saber si puede venir un perro,	porque en otros sitios nos han dicho que no	9	información efectiva
Jordi	< 35	2020	2	Desconocido	Habíamos pensado en hacer una sesión ahí en el estudio con dos o tres modelitos distintos, traerá muchas fotos	vosotros tenéis algún escenario bonito?	9	información efectiva
Patri	35–47	2020	5	Valencia	Hay que publicar cada cambio que se haga en el negocio		9	información efectiva
Patri	35–47	2020	6	Albaida	quiero que me informes de las opciones	para comentarlas con otra persona	3	información efectiva

(continued)

Table 2. (continued)

Attending	Age	Year	Month	Origin	Request	Extended	EPW	Expectation
Patri	< 35	2020	6	Ibiza	Dime las opciones que pueden ser		9	información efectiva
Toni	35–47	2020	7	Altea	Soy Antonio de Altea. Tengo a mi mujer embarazada y queríamos hacer un book	Necesitaría saber disponibilidad y precio	9	información efectiva
Toni	35–47	2020	7	Alcoy	em pots dir possibilitats		3	información efectiva
Patri	48–67	2020	9	Alcoy	Quisiera saber vuestra disponibilidad, ya hablé con Toni,		9	información efectiva
Toni	< 35	2020	9	Alcoy	qué tendría que traer ropa diademas o algo	por messenger	1	información efectiva
Patri	35–47	2020	9	Alicante	queremos información de como lo hacéis		3	información efectiva

Table 3. Calculation of the *broad listening* indicator = 0.10

	Listening Characteristics [<i>Lc</i>]	<i>Lc</i> Level	<i>Ec</i> Level	Trust Characteristics [<i>Tc</i>]
1	Hear	3	1	Positivity [1]
2	Attention	1	0	Primary Balance [2]
3	Comprehension	1	0	Self-control [3]
4	Memorize	1	1	Self-confidence [4]
5	Appraisal	0	1	Broadmindedness [5]
6	Outcome	6	3	
	<i>bl</i> :	0.10		

As can be seen, the expectations obtained with a *broad listening* ability of 0.1 correspond to a shallow emotional level on the Emotional Perception Scale. Providing reliable information about products (effective information,) knowing one's business well (job mastering,) or being able to offer the appropriate product for a gift (suitable gift) are pretty basic to every business.

Table 4. Expectations from $bl = 0.1$

Expectation	Count of EPW
effective information	43
job mastering	41
suitable gift	39
Grand Total	123

Table 5. Utilities from $bl = 0.1$

Utility	Sum of EPW
Product	281
Guide	49
availability	9
Grand Total	339

Source: Fieldwork carried out in Spanish stores, 2019–2023

As an inevitable effect, the utilities offered will also be perceived by customers as insubstantial, leading to a weak capacity for attraction and appreciation for the offer (Table 6).

Table 6. Calculation of the *broad listening* indicator = 0.40

	Listening Characteristics [Lc]	Lc Level	Ec Level	Trust Characteristics [Tc]
1	Hear	9	3	Positivity [1]
2	Attention	3	3	Primary Balance [2]
3	Comprehension	1	3	Self-control [3]
4	Memorize	1	1	Self-confidence [4]
5	Appraisal	3	9	Broadmindedness [5]
6	Outcome	17	19	
	bl :	0.40		

People with a *broad listening* ability (bl) of 0.40 were able to extract the expectations and utilities shown below (Tables 7 and 8).

Table 7. Expectations from $bl = 0.4$

Expectation	Sum of EPW
heartfelt brotherhood	451
recovering sensations	220
rooting happiness	204
perceived pride	200
emotional intensity	177
live fantasy	143
Grand Total	1395

Table 8. Utilities from $bl = 0.4$

Utility	Sum of EPW
core freedom	198
evoking happiness	172
friendship feeling	156
joy	118
common purpose	97
family moments	59
tradition	48
funny moments	27
Grand Total	875

Source: Fieldwork carried out in Spanish stores, 2019–2023

As can be seen, as opposed to the expectations obtained with a $bl = 0.1$ indicator, the expectations brought with a *broad listening* ability of 0.4 correspond to a high emotional level on the Emotional Perception Scale. Hence, the utilities offered will be perceived by customers as substantial, leading to a strong capacity for attraction and appreciation for the offer. Therefore, the ability to compete in extreme circumstances will be superior.

3 Conclusions

From the study presented, two major conclusions can be extracted:

1. The ability of a business to thrive in a hypercompetitive environment, generating double-digit profit margins, is directly related to developing a much higher level of listening skills than is common in our society.

2. This profound ability to listen is linked to the perception of trust that a person can generate, which, in turn, will depend directly on the person's habits. In other words, a person will only be able to achieve comprehensive listening if they understand which behaviors need to abandon and which they need to adopt.

This approach, which is part of a broader methodology,⁷ has been deployed over the last 20 years in more than 170 different types of business in several countries (Europe and Latin America, mainly,) having proven sufficient for the severe global crises that have occurred in this period not to have harmed the companies that decided to work on broad listening.

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⁷ The broad listening method is part of the Expansive Emotional Influence methodology developed by the author of this article.



On the Dependence of Drop-Out Rates on Cohort Size in Public Universities

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Abstract. We investigate the relationship between the number of graduates at a university for a particular year and the size of this cohort when they entered the University. We focus on publicly funded Universities in which student fees are heavily subsidized by the Government and hence finance plays a smaller role for applicants. In fact, in some countries, fees at Government funded universities have not changed over the last decade. If such universities, consider profit as their main objective then they may accept too many candidates, and this will lead to high dropout rates. However, since these Universities are publicly funded by their respective Governments, their objective should instead be to maximize the number of students that successfully graduate (sometimes called the Goodput of a process). We investigate this relationship and propose a simple model that we believe represents it. Note that we acknowledge that many other factors play a role, but our objective is simply to illustrate that, increasing the number of students may in fact cause a reduction in graduates. In fact, we see this in the many examples that we investigated.

Keywords: Optimization · Data Science · Decision Making · Education

1 Introduction

University tuition at private universities has been rising rapidly throughout the world [4]. However, in many countries, public Universities are funded by the Government and are restricted from increasing tuition. Such Universities may instead try to increase revenue (to offset rising teaching costs) by increasing the number of students they accept. This may be done by reducing admission requirements. We conjecture that such increased intake rates may result in higher drop-out rates and hence lower graduation rates. This stems from, (a) acceptance of less capable students (who may not have been admitted in previous years) and, (b) lower teaching quality because of the increased teaching loads.

We investigate this conjecture by studying incoming and graduating rates at sample Universities. Unfortunately, since drop-out rates are typically not provided, we assume that the number of graduates of a cohort minus the number that entered equals the number who dropped out. We propose a simple function that explains the relationship between graduates of a cohort and incoming size of the cohort. We use real data to demonstrate the accuracy of the proposed model.

2 Related Work and Contributions

Several studies have been conducted by universities in their effort to become more accountable while increasing both admission and graduation numbers. Most have focused on increasing admission and enrolment numbers instead of graduates since their objective is profit. Empirical approaches for these studies typically involve the development of different models based on regression analysis.

In the case of publicly funded universities targeted in this study, factors such as student fees and geographical location do not play a big factor when compared with private universities on which most studies have been focused. For private universities, one of the main ways to increase student enrolment entails reducing the academic standards required for admission [11]. Benefits to universities include being more open and providing opportunities to persons that may have been unable to meet previous admission requirements as well as increasing profits associated with higher admission numbers. However, to increase graduation numbers based on this new admissions model, the standards required to complete the degree must also be reduced leading to lower quality graduates. This negatively affects the reputation of the University.

In [6, 9] a strong correlation was found between lower graduation rates and decreasing the test score for new admissions whilst maintaining the same completion standards. A study done at the University of Hawaii suggested that efforts to raise admission selection criteria to maximize first year retention would diminish admission numbers between 19.2% and 25.3% for the years 1999 to 2001 [9]. In order to increase admission rates and maintain retention they propose an alternate assessment process that was better suited to “opportunity” admissions and a faculty review process.

While many studies focused on increasing profits, [16] attempted to create a better model that focuses on increasing success rates. A Dual Admission Model (DAM) using regression analysis based on student achievement data was used to determine a student’s success. This in turn was used to maximize student retention as the selection criteria was centred on the predicted GPA that would be obtained from students in their second year.

Research from [3] also studied post-entrance screening policies that have been used in some countries to balance initial enrolment and degree completion rates. A dynamic discrete choice model was developed where the enrolment outcome was uncertain. Though the admission policies for publicly funded universities vary for different countries within Europe [2, 8, 10], success was typically achieved through screening policies. Well thought out admission standards were found to lower the occurrence of unsuccessful new admissions whilst simultaneously leaving degree completion rates unaffected. More emphasis on matching new students to their right degrees showed greater promise of reducing drop-out and increasing degree completion.

The paper [14] emphasized the superiority of logistic regression over other methods. These models were also seen to perform relatively well for classification and prediction, providing good results [5] when compared to discriminant function analysis. Similar techniques have been used to predict student matriculation based on admissions data [7]. Although most of the studies mentioned are focused on student admissions and retention, the same methods can be applied to degree completion.

This paper seeks to contribute to a different perspective of university accountability where graduation rate is the primary objective. We demonstrate that graduation rates may in fact decrease as enrolment rates are increased. Therefore, one must balance profit (high enrolment rate) with education quality (low drop-out rate). We believe that Universities can use their available data to estimate the right balance and that the proposed model can help.

3 Proposed Mathematical Model

The proposed model can be applied at different levels within a university's hierarchy, at the University level, the faculty level and even the Department level. However, statistics at the lower levels are rarely made public so our examples will focus on the higher levels.

Consider a university in which N students are accepted for a school year. Naturally N will vary with entry requirements. The more stringent the requirements the smaller the value of N (lower acceptance rate). Therefore, as N increases (i.e., requirements become more relaxed) then the average quality of the student body decreases and hence the dropout rate will typically increase. This will hold true even if the student/teacher ratio remains the same (i.e., more staff are hired for the increased student intake). If the staff size has not increased, then the dropout rate is expected to increase even further since the resources per student will decrease. Hence, we expect the dropout rate to be a nonlinear function of the student intake, N . We propose a logistic function for this relationship and will provide support for this choice. We first demonstrate the approach using an illustrative example and then use real data to show that the model is valid in practice.

Let us consider a university with an intake of N students. We denote the dropout probability by $p(N)$ which means that the number of students who complete successfully is $N(1 - p(N))$. The function $p(N)$ depends on many factors and later in the paper we describe how this function, and its parameters can be estimated from historical data. As N increases, the intake will have a higher percentage of lower quality students (since we assume that the top candidates are made offers). This is the primary reason for the increase in $p(N)$ with N . Another reason is the diluted attention provided to students. If we assume that the teaching staff remains constant, then the student to staff ratio increases and hence less individualized attention results in lower student grades and hence increased likelihood of failing or dropping out. Consider the following logistic function for representing the dropout probability as a function of intake size:

$$p(N) = 1/[1 + e - ((N - a)/b)] \quad (1)$$

where $a > 0$ and $b > 0$, are parameters.

Note that when N is small $p(N)$ is small and as N goes to infinity $p(N)$ approaches 1. The parameter a is used to shift the curve horizontally while the parameter b determines the steepness of the curve. These parameters will be determined using historical data. The number of graduates (as a function of N) is then given by

$$G(N) \equiv N(1 - p(N)) = N/[1 + e(N - a)/b] \quad (2)$$

Suppose that $a = 4500$ and $b = 800$ then the resulting dropout probability curve is given in Fig. 1 (left) while the number of graduates as a function of intake is provided in Fig. 1 (right). We can take the derivative of $G(N)$ and set it to zero to obtain the optimal student intake. Unfortunately, there is no closed form solution and hence one would need to determine the optimal value numerically. Next, we validate this model with actual data.

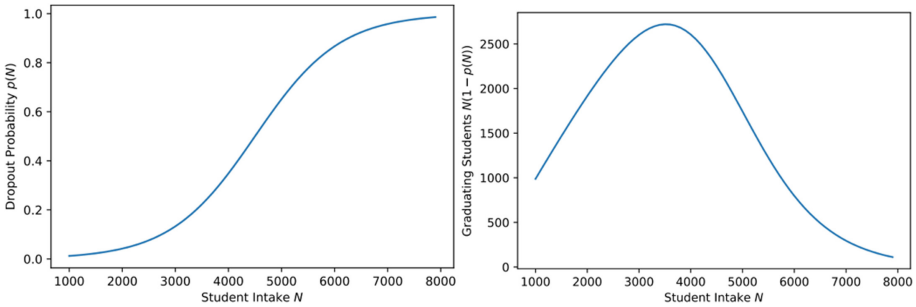


Fig. 1. Dropout probability (left) and graduating students (right) as a function of intake.

4 Model Validation

We first consider a particular University with campuses in different countries. Each campus manages their own admission process and so can be treated separately. The data used for this university is publicly available on their web site and hence can be freely be used. We considered three of the campuses for which data was available. We also found data for another University in another region of the world which we also used to illustrate the model.

4.1 University Example (STA)

We were able to obtain publicly available data from a university web site [15] for undergraduate student intake and number of graduates for each year. The degrees are designed to be completed in 3 years and so we will assume that, for a given year, the number of entering students for that year minus the number of students who graduate in 3 years' time is the number of dropouts for that class. More detailed information (dropouts in each year for example) would allow us to do a more detailed analysis but such data was not publicly available. We provide the number of new students (intake) and number of graduates for various years in Fig. 2 (top). The year denotes the first year of the academic year. Note the dip in graduating students for the academic year 2019/2020. These students would have graduated in September of 2020 but because of COVID many of them were not able to complete their degrees. This sample will be highlighted in our plots but will be treated as an outlier and hence not included in our regression analysis.

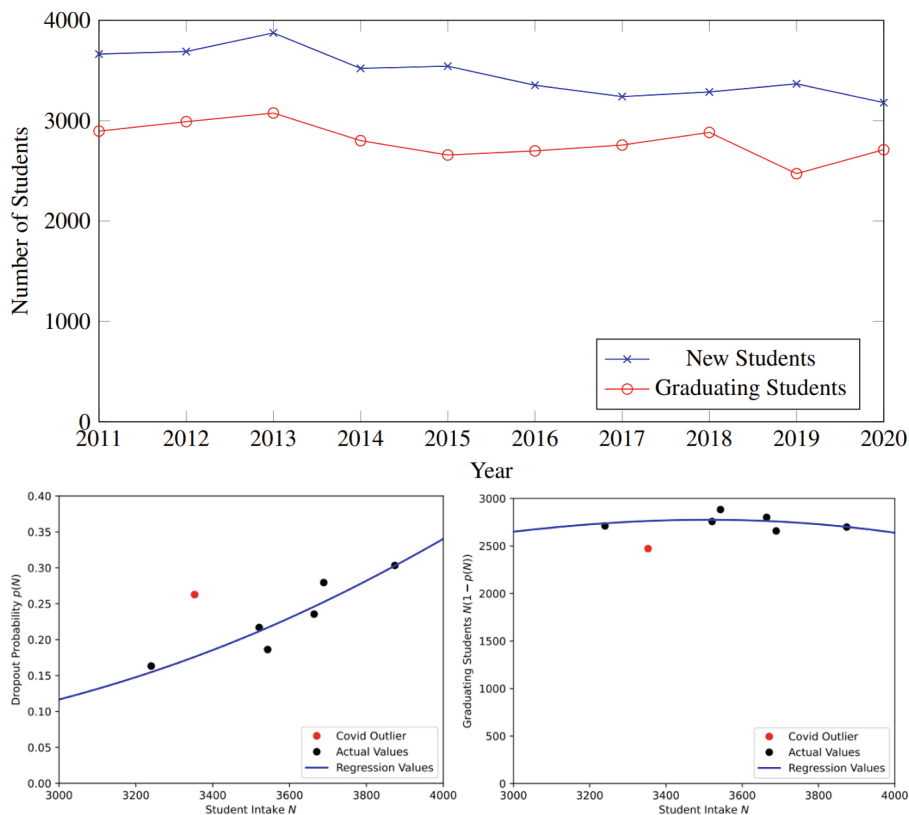


Fig. 2. STA: Intake and Graduates by year (top), Dropout Probability (bottom left) and Graduates (bottom right) vs Intake.

We obtain a sample for each year as a pair consisting of the intake size for that year and the number of those students who graduate (taken from 3 years in the future). Therefore, we can obtain samples for the years 2011–2017 which is what we use for our analysis. However, we ignore the year 2017 (with graduating year 2020) because the graduating class was particularly small because of the COVID pandemic.

We can determine the probability of graduating as the ratio of the graduating class size and the corresponding entering class size. The drop out probability is the number of students who drop out divided by the intake size and we denote this by $p(N)$. Given these samples we next determine the values a and b in 1 that provides the smallest Mean Square Error (MSE). The error is the difference between the actual value and the value obtained with the model. We do this using a coordinate descent approach as follows. We fix b and optimize (i.e., find the lowest MSE) over a by doing a simple linear search along values for a . We then fix a at this optimal value and optimize over b . We then fix b at this new value and optimize over a . This process is repeated until neither a nor b changes. When we do this, we obtain $a = 4486$ and $b = 734$.

Using these parameter values, we plot the function $p(N)$ versus N in Fig. 2 (bottom left). We include the sample point (in red) corresponding to the COVID graduating year to show how far off it is from the other points. Note that typically R^2 values are only used for checking performance for linear regression but not for non-linear regression. However, we can see that the portion of the curve within which the sample points lie is close to linear, so we did the computation to obtain $R^2 = 0.87$ which indicates a good regression approximation.

Given the function $p(N)$ we can now determine the graduating class size, and this is provided in Fig. 2 (bottom) right. The maximum graduating class of 2776 students is obtained with an intake of 3510 students. With this intake the dropout rate is 21%. These numbers suggest that this campus is already running at capacity and that any attempts to increase student intake must involve a discussion on increasing staffing and resources.

4.2 University Example (CH)

In this section we consider another campus of the same university which is on a different island with a different admission process. The student intake and graduates per year is provided in Fig. 3 (top).

We note two strange transitions. In 2013 there was a sudden drop in new students. This was due to the Government in the country stopped providing a fee subsidy to students [12]. This caused several students who could no longer afford to pay tuition to dropout leading to an unusually high dropout rate, so this sample was removed from the regression.

Next, we see a sudden rise in new students from 2018. This was since the Government changed its policy and reinstated the subsidy [1]. However, during the prior 3-year period, staff was significantly reduced due to the drop in registrations. The sudden rise in students from 2018 could not be properly managed and again this led to an unusually high dropout rate. Over time, Faculty and resources will be increased but we ignore this sample point because it violates our assumption of a stable system. In Fig. 3 (left) we plot the dropout probability, and, on the right, we plot the number of graduates, both as a function of student intake. Note that the two anomalies (red and blue) are provided for reference. In this case we obtain $a = 2571$ and $b = 609$. The optimal intake is 2050 with a dropout probability of 30%.

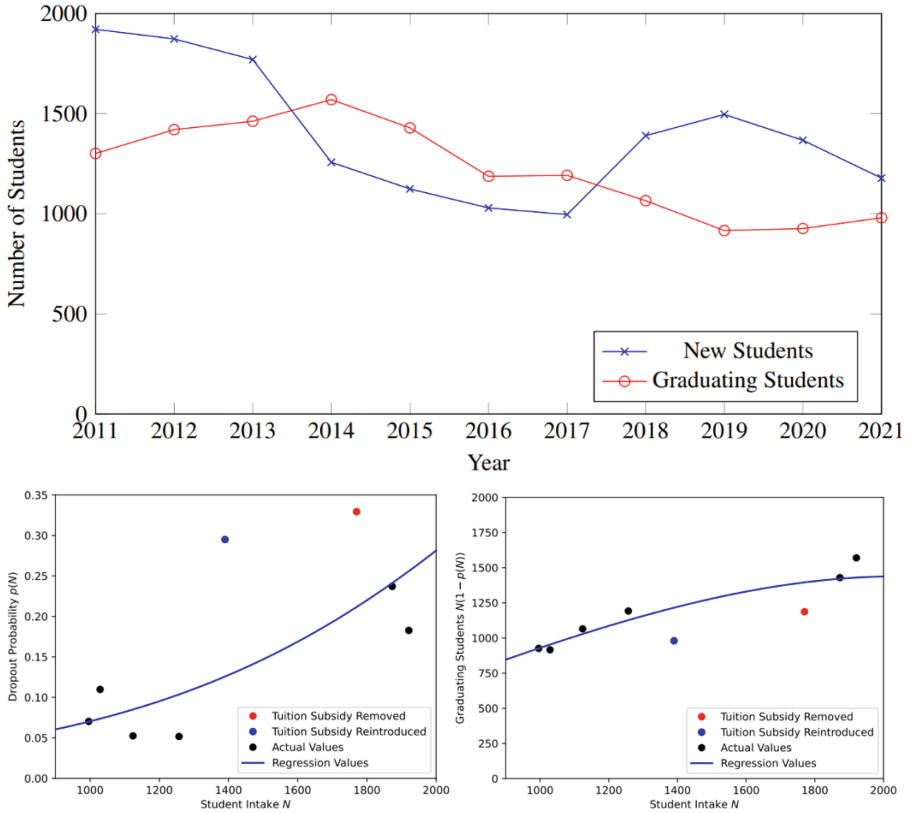


Fig. 3. CH: Intake and Graduates by year (top), Dropout Probability (bottom left) and Graduates (bottom right) vs Intake.

4.3 University Example (Mona)

Figure 4 has results for the third campus. In this case the dropout rates are high with the lowest sample dropout rate being 25%. Although the model indicates a small increase in graduates with increased intake, this will come at the cost of even higher dropout rates. Therefore, in this case the focus should be on reducing dropout rates by reducing intake and/or increasing staff and resources.

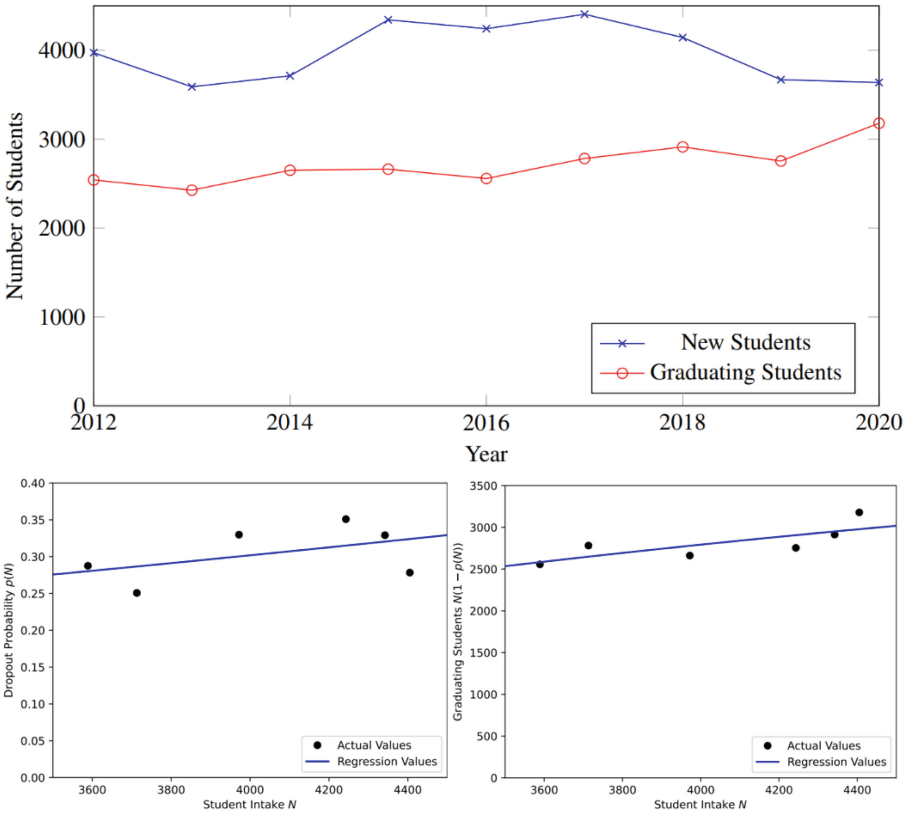


Fig. 4. MONA: Intake and Graduates by year (top), Dropout Probability (bottom left) and Graduates (bottom right) vs Intake.

4.4 University Example (Oxford)

We decided to include a university from a different region and was able to get data for Oxford University [13]. The results for this case are provided in Fig. 5. Although Oxford is considered to be a Public University, the vast majority of its revenue comes from private sources and hence maintaining its reputation is important. We therefore find that the dropout rate is very low. However, the proposed model seems to fit this Institution as well. The optimal intake is 3250 with a dropout rate of only 10%. The regression curve is almost linear for the graduation rate curve and hence we computed the R^2 value and obtained 0.92. The University appears to be operating close to its optimal capacity.

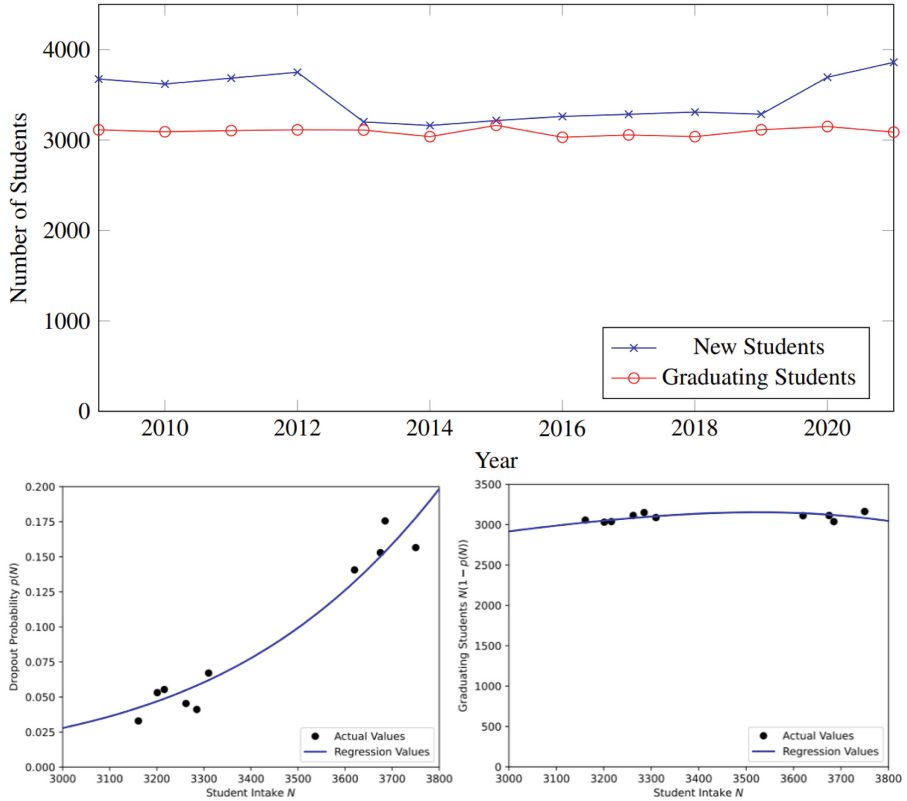


Fig. 5. Oxford: Intake and Graduates by year (top), Dropout Probability (bottom left) and Graduates (bottom right) vs Intake.

5 Conclusions

We proposed a model for estimating graduation rates based on student intake. The parameters for this model were obtained from historical data of the University. Unfortunately, since the number of samples per dataset was small, we could not use the traditional train/test validation approach. However, using real statistics from different universities we demonstrated the value of the approach. In the future we plan to perform similar analyses based on Faculty and possibly on Department level results. We believe that this work can assist Universities when making decisions on aspects such as admission requirements and staffing requirements.

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Digitalization of Sustainability Reporting - Current Trends and Future Problems

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Abstract. The digital transformation of sustainability reporting requires careful analysis and standardization of data sources, implementation of digital taxonomy, and building a cross-functional team of experts. The implementation of digital solutions is complicated by the fact that regulators require both quantitative data and qualitative explanations, which are more difficult to interpret from a technical point of view. The aim of this paper is to analyze the existing state and requirements regarding the processes of digitization of sustainability reporting and, on this basis, to formulate the main problems in the implementation of this process. Our analysis shows that the benefits of using XBRL in sustainability reporting are still being evaluated, and the level of environmental disclosure remains low. However, some studies suggest a significant correlation between digitalization, sustainability, and profitability. We suggest that a clear introduction of uniform sustainability reporting standards is needed. Otherwise, digitizing this information will become an exercise with unclear effectiveness.

Keywords: Sustainability Reporting · Digitalization of Corporate Reporting · Sustainability Reporting Trends

1 Introduction

The digitization of business processes in the economy has been developing at a very high speed in the last few years. As a result of the digital revolution, the way many companies and even entire industries work has changed. The specialized literature mentions a change in traditional business models and the emergence of the so-called digital business models. A WEF report states that in this “new world”, analogue firms – large, successful companies that preceded the digital revolution – can feel as they are being ‘hunted’ from all sides [14]. In the context of this economic reality, the need for adequate, timely, clear and verifiable corporate information is increasing. In the conditions of digital transformation, change of business models and more requirements for transparency and accuracy of disclosed information, corporate reporting - financial and non-financial - continues to adhere to the paper format. At the same time, in the field of sustainability reporting, new rules are in force, regulated in the Corporate Sustainability Reporting Directive (CSRD), according to which companies that will prepare a Sustainability Report will be

obliged to use a uniform XHTML format in their reports and to mark the information for sustainability in accordance with the digital taxonomy. The directive is part of the EU's Sustainable Finance Package, which supports the implementation of the Green Deal by helping to channel private investment in the transition to a climate-neutral economy.

The purpose of this report is to analyze the existing state and requirements regarding the processes of digitization of sustainability reporting and, on this basis, to formulate the main problems in the implementation of this process.

2 Digitization of Sustainability Reporting – Current Trends

The European Union has been motivated to legislate on non-financial reporting due to its significance. In 2014, Directive 2014/95/EU was adopted by the European Parliament and Council of the European Union, which requires large companies and groups to disclose information related to sustainability, such as social and environmental factors, known as the NFRD. This directive acknowledges the importance of businesses disclosing sustainability risks to increase investor and consumer confidence. However, three years after its implementation, a major revision was made due to significant weaknesses in its implementation. The main weakness identified is that the directive does not mandate a specific format for disclosures, which has allowed companies to use their discretion in presenting relevant information. Companies have referred to various guidelines and frameworks such as the UN Global Compact, OECD Guidelines for Multinational Enterprises, ISO 26000, the Framework for International Integrated Reporting, and the Global Reporting Initiative.

In April 2021, the European Commission introduced the Corporate Sustainability Reporting Directive (CSRD) as a complete replacement for the NFRD. The CSRD, which was published in the Official Journal of the EU on 16 December 2022 as Directive 2022/2464 (EU), is designed to support the European Green Pact, a collection of political measures aimed at addressing the climate crisis by transforming the EU into a modern, efficient, and resource-efficient economy that will achieve net-zero greenhouse gas emissions by 2050. In addition, the CSRD is part of the Sustainable Finance packages, which aim to encourage private investment in the transition to a climate-neutral economy and support the implementation of the Green Deal.

As per the Taxonomy, companies that are considered to be of public interest and have more than 500 employees are required to disclose their sustainable economic activities based on the European Union's guidelines for the accounting year 2021. In order to meet this obligation, companies must report the proportion of their turnover, capital expenditure, and operating expenditure that relates to sustainable economic activities as described in the EU Taxonomy. Additionally, they must be prepared to provide certain qualitative information as part of these disclosures. At the start of the 2021 reporting period, it is sufficient for companies to report the general eligibility of their economic activity according to the Taxonomy guidelines, without conducting a detailed analysis of whether their activity meets all the specific criteria in the Taxonomy. This reporting requirement is the first step towards encouraging investments in sustainable activities, which are seen as the investments of the future.

Apart from the change in the scope of the companies that will be required to implement the CSRD, two main changes can be highlighted that we believe will be

of significant importance in shaping the corporate reporting landscape in the coming years:

- The CSRD requires the application of uniform European Sustainability Reporting Standards (ESRS) by all undertakings covered by the CSRD. The information reported must comply with EU regulations, including the EU taxonomy, an EU-wide classification system that establishes a list of environmentally sustainable economic activities;
- Companies will be required to prepare their financial statements and their management reports in a single XHTML format and to mark (tag) the sustainability information marked according to a digital taxonomy. This requirement is introduced to make sustainability information easier for users and machine readers to find;

It is evident from the preceding text that companies falling under the CSRD framework will need to rapidly adjust their reporting to conform to the new standards established by EFRAG. These new standards are essential in generating sufficient quantitative information related to specific sustainability key performance indicators (KPIs) and disclosing the company's business model and risks to its operations. The existence of established indicators pertaining to various aspects of Environmental, Social, and Governance (ESG) will simplify the process of digitizing information and facilitate the creation of a unified digital taxonomy for sustainability information. This is particularly crucial as the digital transformation of information flows and data management becomes strategically important for companies. To earn stakeholder trust in the data they use and analyze every day, companies must have machine-readable, comprehensible, auditable (verifiable), and accessible data.

In fact, public companies in the EU already use XHTML format when presenting their financial statements, since in 2013 the Transparency Directive (Directive 2013/50/EU) was amended to require all annual financial statements of issuers whose valuable securities are admitted to trading on the regulated markets in the European Union, to be prepared in a single electronic format for reporting, starting from January 1, 2020 [4]. In connection with the mentioned amendments, Delegated Regulation (EU) 2018/815 of the Commission was issued, known as the Regulation on the European single electronic format, which introduced both general rules for the format of annual financial statements and specific rules that concern for the marking of the financial statements included therein.

According to the requirements of the Directive and Delegated Regulation 2018/815, all public companies that prepare an individual financial statement must submit it to the Financial Supervision Commission in XHTML format. The "single report" submitted in this new format should include both the financial report and the activity report, the corporate governance statement, the non-financial statement, the government payments statement, the remuneration policy implementation report and other legally required documents.

The recently implemented ESEF format is now mandatory for all securities issuers operating in the EU, and requires them to use eXtensible HyperText Markup Language (XHTML) for individual financial statements, while consolidated financial statements by IAS/IFRS must be labeled with XBRL tags. Essentially, XHTML is a markup language used for hypertext that is part of the XML family of markup languages [3].

Troshani and Rowbottom explain that digital corporate reporting refers to the process of converting and presenting corporate reports that were previously in paper format to a machine-readable digital format. This process is distinct from electronic reporting, which simply involves presenting traditional paper-based corporate reports in electronic formats such as PDF or HTML [12]. Therefore, they believe that in “true” digital enterprise reporting, information is assigned or “tagged” with contextual meaning to enable computers to have some “understanding” of what is being reported. This allows users to easily retrieve whatever reporting information they want, in any order and for different companies.

According to Pikard and Loitz from PwC’s, the new CSRD reporting requirements will present real challenges for companies to organize, collate, access, research, evaluate and act on relevant data. Accounting for transformation and digital enablement should be fundamental to overcoming these challenges. It won’t be easy, but it will provide huge opportunities for companies that get it right [8].

Based on the information above, it is possible to conclude that some of the companies that the CSRD targets already have knowledge of presenting data in the XHTML format, and therefore the new requirement should not pose a significant challenge for them. However, the scope of the CSRD is expanding significantly, as it will now cover around 50,000 companies, compared to the current NFRD which covers only about 11,000 companies.

3 The (Im)possible Digitalization of Sustainability Reporting

Companies are facing the question of their readiness to comply with the new sustainability reporting regulations and whether there are specific sustainability information disclosures that could pose significant obstacles to meeting these requirements. The use of digital technologies alone is unlikely to ensure the availability of all necessary data, as careful analysis of data sources and standardization of data collection is essential to meet the requirements of the forthcoming digital taxonomy. Building a cross-functional team consisting of environmental technologists, data engineers, social experts, and financial accounting professionals is necessary to identify relevant data sources and to demonstrate the impact of this data on sustainability through financial accountability. Additionally, company management must provide the appropriate systems and digital control infrastructure to support the production of high-quality and ultimately secure data.

Rowbottom et al.’s study on the digitization of IFRS highlights one of the main criticisms of this process, as it has disrupted corporate reporting and had various effects resulting from the new requirement of providing taxonomy that distributes contextual metadata to all disclosures on corporate reports [10]. The study conducted by Rowbottom et al. investigates the impact of digitization on principles-based IFRS reporting, specifically on the construction of a taxonomy that aims to provide contextual metadata to all disclosures on corporate reports. The study highlights that standard-setters aim to mitigate the impact of digitization by modeling the taxonomy only on disclosures that are explicitly required by accounting standards. Therefore, the study suggests that some disclosures may not be included in the ESEF if they are not part of the established IFRS taxonomy.

The literature offers varying perspectives on the effectiveness of a unified electronic format for non-financial information in Europe. Bertolacci et al. argue that using XBRL offers similar advantages as financial reporting, such as the ability to create precise sustainability metrics that enhance comparability and minimize expenses, better and more reliable data management, and immediate reporting to both internal and external stakeholders [1].

La Torre et al. consider that the main advantages of using XBRL in integrated reporting should also be taken into account the need to codify sector-specific information so that efforts are directed towards developing specific taxonomy extensions when developing an XBRL taxonomy for integrated reporting [5].

Leitoniene & Kundeliene conclude that the level of environmental disclosure is quite low in the sustainability reports and websites of members of the Lithuanian Association for Responsible Business. Furthermore, no strong trend was found for companies to use digital technologies to achieve environmental goals based on the information disclosed by sustainability reporting. They conclude that the research results do not support the theoretical assumption about the benefits of digitization for sustainable environmental development [6].

Lichtenthaler [7] examines the potential cross-fertilization effects between digitization and sustainability, which he believes are often overlooked. He believes that digitality offers an opportunity to go beyond optimization and cost savings due to digitization and sustainability initiatives to capture the potential for mutual enrichment of these two megatrends for innovation and new business development, even introducing a new term “digitainability”.

Ricci et al. study digitalization-related disclosure as a form of intellectual capital disclosure that provides potentially value-related information to investors. Empirical results show that stock market participants include digitalization-related information in their business valuation process and that firms with better corporate sustainability reputations achieve higher valuations from disclosing their digitalization efforts [9].

At the same time, Broccardo et al. ascertain significant connection between digitalization, sustainability and profitability of the company. Their results show that the achievement of positive results in the area of environmental and social dimensions are also related to the improvement of the economic results of the companies [2]. With these results, Broccardo et al. are also in line with Vărzaru’s results, which show that digital technologies have a significant impact on the reporting and reporting of sustainability and the sustainability-oriented culture of the countries included in the empirical study [13]. The author demonstrates that digital transformation contributes to the potential improvement of sustainability reporting, with significant links between sustainability and digitization.

Despite the stated positives, it should be noted that the digital transformation of the reporting ecosystem will require the collection and analysis of large sets of quantitative data - comparable to financial reporting - with the special characteristic that arises within technical characteristics (digital taxonomy) that never existed before. This is no doubt one of the reasons why standard setters are finding it difficult to define precise provisions at this time. The requirements for technical solutions are complicated by the fact that in addition to quantitative data, regulators require a significant number of qualitative explanations that are more difficult to interpret from a technical point of view.

The above corresponds to our understanding that the application of ESEF to the non-financial report (sustainability report) prepared by companies, at this stage when there is no requirement for a uniform format for reporting non-financial information, raises a number of questions related to what data companies will choose to flag in their non-financial statements and how comparable the information will be between individual entities. Moreover, the CSRD requires digitization of the presented and disclosed information and data on the sustainability of the enterprise, which according to the Directive should be done in the management report instead of a separate sustainability report. It is believed that this will help improve the integration of sustainability information (non-financial) and financial disclosures and enable consumers to have direct access to sustainability information. It is this requirement in combination with the requirement to apply a digital format to sustainability data that raises the main question that is currently unanswered, namely: How will the Activity Report (Management Report) be digitized given that it includes both non-financial and financial information, development forecasts, analysis, etc., for which there is no explicit taxonomy? How will the activity report be digitized when it does not have a strict structure and includes the subjective view of each management about the company's past and future?

Stolowy & Paugam [11] have identified various factors that hamper the achievement of convergence in sustainability reporting, including the diversity of sustainability reporting requirements, which they believe leads to differences in corporate governance decisions. We support their argument as our analysis of the first published standards from ISSB and EFRAG indicates that although they share a common starting point, there are fundamental differences between the two sets of standards. For instance, EFRAG's sustainability reporting framework and standards incorporate the concept of "dual materiality" as a crucial factor, while ISSB's published standards explicitly state that financial materiality, as defined in the Conceptual Framework to IAS/IFRS, is the primary consideration. ISSB's emphasis on financial materiality and catering to the information needs of investors and creditors creates a significant divergence between EFRAG and ISSB. We believe that the emergence of two parallel sustainability reporting regimes - the EU's European Sustainability Reporting Standards (ESRS) and ISSB's IFRS Sustainability Disclosure Standards (IFRS SDS) - will cause additional confusion for businesses regarding which standards to follow. The proposed drafts of the two sets of standards differ significantly on some fundamental issues.

The indicated organizational and methodological problems in the development of the normative basis for the reporting of sustainability are a prerequisite for the emergence of problems in the development and introduction of a unified system for marking data in electronic format, the so-called a digital taxonomy for sustainability reporting.

4 Conclusion

The objective analysis of the mentioned facts shows that the digitization of sustainability reporting would have positive effects, both for individual companies and, above all, for the users of the information from the published sustainability reports. Among the main positive aspects of the introduction of the digital XHTML format for reporting information, we could point out: obtaining comparable disclosures in organizations,

a better and faster decision-making process, improving the quality of sustainability reporting, as digitalization can even optimize existing company processes, which can further unlock untapped benefits to the corporation's strategy and operations.

However, in order to realize all this, a clear introduction of uniform sustainability reporting standards is needed, which includes a finite number of mandatory sustainability KPIs, tailored to the business model and key characteristics of the business, as well as a clear regulation on digitization and the future marking (tagging) individual parts of the report on the activities of the enterprises. That is why we see the solution in the use of a single integrated activity report, including both financial and related, structured non-financial (sustainability) information. Otherwise, digitizing this information will become an exercise with unclear effectiveness.

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An Empirical Study of the Effect of Enterprise Resource Planning System on Tobin's Q

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Abstract. The purpose of this article is to investigate the nexus between Enterprise Resource Planning (ERP) system and company market performance measured by Tobin's Q in Jordan. This research employs a matched-pair design and the robust standard errors for random-effects regression model to draw conclusions. The study sample is based on 58 non-financial firms listed on Amman Stock Exchange (ASE) from 2020 to 2022. The results show that ERP implementation is positively and significantly related to company market performance, indicating that cutting-edge technologies (i.e. ERP system) can be crucial in improving the firm market performance and an important measure for the sustainability of Jordanian businesses. This article provides novel evidence detailing the effect of ERP adoption towards market performance in an emerging market following the limited amount of research on the topic.

Keywords: Cutting-Edge Technologies · Enterprise Resource Planning · Firm Market Performance · Jordan · Tobin's Q

1 Introduction

The era of big data has resulted in significant advancements in the area of information systems, where the emergence of internet and electronic data interchange paved this development [1, 20]. A new generation of business management solutions like material requirements planning (MRP), customer relationship management (CRM), and enterprise resource planning (ERP) systems are examples of the most cutting-edge technologies in today's business environment [14]. Institutions strive to establish new technologies in order to maintain their competitiveness, one of which is an ERP system. ERP is most likely the fastest growing system in today's business operations [33]. This system integrates all of the organization's different department, such as accounting, manufacturing, and human resources, into a sophisticated software database [17, 25].

The implementation of ERP systems has risen considerably over the last three decades due to its effectiveness and the growing need for an integrated business system [6]. An ERP system can be a suitable solution for a variety of cutting-edge businesses, which offers numerous advantages to organizations by producing appropriate, responsive, and integrated data to enhance decision making process [4, 22]. In addition, ERP

adoption can minimize costs and expenses by increasing efficiencies via computerization. Therefore, these impacts should lead to improve the company financial performance [18].

The study looked into the nexus of ERP systems implementation and firm performance among Jordanian publicly traded companies, as well as providing insights into cutting-edge businesses from the country's prominent sectors. The government is a substantial investor in a wide range of important entities and industries, which is especially significant considering Jordan's institutional setting. Moreover, using data from a domestic context, this study helped to improve international understanding of this association, which had previously relied on data from developed economies.

Methodologically speaking, the statistical methods used in this article will contribute to the body of literature. According to Baltagi [2], panel data analysis can effectively recognize and quantify impacts that are not observable in pure cross-section or pure time-series data. Thus, panel data analysis is applied in this article to draw conclusions. The findings of this research may be useful to shareholders, analysts, managers, and regulators, especially in identifying whether ERP implementation can improve the company market performance proxied by Tobin's Q. Furthermore, the discoveries obtained from the current research are beneficial to scholars investigating the implications of ERP system in improving a firm's competitive advantages and performance.

The remainder of this paper is structured as follows. The second section presents the hypothesis development. The third section discusses the research methodology, which includes sample and data collection, variables measures, and regression model. The fourth section provides the primary findings, which include summary statistics, Pearson correlation, paired *t*-test, and the robust standard errors for random-effects model. Finally, the fifth section offered the conclusions of the study.

2 Hypothesis Development

Several definitions exist for ERP system in literature. Klaus et al. [13] described ERP system as "a comprehensive, packaged software solutions that seek to integrate the complete range of a business's processes and functions to present a holistic view of the business from a single information and information technology architecture". In addition, Widjaya [29] defined ERP system as "an integrated system that regulates and describes all existing resources, both in terms of finance, marketing, sales, services and other support to facilitate and support the performance of all related elements in the company". According to AlMuhayfith and Shaiti [1], ERP systems are continually incorporating a broader variety of features, and the most important features of ERP systems are their data assimilation and instant outcome.

Business sustainability depends on a constant, effective organizational model that maximizes corporate operating performance by employing modern technologies. Enterprises used ERP systems to safeguard business assets for efficient allocation as well as offered timely and accurate information for sustainable business growth [9]. As a result, ERP implementation can be a critical factor in improving firm performance through better decision making and cost reduction [12]. In this regard, previous research has looked into the impact of ERP system adoption on several firm performance indicators. For example, Ulrich and Güler [27] determined a significant and positive association between

ERP system and financial performance in European companies through enhancing the decision-making process. Using a sample of 88 ERP adopters and non-adopters among the largest firms in Greece for the period spanning from 2011 to 2011, Voulgaris et al. [28] discovered that ERP adopters' performance indicators outperformed those of other firms.

Further, based on a sample of 126 listed firms in the United States, Hunton et al. [10] revealed that the firm performance proxies were higher for companies that used ERP systems than those with non-ERP systems. Fauzi [7] reported that the adoption of ERP system was positively and significantly associated with company financial performance. Ince et al. [11] found that the ERP system had a positive impacts on a company performance and competitive advantages in Turkey. Similarly, Ali et al. (2020) documented comparable results in Pakistan. In contrast, Wieder et al. [30] found that the firm market performance was not related to the ERP system implementation among Australian firms. Also, using a sample of manufacturing companies in Indonesia, Tarigan [24] observed that ERP system had no significant effect on company performance.

Based on the preceding debate, this research intends to investigate the influence of ERP implementation on company market performance, and to develop the following hypothesis:

Hypothesis: *Ceteris-paribus*, ERP system adoption is positively related to company market performance.

3 Research Methodology

3.1 Sample and Data

The Amman Stock Exchange (ASE) classified listed companies into two groups: financial and non-financial. Financial companies were eliminated from the sample because their financial reports differed from those of non-financial companies, which could have an undue impact on the Tobin's Q metric [15]. The current study's initial sample includes all non-financial firms from the manufacturing and service industries from 2020 to 2022, and the chosen firms' financial reports had to cover the entire study period and be obtainable on the ASE website.

The data for measuring Tobin's Q and the control variables were manually gathered from the published financial statements of the sampled companies. Moreover, there is no set of data to identify the list of Jordanian ERP adopter firms. As a result, this study depended on survey-based data to determine companies that used ERP systems. A telephone poll was executed using the contact information listed on the ASE website. Following that, all non-financial publicly traded firms were contacted, yielding a final and valid sample of 29 companies that adopted ERP systems. The influence of ERP implementations on Tobin's Q was investigated using a matched pair approach. Thus, the inclusion of the 29 control firms increased the total sample size to 58 firms and 174 firm-year observations for the period of 2020–2022.

3.2 Variables Measurements

ERP adopter and non-adopter firms were compared to examine the impact of ERP system on Tobin's Q. A dummy variable was employed to recognize the impact of ERP systems [17]. Then, if a company utilized an ERP system, a dummy coding value of 1 (adopting companies) and 0 (control companies) will be assigned. This research used Tobin's Q to gauge the market performance of the sampled firms, computed as the market value of the company's assets to its total book value of assets [5, 19]. Various variables that may affect the company market performance were included in the current research, namely, Financial leverage (LEV), firm size (FSIZE), and industry (IDUS). Financial leverage is calculated by dividing a company's total debt by its total assets [32]. The natural logarithm of the total assets referred to the firm size. Industry is a binary variable takes the value of 1 if the sampled firm is under the manufacturing sector, and 0 if otherwise [26].

3.3 Regression Model

Consistent with panel data analyses, several statistical methods were undertaken to decide which model is appropriate for the dataset. The Wald and Hausman tests were used to determine whether to run fixed-effects model or random-effects model. The Wald and Hausman tests had insignificant p-values, indicating that the fixed-effects model was not suitable for the study. Then, the Breusch-Pagan Lagrangian Multiplier (LM) test was conducted. The finding reported a significant χ^2 value, concluding that the random-effects estimation method was appropriate for the analysis [2]. Accordingly, the random-effects regression model was employed to investigate the nexus between ERP implementation and firm market performance using the following equation:

$$\text{Tobin's } Q_{it} = \beta_1 + \beta_2 \text{ERP}_{it} + \beta_3 \text{LEV}_{it} + \beta_4 \text{FSIZE}_{it} + \beta_5 \text{IDUS}_{it} + \varepsilon_i + u_{it}$$

where Tobin's Q is the market-based performance, ERP denotes the adoption of ERP system, LEV donates the company financial leverage, SIZE donates the company size and INDU donates the Industry of a company.

4 Empirical Results and Discussion

Table 1 shows the summary statistics comprising the mean, standard deviations, minimum and maximum for the variables of the study. The average of Tobin's Q was 1.5% ranged from 0.1% to 12.7%, with standard deviation of 1.7%. LEV varied from 0.3% to 94.7% with an average of 40%. The FSIZE had a mean value of 17.512 with a minimum value of 13.792 and a maximum value of 20.884. Concerning the IDUS variable, 48.3% of the sample were classified as manufacturing companies, while 51.7% were classified as service companies.

The paired *t*-test was employed to compare the mean differences in the firm market performance indicator between two groups. Table 2 demonstrates that the average of Tobin's Q in ERP observations were higher than in non-ERP observations at the 0.01 significance level. This finding implies that ERP firms had a higher firm market performance than those of non-ERP firms.

Table 1. Descriptive Statistics

Variable	Mean	Std. Dev	Minimum	Maximum
Tobin's Q	0.014	0.017	0.001	0.127
LEV	0.400	0.243	0.003	0.947
FSIZE	17.512	1.394	13.792	20.884
IDUS	0.483	0.501	0	1

Table 2. Paired *t*-test

ERP Sub-Samples					
	ERP Adopters (ERP = 1)	Non-ERP Adopters (ERP = 0)	Mean Difference	t	p
Mean of Tobin's Q	0.018	0.010	0.007	2.762	0.007
Observations	87	87			

Table 3 contains the Pearson correlation, which was applied to identify the magnitude and direction of the bivariate correlation between all of the variables investigated. As described in Table 3, all of the correlation coefficients were within the acceptable range (≤ 0.80) [8].

Table 3. Pearson Correlation

Variable	Tobin's Q	ERP	LEV	FSIZE	IDUS
Tobin's Q	1				
ERP	0.209***	1			
LEV	-0.279***	0.068	1		
FSIZE	0.022	0.039	0.018	1	
IDUS	0.072	-0.253***	-0.148**	-0.141*	1

Note: *, **, and *** denote the significance level at 0.1, .05, and 0.01 respectively

The variance inflation factor (VIF) was also performed as an additional test for multicollinearity diagnostic. Table 4 indicates that none of VIFs were greater than 10, and none of tolerance values were lower than 0.10, suggesting that there was no serious violation of the multicollinearity assumption in the study [21].

Table 4. Multicollinearity Test

Variable	Variance Inflation Factor (VIF)	Tolerance Value (1/VIF)
ERP	1.07	0.935
LEV	1.02	0.977
FSIZE	1.02	0.980
IDUS	1.11	0.902
Mean VIF	1.06	

Table 5 presents the results of the heteroscedasticity tests, namely, Breusch-Pagan/Cook-Weisberg test and White's test [23]. Both tests revealed significant p-values, implying that the dataset was not homoscedastic. In the presence of heteroscedasticity issue, the robust standard errors for random-effects model is utilized in order to resolve the problem of heteroscedasticity and to produce unbiased standard errors of the regression coefficients [31].

Table 5. Heteroscedasticity Tests

	Chi-Square(2) value / F-value	p-value
Breusch-Pagan/Cook Weisberg Test	90.64	0.000
White's Test	26.68	0.009

Table 6 provides the findings of the robust standard errors for random-effects regression. The model had a significant Wald χ^2 value at the 0.05 level, which means that the overall of the random-effects regression was statistically significant. The R-squared was 0.184, providing that the model explained 18% of the total variance in the company market performance. The results revealed that the predictor variable ERP adoption was positively and significantly associated with the firm market performance measured by Tobin's Q proxy. This outcome supports the prediction of the study's hypothesis and consistent with the paired *t*-test finding reported in Table 2. Similarly, the obtained findings parallel those of Fauzi [7], Huang et al. [9], Ince et al. [11], Neves et al. [16], and Voulgaris et al. [28], who found that the performance metrics were higher for firms that installed ERP systems than those with non-ERP systems.

Financial leverage (LEV), firm size (FSIZE), and industry (IDUS) variables were included as control variables in the model to identify any impact on Tobin's Q. The findings revealed that, across these variables, the coefficient of FSIZE had a negative and significant relationship with company market performance at the 0.10 level. This result aligns with the Buallay et al. [3], who observed that FSIZE was negatively and significantly related to Tobin's Q. Further, LEV and IDUS variables were discovered to be positive but not significantly associated with firm market performance.

Table 6. The Robust Standard Errors for Random-Effects Model

Variable	Coefficients	Z value
Intercept	0.006	0.23
ERP	0.005	2.38**
LEV	-0.009	-1.80*
FSIZE	0.004	0.35
IDUS	0.003	0.84
R-squared	0.184	
Wald χ^2 (p-value)	9.08**	
Observations	174	

Note: *, **, and *** denote the significance level at 0.1, .05, and 0.01 respectively

5 Conclusions

This study investigated whether the level of company market performance proxied by Tobin's Q was related to the implementation of ERP system. To achieve this purpose, the current article used a matched-pair design to evaluate the Tobin's Q levels in 29 ERP firms and 29 non-ERP firms. Furthermore, the robust standard errors for random-effects regression was used as the main research instrument to provide supporting insight for this association. The findings established a significant and positive nexus between ERP adoption and Tobin's Q, suggesting that ERP implementation have further potential to enhance the market performance.

The results of this research have significant implications. Investors and Shareholders looking to invest in the non-financial sector of ASE can use the ERP adoption as a quantifiable instrument to assess the market return of the service and industrial listed companies. In addition, the findings have important implications for the board of directors of publicly traded firms, policy makers, institutional investors, and other stakeholders. The results of this research attempt to communicate the ERP implementation factors that could be considered in promoting the company market returns.

The current research acknowledges some limitations. For instance, this study included three control variables, which are Financial leverage (LEV), firm size (FSIZE), and industry (IDUS). Nevertheless, other factors that could have influenced firm performance in the sampled companies were not examined. Also, the study focused on the market performance indicator (i.e. Tobin's Q). Therefore, one strong recommendation for future researchers is to detect alternative proxies for the company performance.

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The Role of User Engagement and Instagram Influencer in a Corporate SNS Account

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Abstract. With the growing importance of social networking sites (SNS) in corporate marketing strategy and the growing number of celebrities as influencers on SNS platforms, it is worthwhile to investigate how these influencers impact customers' engagement and purchase behavior. Using the presence formation paradigm, this study investigates the impact of social presence and telepresence, as well as Instagram intensity, on increasing user engagement, which in turn influences their actual purchasing behavior. A survey of 750 corporate Instagram users was performed across 10 major cities in Indonesia. The findings show that telepresence improves flow experience and may successfully engage users (i.e. like, following, and sharing), eliciting purchase activity inside a corporate SNS account. In addition, the findings illuminate the role of Instagram influencer as crucial moderator to purchasing behavior which provide business owners effectively utilize it to maintain and foster customer relationships.

Keywords: User Engagement · Purchasing Behavior · Instagram Influencer · Telepresence · Flow Engagement

1 Introduction

The way individuals connect and form relationships has changed substantially as a result of the quick development of technology, notably the rising popularity of social networking sites (SNS) [1]. SNS is progressively developing into a potent marketing tool that helps businesses connect with, engage, and reach their target audiences [2]. Only Facebook, YouTube, and Wechat are currently larger social networks than Instagram [3]. According to Sproutsocial's statistical data, Instagram has the highest user engagement rates of all social media platforms, with an average engagement rate of 1.73% for brand posts [4]. An initial investigation into the connection between Instagram use and consumer engagement is already under way. [5] studied 100 Instagram brand posts from eight different industries, and discovered significant variations in customer interaction. Compared to users of Facebook, Twitter, and Snapchat, according to a survey [6]. Due to the physical isolation between users and merchants, cooperative SNS accounts provide challenges for corporates in terms of establishing presence in comparison to offline channels [7].

Users of SNSs have been seen to engage with an online brand only when they are aware of it while using the site [8] or when they feel trusted by its presence [9]. Consequently, presence has a significant impact on how well a participating SNS account performs. [10] shed some insight on the impact of presence on client repeat business. Customers will become more familiar with a brand by participating on a specific corporate SNS account. [11] It would also affect their inclination to use the goods or service and encourage electronic word of mouth (eWOM) [12]. [13] and foster greater client loyalty [14]. Overall, client participation in corporate SNS accounts can boost business output and sales [15].

2 Literature Review

2.1 The Impact of Telepresence on Flow Experience

The existence of computer-mediated communication, such as websites or social media, is thought to have a significant impact on users' attitudes, particularly in circumstances where face-to-face contact is limited [9]. Presence is defined as the perception of a direct experience in a communication situation caused by technology [16]. In this context, presence refers to the degree of realism seen by an online shopper [17]. Several scholars have recognized the importance of presence in online communication and have since focused on how presence is formed and expressed. Telepresence is the sensation of being present in an environment created by a communication medium, in this case virtual reality [18].

Telepresence has been proven to increase the flow states of online shoppers [20]. When engaging in virtual world activities, the perception of telepresence leads to a higher level of attention, resulting in a loss of self-consciousness and a sense of escapism [21]. The beneficial association between telepresence and customer brand engagement is established in the context of social media marketing [22]. The concept of flow was introduced and defined as a state in which a person is entirely engrossed in an activity and nothing else matters [23]. Flow has been defined as a mental state in which a person experiences satisfaction while engaging in an activity [24]. As a result, the following hypothesis emerges:

H1: Telepresence on an Instagram page positively affects flow experience.

2.2 The Impact of Flow Experience on User Engagement

Social media engagement is defined as customer participation in a social media environment or user participation in a social media scenario [31]. Social media enables two-way communication between consumers and brands, which enhances customer engagement [14]. According to [32], positive-valanced social media engagement habits include co-creation, positive contributions (likes, shares, retweeting, etc.), and consuming. Users help to improve the content on a large scale by expressing their preferences through the like and share functions on Facebook and Instagram, as well as the favorite and retweet functions on Twitter [32]. [33] revealed that when individuals like, share, retweet, or otherwise show their preferences for a piece of content, their social media connections are more likely to engage with it as well.

Although these consumers don't create material, they nonetheless show some levels of participation by watching and sharing other people's activities. The relationship between user involvement and flow experience in the context of online games has largely been acknowledged [34, 35]. Additionally, engagement is positively impacted by the flow experience that virtual reality storytelling creates [36]. It has been demonstrated that flow experience produced the "ideal" user experience for online purchases, which may enhance behavior that is motivated by intrinsic factors as well as engagement and loyalty [37]. This leads to the following conclusion:

H2: Flow experience positively affects user engagement with an Instagram page.

2.3 The Impact of User Engagement on Purchase Behavior

[38] discovered that user involvement had an impact on purchase behavior among online travel buyers in India. According to [39, 40] study, user involvement has a favorable and substantial influence on buying behavior. Therefore, H3: User Engagement Influences Buying Behavior.

2.4 The Potential Moderator of Instagram Influencer

According to [41] the idea of influencer involvement may be altered by utilizing cognitive behavior to establish how a person plans to purchase a specific product. As a result, customers' buy intention is defined as their behavior, perception, and attitude toward persuasion, experience, and preference that a product or advertisement would influence their purchasing choice [42]. According to the researchers, the link between user engagement and purchasing behavior offers the potential for expansion and the incorporation of new components. Scholars have incorporated various dimensions to describe the influence of intention on action to boost the explanatory power of behavioral theories [44] Based on the above explanation, the following hypothesis is formed: H4: Instagram Influencer has

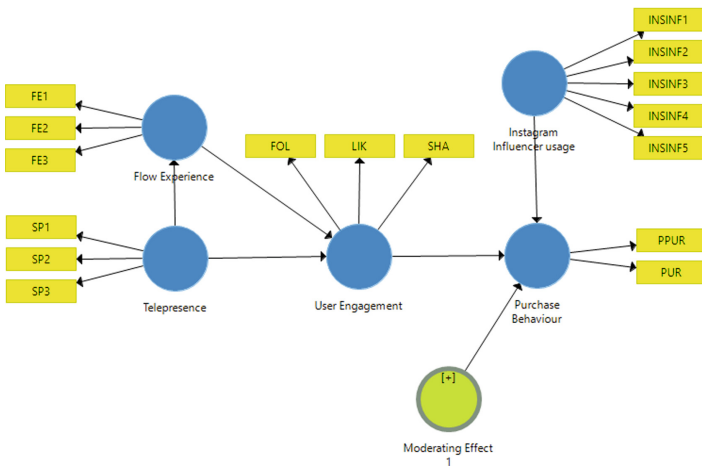


Fig. 1. Conceptual Model

a moderating effect on the relationship between User engagement on Purchase Behavior. The conceptual model shown in Fig. 1.

3 Research Method

This study used a questionnaire survey with a specific set of people. This study used a non-probability sampling approach with the criterion of being a corporate Instagram follower. Respondents were chosen from the Instagram followers of one of the famous influencers on corporate social media particularly in fashion.

The following factors led to the selection of the influencer's followers to complete the questionnaires. First, the Instagram Influencer Database study for 2021 states that the two industries receiving the most attention from Instagram marketing are fashion and food. It also helps to minimize bias and the compounding effect because there is no concern about the age or gender differences when choosing a specific IG influencer. With more than 2 million followers on Instagram, the IG influencers is also the most well-known Instagram influencer. 750 people in total were chosen from the company Instagram followers.

The questionnaires from [28] were used to gauge telepresence. To measure real engagement activity, five questions were employed, including whether they follow or share a post from the company's Instagram page. Additionally, a questionnaire from [45] is used to evaluate shopping preferences. The measure from [46] was used for Instagram Influencer utilization. As control variables, gender, age, and frequency of use were also added. To measure each issue, a 5-point Likert scale with the statements "strongly disagree" and "strongly agree" is used.

In this study, a trial test was conducted to test the reliability and validity of the questionnaire. The first 30 answers to the questionnaire from respondents were tested of its reliability and validity through SPSS. The reliability of a measurement indicates the extent to which it is without bias (error-free) and hence ensures consistent measurement across time and across the various items in the instrument. On the reliability test, the researcher uses Cronbach's Alpha and it should be higher than 0.7 to reach a good quality result or most researchers will remark it as sufficient [47] Validity is the extent to which the differences found in scale scores show the right differences between objects on the characteristic measured. Pearson's Correlation is commonly used to determine the validity, with 0.3 is the legitimacy of relationship between the factors to quality their adequate run [47]. SmartPLS3 was utilized to analyze data and evaluate the significance of the path coefficients in order to examine the hypothesized relationships.

4 Data Analysis and Result

4.1 Respondent Profile

There were 750 respondents, of which 83% were men and 17% were women. In the largest age range of 15 to 18 years old (42.5%), The majority of respondents (45.9%) reported using Instagram for 1–3 h each day, followed by 3–5 h (36.8%), and over 5 h (17.3%).

4.2 Hypothesis Testing

The path coefficient results in Table 1 showed that telepresence produced significant impacts on flow experience respectively ($\beta = 0.199$, $p\text{-value} = 0.000$) and user engagement ($\beta = 0.371$, $p\text{-value} = 0.000$). Subsequently, flow experience was reported to positively affect user engagement ($\beta = 0.236$, $p\text{-value} = 0.000$). User engagement positively effect on purchasing behavior ($\beta = 0.276$, $p\text{-value} = 0.000$). Instagram influencer moderates the relationship between user engagement on purchase behavior ($\beta = 0.096$, $p\text{-value} = 0.028$).

Table 1. Hypothesis testing result

Ha	Impact of	β	p Values	Result
H1	Telepresence \rightarrow Flow Engagement	0.371	0.000	supported
H2	Telepresence \rightarrow User Engagement	0.199	0.000	supported
H3	Flow engagement \rightarrow User Engagement	0.236	0.000	supported
H4	User Engagement \rightarrow Purchase Behaviour	0.276	0.000	supported
H5	Moderating Effect 1 \rightarrow Purchase Behaviour	0.096	0.028	supported

5 Discussion

The current study looked at the impacts of telepresence on flow experience and real engagement behaviour, such as following and sharing. The findings showed that telepresence had a favourable impact on flow experience. This study demonstrates that telepresence favourably improves flow experience, which is corroborated by [28, 47, 48]. Their research found that when people are exposed to high levels of telepresence, they lose knowledge of their physical surroundings and become immersed in the mediated world. Additionally, flow experience was shown to have a substantial favourable association with engagement behaviours. It was discovered that user involvement had a beneficial influence on purchasing behavior. The discovery is consistent with the findings of [49], as well as [50].

6 Theoretical Contributions and Practical Implications

In two ways, this study adds to the body of literature already in existence. First off, past studies have tended to focus solely on flow experience as a key predictor of users' attitudes and behaviors in a variety of situations, including online education [51] and telecommunication [54]. However, there hasn't been much focus on how flow experience is developed, particularly in the context of corporate SNS.

Thus, this study includes Instagram's telepresence to offer a more thorough understanding of the mechanics underlying user engagement in a business SNS account. Second, our findings show how important Instagram influencers are in mediating the link between social media activity and purchasing decisions. By focusing on examining the impact of influencers on Instagram users, the current study adds to the body of knowledge on engagement.

This work has both theoretical and practical applications. To begin, while telepresence is defined as the illusion of being physically present in a virtual world, businesses should also make use of Instagram's accessible features on the page (posts, stories, reels, and calls to action) to boost user experience. People are more likely to follow the page or share the post if they consider it is more genuine and trustworthy. Marketers may use these capabilities to post a range of photos or videos to provide customers with additional information about their brands and products. They might also use an interactive poll to get consumer feedback.

7 Limitations and Future Research

While our research was done on an Instagram profile for a physical shop, the findings may not be applicable to online retailers. Future study might fill this knowledge gap by carefully distinguishing between merchants who use Instagram as their primary online business platform and those who simply use it to lure customers to their physical locations.

8 Conclusion

The goal of this research is to investigate the effect of telepresence on flow experience and user engagement behavior (like, follow and share). Telepresence and flow experience, according to the research, have a significant impact on consumer engagement. Furthermore, engagement habits influenced buying behavior. Instagram influencers, according to the findings, modulate the relationship between user engagement and purchase behavior. The findings extend to the presence idea by looking at the influence of individual Instagram influencers on purchasing behavior. Building long-term customer relationships on social media platforms through Instagram influencers is an effective technique for businesses and business owners to encourage customers to participate in consumption and contribution behavior on SNS.

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Toward an Understanding of Cutting Edge Technologies in Financial Industry: Cryptocurrency Adoption

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Abstract. The aim of this study is to empirically investigate the factors influencing cryptocurrency adoption as a medium of financial transactions in Jordan. Factors from the unified theory of acceptance and use of technology (UTAUT) model and two additional variables, innovativeness (IN) and perceived readiness (RD), are tested to predict the individuals' adoption behavior. An online questionnaire was employed to collect the participants' answers on a five-point Likert scale. A non-probability convenience sampling practice was applied to collect data from the 391 participants in the Jordanian. The collected data set was analyzed using the statistical package for the social sciences (SPSS) and AMOS software, applying structural equation modeling (SEM). The findings indicate that three out of the five suggested constructs (performance expectations PE, effort expectations EE, and facilitating conditions FC) are significant determinants of cryptocurrency's adoption as a medium of financial transactions. Interestingly, RD is not a significant determinant even though earlier studies revealed otherwise. Similarly, the association between cryptocurrency adoption and social influence (SI) was insignificant. Jordanian people are still cautious of cryptocurrencies, even though international tech companies such as Microsoft are already accepting cryptocurrencies (e.g., Bitcoin) as a payment technique. This research aims to offer related interested parties, authorities, financial institutions, and businesses better insights toward understanding the variables people consider if they were to adopt cryptocurrencies as a medium of payments and other financial transactions.

Keywords: Cryptocurrency · Jordan · UTAUT · Adoption · Financial Industry · Technology Readiness

1 Introduction

The swift development of online technologies has a remarkable effect on how financial institutions run their business and how customers conduct their financial activities and payments [1, 2]. Cryptocurrency is one of these technologies, also known as digital currency, and is applied as a tool for exchanging money by means of Blockchain technologies. Other names for it include “virtual commodity,” “virtual token,” “virtual assets,” “payment token,” and “cyber currency.” [3]. Satoshi Nakamoto invented Bitcoin, the first cryptocurrency, in 2008 [4]. It enabled people to transfer money without the participation of financial intermediaries because it was designed to be decentralized and independent of governmental oversight [5]. In other words, banks are not required to be involved in deals and trades. Beyond the use of debit/credit cards or cash money, consumers have a variety of options.

Simple financial transactions like cryptocurrency selling for programming help have used bitcoin as their medium of exchange. It’s interesting to note that the first recorded commercial use of Bitcoin occurred when 10,000 Bitcoins were exchanged for a pizza costing \$25 delivered. Since then, the value of Bitcoin has grown dramatically. By 2022, the cryptocurrency had developed into a speculative tool for short-term trading, been kept as an investment under the category of crypto-assets, and been utilized as a means of exchange and money for transactions. After 12 years after its launch, the value of one Bitcoin improved considerably, reaching a value of about USD 67000 in 2021.

Cryptocurrency has established itself as a catalyst for economic change ever since it first appeared. According to Morkunas et al. (2019), Bitcoin and the blockchain technology that underpins it has the potential to change the traditional financial services sector [6, 7], particularly in countries like Venezuela that are experiencing a financial crisis [8, 9]. The US Federal Reserve has already criticized the existing payment systems (the credit cards) for its lack of efficiency, effectiveness, and timely cross-border payment [10]. In order to address the aforementioned issues, cryptocurrencies are viewed as a possibly disruptive technology [11]. In May 2020, there were over 5,400 different kinds of cryptocurrencies on the market, with Bitcoin leading the pack with a market capital of US\$160 billion [12, 13]. Cryptocurrency assets and the enormous range of associated goods and services have extended rapidly in recent years and are becoming more and more connected to the controlled financial systems. Policymakers appear to be finding it difficult to monitor the risks presented by a sector where the majority of activities are either unregulated or only minimally regulated [14].

Despite the development and growing popularity of cryptocurrencies, few studies have been conducted on them. Even though Bitcoin was introduced to the market in 2008, scholarly research on the topic didn’t begin until much later. Peer-reviewed journals only started taking submissions in 2013, while studies from cryptocurrency conferences only started to be published in 2011 [15]. Because of this, there is less written about cryptocurrencies than about other well-established financial technologies, like online banking or smartphone payment. Furthermore, developed nations (such as the USA and the UK) are the primary emphasis of the existing literature on the adoption of cryptocurrencies and blockchain technology [16, 17]. Users’ perspectives on the adoption of cryptocurrencies in developing nations like Jordan are not taken into account, and there are few

significant theoretical contributions and empirical data in this area. There are no quantitative academic research papers on cryptocurrency adoption in developing countries (e.g., Jordan), according to Al-Amri et al. (2019) and Almajali (2022). In conclusion, there is a dearth of quantitative research on cryptocurrency-related technology adoption, particularly in developing economies.

Major tech companies and businesses have started taking cryptocurrency as payment in real-world apps, either directly or indirectly. Examples include Microsoft, Expedia, Rakuten Japan, and Amazon [18]. Despite the fact that the use of Bitcoin is increasing, many developing nations are still ignorant of it [19, 20]. According to Shahzad et al. (2018), regulations are a crucial step in raising customer confidence and raising knowledge of new financial technology so that the vast majority of people will accept and use it. According to Shahzad et al. (2018), the adoption of cutting-edge technology will boost the financial strength and individual autonomy of developing countries. Digital currencies are still illegal in Jordan, as stated by Adel Al-Sharkas, the Central Bank of Jordan's director at the time.

In this context, in 2014, the Central Bank of Jordan (CBJ) issued its first circular related to cryptocurrency, according to which it prohibited banks and all other financial institutions subject to its supervision and control to deal with them in any way, or exchange them for another currency, or open accounts for customers to deal with them or sending or receiving transfers in return for it or for buying or selling it. This suggests that cryptocurrencies are illegal because no central bank is required to convert their value into legally issued money or widely traded commodities like gold. The CBJ continued to forbid trading in encrypted virtual currencies in its second circular, which it distributed in 2018 to all banks and other financial organizations under its supervision and control. On 11/24/2019, the CBJ also affirmed the circulars stated above [21].

However, despite the prohibition on trading in these currencies by the Jordanian government, individuals have still managed to acquire them. Jordanians who trade cryptocurrencies often use foreign brokers or more conventional techniques, like paying the currency's owner in cash and having him transfer their funds online. Blockchain technology expert Moaz Khalifat explained, "In Jordanian law, there is nothing criminalizing dealing in cryptocurrencies, but the Central Bank's directives to banks forbid them from dealing in these currencies," [22]. In Jordan, the number of people who lost their jobs during COVID-19 in 2020 increased by 170% to 191,000 employees, Al-Ghad News reported [23]. The International Labor Organization also reported high unemployment in all sectors of Jordan during and after the pandemic [24]. In this context, Economic and social expert Mr. Hussam Ayesh claimed that Jordanians were searching for work possibilities, extra money, or a quick fortune with the least amount of effort. He added that Jordan had a sizable digital infrastructure and that people could make thousands of dinars from undertaking activities that make use of that infrastructure, as demonstrated by YouTube and other social media platforms' users. He continued by saying that some jobless people were making good money by trading in these currencies.

Based on the above-mentioned discussion, the research problem has two lenses. From a theoretical point of view, there is a lack of quantitative studies on the adoption and use of cryptocurrencies, especially in emerging economies (e.g., Jordan). Also,

existing research indicated that factors specific to each different context need be integrated when make an attempt to understand users' adoption of IT/IS. Thus, for this study, there is a need to incorporate the UTAUT with context factors such as innovativeness and technology readiness. From a practical point of view, understanding the experience, lessons, concerns and challenges encountered by the Jordanians regarding the use of cryptocurrency for financial transactions could advantage professionals, particularly those in Jordan and other developing nations in terms of enhancing the acceptance and usage rate. Thus, as Jordan still in a rudimentary stage of using such technology, empirical study is required to identify the factors affecting cryptocurrency in Jordan.

Although there is no denying that the cryptocurrency trading market is risky, millions of dollars were being invested in this strangely unregulated market, leaving traders there without protection. The anonymity of the currencies in this case contributed to the lack of control. It is reasonable to identify the variables influencing the behavioral intention to adopt cryptocurrencies in Jordan given the risks associated with cryptocurrency trading, the government of Jordan's present stance on it, and the fact that people there are still engaged in it. Thus, this research examined the variables influencing Jordanians' behavioral intention to adopt cryptocurrency. This study specifically sought to understand what encourages and discourages Jordanians from using this method of payment.

This study made a number of contributions that are noteworthy in this respect. First off, the current research used a novel model to investigate cryptocurrency from the perspectives of individuals and technology. As most studies on the topic were primarily focused on the technological points of view, this fills the literature gap. The Unified Theory of Acceptance and Use of Technology (UTAUT) was thus used in the current research along with two other factors that were pertinent to the technological viewpoint of using such technology. The model was verified empirically in the Jordanian setting. This research is one of the first that empirically investigated the subject of Cryptocurrency adoption in Jordan. This will offer a better understanding and broader knowledge of Cryptocurrency and provides respected information and recommendations to be perused by interested parties like individuals who are interested in cryptocurrency investment, stockholders, banks, and governments.

2 Study Model and Hypotheses Development

2.1 UTAUT

The association between user beliefs, attitudes, and behavioral intentions (BI) to use the technology has recently been addressed as part of a number of well-known theories and models [25]. From the perspective of social psychology and information technology, "the theory of reasoned action (TRA), the theory of planned behavior (TPB), the social cognitive theory, the motivational model (MM), the model of perceived credibility (PC) utilization, technology acceptance models (TAM), an integrated framework that combined factors from TAM and TPB, and diffusion of innovation (DOI) theory", are only a few of the key theoretical viewpoints that have to direct the research in the technology acceptance and use [26]. A review and synthesis of eight theoretical frameworks of IT adoption have resulted in the formulation of UTAUT [27–29].

UTAUT has been demonstrated to be an acceptable study tool that contributes to predicting the users' adoption behavior by highlighting performance expectancy (PE) as one of the most prominent determinants of acceptance [30]. Therefore, this theory becomes one of the most widely applied theories among others because of its robustness, simplicity, and parsimony [31, 32]. It was also evidenced to be superior compared to other predominant competing theories [26].

Although the wide replications, applications, and integrations of UTAUT have supported many scholars to understand IT/IS acceptance and adoption, it is still essential for a systematic examination of the salient constructs that address the context-related variables [26, 33]. Furthermore, there is considerable debate among scholars who contend that the UTAUT's factors may not be adequate to understand users' acceptance of innovative technologies as the original UTAUT version focused on large organizations in the business setting which limit its explanatory power. Furthermore, for investigating the adoption of cryptocurrency, some other variables should be taken into account such as technology readiness and innovativeness. By extending the UTAUT to take account of these two constructs, a more comprehensive theoretical perspective of users' IT adoption in the context of cryptocurrency will be offered.

2.2 Hypotheses Development

Figure 1 represents the proposed study model and an explanation of each variable is provided in the following subsections.

2.2.1 Performance Expectancy

PE can be described as "the degree to which the user expects that using the system will help him or her attain gains in job performance" [27] and is the most commonly applied factor in predicting IT/IS acceptance and use. PE could be measured by how likely individuals are to intend to adopt cryptocurrency if they realized that its adoption would be beneficial and assist them in their daily lives. When a user feels that such technology can enable the event in achieving their goals, PE will enhance the individual's intention to adopt cryptocurrency. Prior research in developing and developed nations addressed how PE construct (or perceived usefulness PU) can positively affect individuals' inclination to adopt financial technologies such as internet banking [34], mobile payment [35], FinTech services [25]. Also, PE has been revealed to positively influence the adoption of mobile payment systems [36]. In the context of cryptocurrency, PE/perceived usefulness has been agreed as a significant predictor for cryptocurrencies' acceptance and use, for example [15, 17]. Thus, the following relationship was hypothesized:

H1. PE has a positive direct impact on cryptocurrency adoption.

2.2.2 Effort Expectancy

EE can be described as "the degree of ease associated with the use of the system" [27] and indicates the effort required to use novel systems and technologies based on their degree of complexity. At this point, EE is defined as the perceived ease of use (PEoU) related to the usage of cryptocurrency. While there is no need to understand the working

principles behind cryptocurrency for different transactions, some required financial and technological knowledge is essential when dealing with cryptocurrency platforms and applications. Earlier studies found EE to have a positive impact in developing countries by affecting the acceptance and usage behavior of financial digital services, such as mobile banking [37], mobile payments [38], internet banking [34, 39]. Moreover, EE has been revealed to lead to a positive effect in predicting usage behaviour for various technologies such as e-grocery shopping [40], online purchases [41], and e-learning [42]. In cryptocurrency studies, EE has been found to positively affect the usage behaviour of cryptocurrency [15, 43]. Therefore, the following hypothesis was suggested:

H2. EE has a positive direct impact on cryptocurrency adoption.

2.2.3 Social Influence

According to Venkatesh et al. (2003), SI contributes to individual trust and use in a novel IT/IS. Users could be willing to use cryptocurrency if many individuals recommend it, particularly if they are important to them (i.e. family members, colleagues, friends, or other close ones). Earlier literature revealed that SI positively influences the behavior to adopt and use financial services, for example, mobile banking [44] and mobile payment [38]. Also, El-Masri and Tarhini (2017) and Alkhwaldi and Abdulmuhsin (2021) e-learning studies found a positive impact of SI on individuals' decision to use the technology. Though, studies on cryptocurrency adoption have reported inconsistent conclusions: Arias-Oliva et al.'s (2019) indicated that SI is not significant factor in predicting the intention to adopt cryptocurrency. Taking into account one of the reasons for cryptocurrencies' growing success is due to its substantial network impacts, the following relationship, per themainstreamfindings, is formulated:

H3. SI has a positive direct impact on cryptocurrency adoption.

2.2.4 Facilitating Conditions

FC can be seen as an enabler or a barrier in a certain situation and could come in the form of ICT infrastructure and business that encourages a new technology [27]. Research investigating blockchain adoption to manage supply chains showed that SI was significant in predicting the intention to adopt such technology [45]. Other studies also revealed that FC significantly impacts financial technologies, such as mobile payments in India [38] and internet banking in Lebanon [34]. FC was a critical construct that influence the usage behavior in both developed and developing nations, such as cryptocurrencies' acceptance in Spain [43] and Fintech adoption in Jordan [25]. Considering that, the current study suggested the following:

H4. FC has a positive direct impact on cryptocurrency adoption.

2.2.5 Cryptocurrency Readiness

Technology readiness (TR) is a term that is frequently used to evaluate an entity's propensity to adopt and capability to use apt novel technological assets, which ultimately gave rise to the Technology Readiness Index (TRI) [46, 47]. Greater TR levels are associated with a greater adoption rate of cutting-edge technologies (e.g., cryptocurrency), more

intensive use of technology, and higher perceived ease in utilizing it. According to TRI, a person's personality is crucial to their ability to embrace innovative technology. According to TRI, a person's personality is crucial to their ability to embrace new technology. To gauge a person's general readiness to use new technology, TRI looks at four personality traits: "optimism, innovativeness, discomfort, and insecurity". While "discomfort" and "insecurity" are inhibitors of TR, "optimism" and "innovativeness" are their drivers.

Personal innovativeness (PI) can be defined as "the degree of the speed of an individual to adopt new ideas in relation to other members of the social system" [48]. PI which indicates the willingness of a user to experience any cutting-edge IT/IS, for example, has been found to affect the adoption of digital technologies. Nowadays, technology users have grown along with the technological revolution, especially contactless technologies, and are shown to be quite tech-savvy, and because of their awareness, involvement, and familiarity with online technologies, they are open and ready to use novel technology [49]. Al-Marouf et al. (2021) employed a modified version of TAM to study smartwatch acceptance in a medical setting, and revealed that late adopters' perceived ease of use (PEoU) is affected by PI [50]. It can be inferred that this is likely to take place because late adopters are more tech-savvy and, as a result, more comfortable using the technologies than early adopters. In addition, Wen et al. (2022) and Patil et al. (2020) found that "Innovativeness" has a significant effect on users' attitudes toward adopting cutting-edge technologies (i.e., mobile payment and food delivery applications [38, 51].

Earlier research, in general, suggested that "innovativeness" plays a vital role in IT readiness and adoption, and considering using cryptocurrency, for example in digital payments, is still in its initial stages, particularly in Jordan, the current research suggests that PI will affect "perceived readiness" directly. Thus the following hypothesis has been formulated:

H5. PI has a positive direct impact on perceived cryptocurrency readiness.

2.2.6 Readiness Role in Cryptocurrency Adoption

Readiness is deemed as a general belief and not as a measure of IT competency. It can be described as "people's propensity to embrace and use new technologies for accomplishing goals in home life and at work" [47, 52], and is consequently associated with greater adoption rates of IT. Earlier research has revealed a significant influence of IT readiness on the adoption of different technologies [53, 54]. In the context of cryptocurrency, "perceived readiness" refers to the status of people transforming from cash and traditional payment methods to a type of cashless payment, and it is theorized to have a direct influence on adopting cryptocurrency.

H6. Perceived cryptocurrency readiness has a positive direct impact on cryptocurrency adoption.

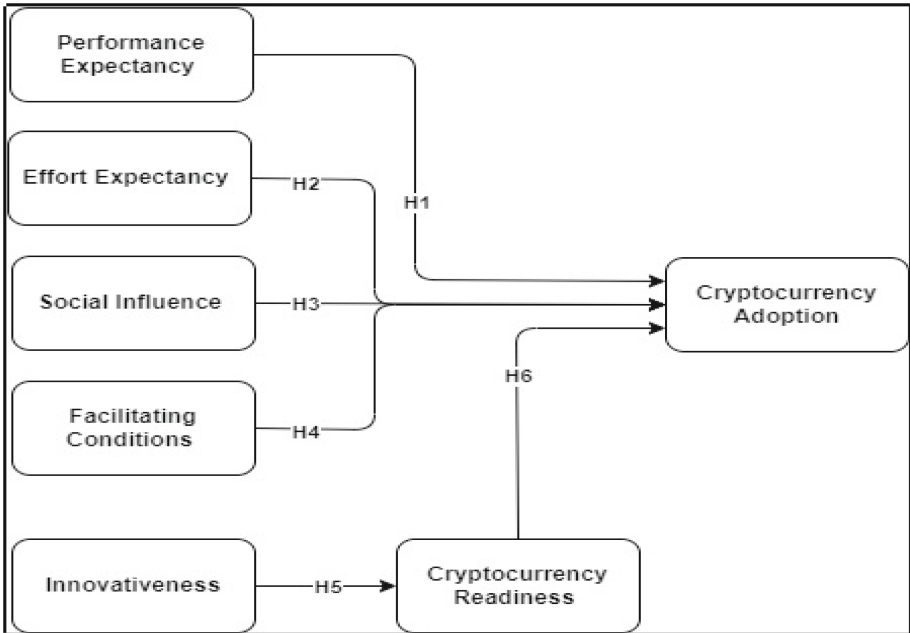


Fig. 1. Study Model

3 Research Methodology

3.1 Study Sample and Data Collection

The current research used the online survey with the convenience sampling approach. The survey link was posted to the targeted study sample using different communication channels, such as personal emails, professional mailing lists, and social media platforms. It was completely voluntary to take part in the questionnaire. Individuals who understood cryptocurrency were qualified participants. As the use of cryptocurrency in Jordan is in the early stages, the participants were potential adopters in the future. In order to make sure that participants understood the questionnaire was regarding cryptocurrency (virtual currency) in Jordan, an official explanation of the cryptocurrency was offered on the first page of the online survey. After affirming that they understood, participants continued to the following sections of the survey. Data collection was carried out from January to February 2023. At last, 391 valid surveys were received.

In the study sample, there were 51% males and 49% females, with the participants' ages ranging principally between "18 and 45" years old. In terms of experience in using online services, 17% of the participants had "some experience", 34% had "moderate experience", and 49% were "experienced". Concerning the educational background, 14% had "secondary education", 35% were "bachelor's holders" and 51% had a "postgraduate degree".

3.2 Study Instrument

The current research included seven key constructs with a total of 36 items. Items were modified or adapted from earlier research to fit this study context. Each item was translated and reviewed by language, finance, and information systems experts. Few original items applied seven-point Likert scales and others applied five-point scales. Though, the scales need to be consistent. According to Dawes (2008), there are no differences between five-point and seven-point data. It has also been recommended that applying a five-point scale is superior compared to a seven- or even eleven-point scale [55]. Based on the abovementioned discussion, and to improve the degree of survey parsimony, each construct was measured by applying a five-point Likert scale “1—strongly disagree to 5—strongly agree”. A greater value meant that the respondent perceived the item as being more strongly true.

4 Analysis and Results

4.1 Descriptive Statistics

The descriptive statistics for each construct in the suggested study model are shown in Table 1. All means were above 3.21 which indicates that the mainstream of respondents expresses positive answers to the factors that are tested in the current. Moreover, Cronbach’s α values indicate that all constructs revealed strong internal reliability.

Table 1. Descriptive statistics of the constructs

Construct	Mean	SD	α
PE	3.22	1.12	.906
EE	3.04	1.03	.903
SI	3.96	1.15	.827
FC	3.62	1.11	.773
AD	3.53	1.21	.837
IN	3.23	1.24	.902
RD	3.45	0.95	.776

4.2 Measurement Model

According to Kline (2015), this study used a two-stages method to verify the associations among the factors within the suggested research model [56]. The “measurement model” was first tested to assess the reliability and validity of the study tool (questionnaire) before investigating the suggested hypotheses in the “structural model”, as a second stage.

First, a confirmatory factor analysis (CFA) based on AMOS 26 software was used to evaluate the fit and also the validity of the “measurement model” [57]. The maximum-likelihood technique was adopted to assess the parameters in the theoretical model where all tests were conducted on variance–covariance matrices [57]. Thus far, analyzing for multicollinearity as a first phase before going on with the other tests was requisite. Multicollinearity is achieved when two or more variables are highly correlated [58]. Various researchers have endorsed different values to be adequate. Yet, Pallant (2014) recommended value of “0.7” or above is deemed problematic. Two key values namely, tolerance and variance inflation factor (VIF) are applied to assess the occurrence of multicollinearity [58]. The absence of multicollinearity is attained when the value of tolerance is “>0.1” and the value of VIF is “<3.0”. Considering that all the independent variables have VIF “<3.0” and tolerance values “>0.10”, this indicates no multicollinearity in the targeted sample in this research.

The researchers measured some fit indices to evaluate the fit of the “measurement model” [56, 57]. The “measurement model” fit was assessed by using the chi-square (χ^2). Yet, as the chi-square was shown to be too sensitive to the size of the targeted sample (number of respondents) and is not always the best sign of model fit, the value of the (χ^2 statics to its “degree of freedom/or adjusted chi-square” ($\chi^{2/df}$) was used as a substitute, with a figure above 3.0 representing an adequate value [57]. The current study used a range of additional fit indices as recommended by Hair et al. (2014) and Kenny (2020), these are: “goodness-of-fit index (GFI); normed fit index (NFI); root mean square residuals (RMSR); comparative fit index (CFI); adjusted goodness-of-fit index (AGFI); and the root mean square error of approximation (RMSEA)” [57, 59], as is inconsistent with the existing studies, for example [60, 61]. The acceptable and actual values of model fit indices are presented in Table 2. It is evident from the values that all fit indices were within the satisfactory levels. Thus, the authors continued to evaluate “convergent validity, discriminant validity as well as reliability” in order to measure and confirm if the “psychometric properties” of the measurement model were acceptable.

Table 2. Fit indices for the “measurement model” and “structural model”

Fit indices	Measurement model	Structural model	Recommended value
χ^2	562	579	$\chi^2 > df$
df	325	332	≥ 0
$\chi^{2/df}$	1.729	1.743	≤ 3.0
GFI	0.912	0.917	≥ 0.9
AGFI	0.867	0.868	≥ 0.8
CFI	0.931	0.930	≥ 0.9
RMSR	0.068	0.070	≤ 0.1
RMSEA	0.047	0.047	≤ 0.08
NFI	0.926	0.922	≥ 0.9

Convergent validity confirms whether each construct can be represented by its own items to make sure uni-dimensionality of the multiple-item factors and to ignore unreliable items [62]. Discriminant validity assesses the extent to which concepts' measures that appear to be statistically unrelated are truly unrelated (Straub et al. 2004). In order to support the "measurement model", this study evaluated the "convergent and discriminant validity" of the suggested scales in the instrument based on CFA. For convergent validity," Anderson and Gerbing (1988) proposed three ad hoc tests [63]. Table 3 presents the standardized factor loading (FL), composite reliabilities (CR), and average variance extracted (AVE). The degree of correlation among scale items and a particular latent factor is depicted by standardized FL. In all cases of constructs' items, the FL values were found to be highly significant. Similar to the α values, the CRs were demonstrated to be adequate >0.7 in each instance, as advised by Hair et al. (2014). The latent variable to random measurement error is estimated by the AVE (Hair et al. 2014). The AVE values are between (0.530–0.768) for all factors. These calculations represent an acceptable AVE cutoff of >0.50 . As a consequence, the outcomes of these 3 tests verified sufficient convergent validity.

Table 3. CR, AVE, and FL

Constructs	CR	AVE	FL
PE	.909	0.768	0.80–0.87
EE	.904	0.764	0.80–0.86
SI	.912	0.743	0.73–0.88
FC	.831	0.530	0.71–0.86
IN	.860	0.608	0.78–0.83
RD	.881	0.741	0.68–0.80
AD	.756	0.538	0.87–0.89

By using the test recommended by [63], discriminant validity was also assessed. The factor correlation between latent constructs needs to be lower than the square root of the AVE to produce findings that are acceptable [57]. "as presented along the diagonal of Table 4 in a bold font" of each factor, as presented in Table 4 through the correlation matrix of the suggested constructs. The estimation of this validity revealed that for every factor, the square root of the AVE was $>$ than the correlation value for any given set of factors. According to Table 4, acceptable discriminant validity was demonstrated.

4.3 Structural Model

The analysis of the "structural model" demonstrated a good fit for the empirical data using the same criteria for the "measurement model" to determine the goodness-of-fit for the study model (Table 2). As a result, the researchers continued to evaluate the proposed associations inside the research model.

Table 4. Discriminant Validity

	PE	EE	FC	SI	IN	RD	AD
PE	0.876						
EE	0.53	0.874					
SI	0.32	0.54	0.861				
FC	0.42	0.36	0.42	0.728			
IN	0.34	0.54	0.61	0.46	0.779		
RD	0.58	0.49	0.48	0.39	0.44	0.860	
AD	0.36	0.36	0.55	0.29	0.49	0.39	0.763

As shown in Table 5, the analysis of the path coefficients (β) demonstrated that three out of five hypothesized direct associations between independent constructs and cryptocurrency adoption (AD) were supported (H1, H2, and H4). In this regard, PE, EE, and FC were found to have a significant positive effect on cryptocurrency adoption in Jordan. Surprisingly, the path coefficient from SI toward cryptocurrency adoption was not significant. Therefore, this study failed to offer support for H3. Also, cryptocurrency readiness was found insignificant determinant of individuals' adoption (H6 not supported).

Table 5. Structural Model

	Path	Path coefficient (β)	Supported
H1	PE >> AD	0.358**	Yes
H2	EE >> AD	0.197**	Yes
H3	SI >> AD	0.075	No
H4	FC >> AD	0.125*	Yes
H5	IN >> RD	0.346**	Yes
H6	RD >> AD	0.028	No

“* $p < 0.05$; ** $p < 0.01$; Not supported $p > 0.01$ ”

5 Discussion

The purpose of this study was to evaluate a theoretical explanation for the acceptance of cryptocurrencies in Jordan. The IN and RD were added to the UTAUT variables, which served as the foundation for the suggested model. The suggested model accounts for 63.5% of the adoption behavior's variation.

The findings imply that PE is a key factor in predicting adoption and that Jordanian present and potential users give priority to technologies that help them complete their financial activities successfully and efficiently. This finding is in line with the results from other FinTech services studies such as factors affecting the adoption of internet banking in Lebanon [34], mobile payment in India [35], and FinTech in Jordan [25]. Studies examining cryptocurrencies in terms of PE (also known as perceived usefulness in some studies) resulted in the same conclusion, for instance, the adoption of Cryptocurrency in Jordan [17]; and the use of cryptocurrency in Malaysia [15].

The empirical findings confirmed the association between EE and individual cryptocurrency adoption. Users require a certain level of knowledge and expertise to deal with cryptocurrencies as a payment method, and using these channels requires them to complete the task autonomously without any help. In fact, Jordanians often attach priority to how difficult or effortless it is to use digital currencies. The studies on the acceptance and use of financial technologies indicated that EE plays a critical role in technology adoption, for example, mobile banking in Jordan [37]. EE, also known as perceived ease of use, has been shown to significantly influence cryptocurrency adoption in pertinent cryptocurrency studies [15, 43].

For the SI construct, this research presented findings that were different from those suggested in the proposed conceptual model. The impact of SI has been stated to be insignificant, and it has been determined that Jordanians' adoption of cryptocurrencies was not influenced by SI. Despite the fact that a more influential portion of society uses cryptocurrencies, Jordanians may be reluctant to use them due to a lack of familiarity and understanding. According to Venkatesh et al. (2003), when the data were analyzed without moderators like "age, gender, experience, and voluntariness", the impact of SI on usage behavior was insignificant. Limited research suggests that "social influence" has an insignificant influence; such as the study conducted to investigate the customer's intention to adopt mobile banking services in Jordan (Alalwan et al. 2017). Literature addressed cryptocurrencies also confirmed the findings of the current study, for example, Arias-Oliva et al. (2019) and Ter Ji-Xi et al. (2021).

Statistical analysis shows that respondents value the utilities, resources, and technological infrastructure needed to promote the adoption of cryptocurrencies in Jordan, confirming the significance of FC on cryptocurrencies' adoption. People who are satisfied with the facilities and infrastructure currently offered will encourage the use of cryptocurrencies. It's interesting to note that the development of internet network services like 4G/5G services and Wi-Fi is the primary driver behind the initial adoption of financial services such as cryptocurrency. Earlier research established this impact, such as the study on blockchain adoption in Australia [45] and mobile payments in India [38], and internet banking in Lebanon [34]. In the case of studies involving cryptocurrency, FC was revealed to have significant explanatory power, as per the research of Arias-Oliva et al. (2019).

The outcome of the SEM along with the path coefficients and predictive powers for the Innovativeness and Cryptocurrency Readiness, in the proposed model, is illustrated in Table 5, which also presents the hypotheses evaluation results. H5 was found to be significant which implies that innovativeness has a significant impact on cryptocurrency

readiness. The result of innovativeness is consistent with earlier studies [49, 50], showing that it is a key factor in people's perceptions of their readiness for a cashless society; specifically, people who use fintech services (like cryptocurrency) for their payments. To reiterate what we said earlier, the majority of the sample being studied is made up of Millennials, who are a generation that was raised in the digital age. They are considered game-changers in the digital world as well as being quite skilled with technological devices, which is why many online stores have implemented e-wallet payment to engage this generation. The Payment Methods Report 2022 indicates that Millennials considerably outpace other generations in their adoption of cryptocurrencies. The Millennial generation views conducting business online as simple and quick [64].

"Perceived readiness" of using cryptocurrency for payments did not have any significant influence on the adoption of such technology (H6), demonstrating that being ready does not automatically translate to IT/IS adoption behavior. Concerns about privacy, security, and trust could explain that regardless of being ready to use digital currencies the majority of the participants may not adopt cryptocurrency for their financial activities [65, 66].

6 Theoretical and Practical Implications

The results of this study offered empirical evidence that 3 out of the 5 suggested variables (PE, EE, and FC) are key predictors of cryptocurrency adoption among non-experienced individuals in Jordan. Also, it was shown that innovativeness has a direct significant effect on cryptocurrency readiness.

6.1 Theoretical Implications

The significant impact of f PE, EE, and FC demonstrated that users would be more inclined to adopt a widely accessible, user-friendly system that enables them to carry out their financial activities and transactions effectively and efficiently.

As far as theoretical implications are concerned, little research has been conducted on the acceptance and adoption of cryptocurrencies, particularly in developing countries (e.g., Jordan). The findings of this research can be referenced by future studies. The researchers in this study found that while UTAUT-related variables must be included, context variables related to the distinguishing characteristics of the specific information technology application must also be included in the study. This study has three major implications for theory development. First, the effect of two context variables (innovativeness and readiness) was investigated in terms of their role in the adoption of cryptocurrency. Second, both social influence and cryptocurrency readiness are not revealed to be significant in this research. Third, regarding the SI, the direct influence was found to be insignificant in predicting individuals' cryptocurrency adoption, which could be because of the negative connotations related to cryptocurrency usage, making individuals cautious of adopting them even though there are important people who use such technology in their social surroundings (i.e. family, colleagues, and friends). Overall, the above findings contribute to the literature streams concerning the employment of UTAUT in different study contexts, and cryptocurrencies in particular.

6.2 Practical Implications

The popularity of cryptocurrencies, FinTech services, and mobile applications is prompting a growing number of online retailers and financial institutions around the world to offer cryptocurrency services. They could refer to the findings of this research when designing and promoting such technology. For example, involved parties could design several promotional activities for current and potential users. The financial institutions in Jordan that intended to provide cryptocurrency services and online retailers could invest money in promotional activities to encourage future users to adopt cryptocurrencies for their payments.

Although the cryptocurrency usage rates are rising, recent news also shows that many publics still refuse to use cryptocurrency due to security and privacy issues. The statistics of the "TripleA" cryptocurrency payment company showed that the total number of cryptocurrency users in Jordan amounted to 129,071 thousand users, with a rate of 1.27% [67]. Given this new data, policymakers, and interested parties in Jordan should be aware that spending money to foster cryptocurrency adoption is really necessary. The Jordanian financial institution has invested in promotional activities to increase the cryptocurrency usage rate, but many people still refuse to use it. Therefore, in addition to this, they must again take into consideration individuals' key concerns and the requirements of businesses and online retailers if their new policy and implementation strategies are to be successful. The results of this research offer related information for business and policymakers.

7 Conclusion

The use of cryptocurrencies offers effective –cost, secure, swift, and anonymous method to conduct a financial transaction, without a need for authorization from an intermediary (a third-party). Although cryptocurrencies have gained more acceptance worldwide, its application is still limited particularly in developing countries. In addition, few researchers have addressed the cryptocurrency adoption, and most of their research were conducted in a particular context (e.g., developed country or specific culture). Also, the existing results on cryptocurrencies are inconclusive/inadequate, while the employed theoretical models of IT/IS adoption did not take into account the constructs of “innovativeness” and “technology readiness”. Cryptocurrency in a developing nation like Jordan demonstrate a respectable potential as revealed by the growth in its use, and however, research on its acceptance and adoption in the country were still very limited. Therefore, this study investigated the factors affecting Cryptocurrency adoption from the individuals' perspective in Jordan. In view of that, this research developed a study model based on the UTAUT model, integrated with additional factors (i.e., innovativeness and cryptocurrency readiness). Quantitative approach was used, and data were collected from current and potential users of this innovative technology, and analyzed based on SEM using SPSS and AMOS. The findings indicate that respondents are more likely to adopt cryptocurrencies for their financial transactions if they perceived it to be beneficial, convenient, and easy for use, as well as facilitating conditions (e.g., skills, IT resources, and IT infrastructure) are available to support the use of cryptocurrency). The results also revealed a significant impact of IN on RD.

8 Limitations and Future Research Directions

There are limitations to this research. First of all, this research paid attention exclusively to cryptocurrency technology. Future research could apply the proposed model across various FinTech services (e.g., mobile payment and online banking) and compare the similarities and differences to make additional contributions. Second, only data from Jordan was used in this research. The authors recommend that samples be drawn from a number of countries in order to understand the impact of cultural differences. Third, additional antecedents of perceived readiness regarding cryptocurrency need to be investigated. In this study, one variable was employed (innovativeness), therefore, future research could address the role of other antecedents (e.g., optimism and lack of awareness) in cryptocurrency readiness and thus the adoption of cryptocurrencies. Also, more critical factors and theories are recommended to advance this study. Finally, participants in the online questionnaire might result in sample bias, limiting the generalizability of the results. However, this is a common limitation of online questionnaires and hence future research could adopt other techniques for data collection.

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Smart Contracts and Blockchain-Based Tools for Privacy-Preservation

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Abstract. This research paper aims to investigate smart contracts and Blockchain technology to build a privacy-sensitive application focusing on a Digital Medication Plan (DMR) containing prescriptions. The DMR is used just as a use case. However, the proposed model applies to any context where confidential information is shared and authentication or proof of validity is necessary. We start by presenting the problem to understand the necessity of digitalizing the medication plans and how Blockchain technology fits to implement this application. After that, we explain Blockchain technology, a recent and comparatively unknown IT solution. Later we propose a design to solve the problem, and we develop a System of Smart Contracts to demonstrate how to build similar applications and suggest policies for Blockchain system design to satisfy the defined requirements. Eventually, we discuss the pertinence of multiple Blockchain solutions in handling the privacy problem.

Keywords: Blockchain · Smart Contracts · Digital Medication Plan · Privacy-Sensitive Application

1 Introduction

This paper aims to illustrate how smart contracts and Blockchain technology are applied to secure and control shared private information between members who perhaps distrust each other. We will develop a proof-of-concept application for Digital Medical Records (DMR) to apply the investigation results to several real-world applications. We identify three Research Questions (RQ) to achieve the research objective:

- RQ 1: What are the storage requirements for prescriptions on a Blockchain application? We will conduct a literature review and study current technologies and structures for data storage (off/on Blockchain).

- RQ 2: How does the Blockchain application architecture preserve privacy and share data among known but definitively untrusted members? We will evaluate the overall architecture of the Blockchain application from a security perspective by collecting the more privacy-critical components of the application. Any deficiency in these components requires redevelopment and reevaluation. However, if the identified requirements in the first research question are sufficient to pass security tests, then additional development is needed.
- RQ 3: How is a Blockchain application designed to handle prescriptions to guarantee that only certified doctors prescribe them, the pharmacies control them, and the patient can access their prescriptions? We will focus on access control in the Blockchain application. We will review the literature to inspect and evaluate the current Blockchain-based applications. The investigation outcomes will be represented as a list of technical requirements. Finally, the resulting application, implementing the requirements, will be tested as reported by [1].

2 Blockchain Technology

The Blockchain is an electronic, distributed ledger [2–4]. The ledger records data about transactions, a list of cryptographically connected blocks. The Blockchain uses a Peer-to-Peer network where the nodes represent the participants connected to the network. Blockchain is commonly known for its essential role in the cryptocurrency system, for example, Bitcoin, for preserving a distributed and secure history of transactions. Blockchain innovation is to ensure the consistency and security of data records and to generate confidence without the necessity of a trusted third party.

Similar to the database, the Blockchain records information in electronic format. The main difference between a Blockchain and a database is their data structure. Typically, the database uses tables to structure its data, while the Blockchain, as indicated by the name, uses linked blocks (chunks) to structure its data. A Blockchain accumulates data into clusters, called blocks, that record information. Each block has some storage capacity. The block is filled out, closed, and then connected to the formerly filled blocks, building a data chain called Blockchain. This data structure defines a permanent record of information in a distributed environment. The filled blocks are uncompromising and become parts of the recorded information. When the filled block is attached to the chain, it is assigned a unique time stamp.

Bitcoin: noted as the first Blockchain. Bitcoin solves a serious problem in the digital currency field known as double-spending, in other words, the usage of a single digital coin for several purchases. Typically, this problem is addressed by a central authority, for example, a trusted third party or a bank, but Nakamoto [5] suggested the usage of a timestamp server to guarantee the chronological occurrence of all transactions in the database. Using a relevant algorithm for consensus establishment on the Blockchain promotes trust in Bitcoin. In the Blockchain system of Bitcoin, the users possess neither accounts nor balances; rather, they sign transactions through private keys. A public key is associated with Bitcoin and UTXO (Unspent Transaction Output). The user whose private key matches the public key is considered the proprietor, and he controls its utilization. In Bitcoin, the UTXO is needed as all sent coins should be consumed, regardless if the user wants or not to spend the whole amount. However, there is a possibility of

transactions split. In the begging, there was no differentiation between Blockchain and Bitcoin, and all the earliest Blockchain applications were within financial sectors or cryptocurrencies. After that, other areas also started taking advantage of the Middleman of trust. This was supported by the introduction of Ethereum, a Blockchain network that extends the Bitcoin cryptocurrency by adding new functionalities for smart contracts [6].

Smart Contracts: In the Blockchain context, a smart contract defines just the reported logic on a Blockchain [7–9]. In other words, the smart contract is a program saved on a Blockchain executed when predefined conditions are fulfilled. Typically, it is used to computerize an agreement completion in order to ensure immediate and unquestionable results to all participants without any lost time and mediators. Moreover, if the conditions are satisfied, the smart contract can automatize processes and trigger the following operation.

Smart contract performs basic "if-then" statements written in the Blockchain code. A computer's network performs the operations if the preset conditions are fulfilled. After the completion of the transaction, the Blockchain will be updated. Thus, the transactions remain unchanged, and only authorized parties see the outcomes [10] (Table 1).

Table 1. Consensus Algorithms.

Algorithm	Used Resource	Advantages	Disadvantages	Example
Proof-of-Work	Processing power	permanent, extremely decentralized	transaction efficiency, Unreliable, Energy usage,	Bitcoin, Litecoin
Proof-of-Stake	Fixed number of tokens	Efficient in throughput, energy, and extensible	Nothing-at-Stake problem	NXT
Delegated Proof-of-Stake	Peer reputation and limited tokens	reputedly more effective than Proof-of-Stake	Elections reduce robustness and lead to excessive centralization in case of voter apathy	BitShares
Tendermint	A security deposit of tokens that can be burned in case of dishonest voting	Proof-of-Stake advantages without its drawbacks	The nothing-at-stake problem remains for a long time	Eris-Db
Proof-of-Authority	Random-designed authorities validate transactions	Effective without the need for any inherent tokens	Authorities corruption is possible	Parity Proof-of-Authority

Consensus algorithms: Consensus algorithms are very important for Blockchain technology as the Bitcoin purpose was to send money, in a doubting and irregular context, in a secure way, and transaction validation is required [11–13]. The consensus algorithm aims to guarantee the uniqueness of existing transaction history that includes correct, non-conflicting, or consistent transactions. Table 2 shows the main consensus algorithms by giving a used resource, the advantages and disadvantages, and an example for each consensus algorithm

Table 2. User Requirements.

Actor	Traceability	Requirements
Patients	1.1	Can see the prescriptions in order to know the drugs to take
	1.2	Can Self-identify before accessing the Blockchain private data
	1.3	Can share data about the DMR with Pharmacies and Doctors on the Blockchain
Doctors	2.1	Can check and modify the patients’ prescriptions
	2.2	Can check the patient’s identity before writing prescriptions or updating the DMRs
	2.3	Can see the patient’s previous prescriptions in order to ensure the patient’s safety
	2.4	Can Self-identify before accessing the Blockchain’s private data
Pharmacies	3.1	Can check patient’s prescription in order to avoid the purchase of unintended drugs
	3.2	Can Self-identify before accessing the Blockchain private data

3 Proposed Model

This section describes the design of a Proof-of-Concept application for DMR that uses Blockchain technology and smart contracts [14–16]. We describe the user types and their scenarios to identify the system’s functional and non-functional requirements. Afterwards, we outline the proposed model, decentralized, dependable, and permanent characteristics of Blockchain technology, along with smart contracts permissions.

3.1 User Requirements

There are three user types: patient, doctor, and pharmacy [17]. Table 3 shows the user requirements.

The patient defines as a person who seeks medical assistance from one of several existing doctors representing healthcare providers. The doctor prescribes a medical professional as certified and authorized to practice medicine. A pharmacy is a state-owned or commercial shop legally selling prescription drugs to patients.

Figure 1 describes the use case diagram of the System of Smart Contracts (SSC), where the different actors interact with the Blockchain that contains the smart contracts.

The general requirements applicable to the whole system are explicitly described in Table 4:

Permanent traceability records a persistent (cannot be modified) history of all prescription changes. This history would be used to know the doctor who prescribed a specific drug, if a drug was vented after it has been prescribed, and from which pharmacy, etc.

3.2 System of Smart Contract Design

This section presents the SSC design to meet user requirements and scenarios.

Table 3. General Requirements.

#	Requirement
R1	No connection between the prescription and the actor's identity without the actor's consent
R2	The network connection should be secure
R3	Permanent traceability should be embedded in the system
R4	Smart contracts should be exchangeable

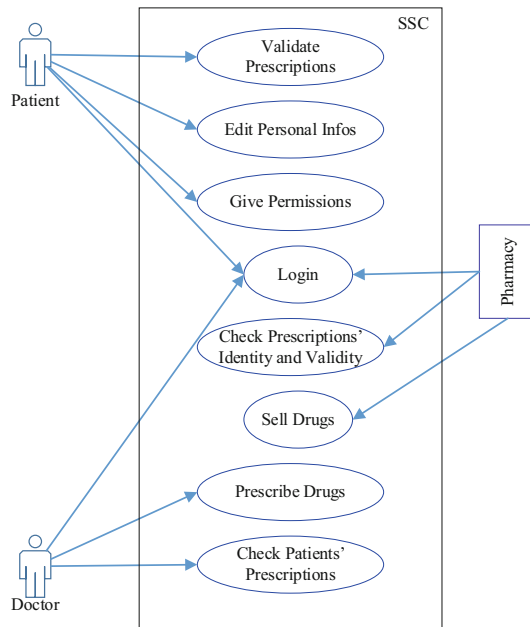


Fig. 1. Use case diagram

Design overview: Fig. 2 shows the DMR architecture. It uses the top-down approach by starting from the abstract level ("System level") to the low level ("Contract level").

Figure 3 illustrates the SSC process and shows the administrator's initial configuration of the contracts.

System of smart contracts: The proposed SSC design contains multiple kinds of contracts in order to carry out distinct activities. "The Five Types Model" is used to classify the contracts [18]. The SSC architecture separates the contracts into [19]:

- *Database Contract*: defines the contract for data storage with fundamental operations such as read, write, and get. It also includes the verification of permissions.
- *Controller Contract*: defines the contract for managing database contracts, such as the execution of a list of reads and/or write operations acting on different database contracts.
- *Contract Manager*: is required to manage and control the operations and the other contracts' presence. It handles the interaction among contracts.
- *Application Logic Contract*: defines the contract that implements application-related activities using controllers.
- *Utility Contract*: is a highly specialized contract that defines generic operations such as hash data.

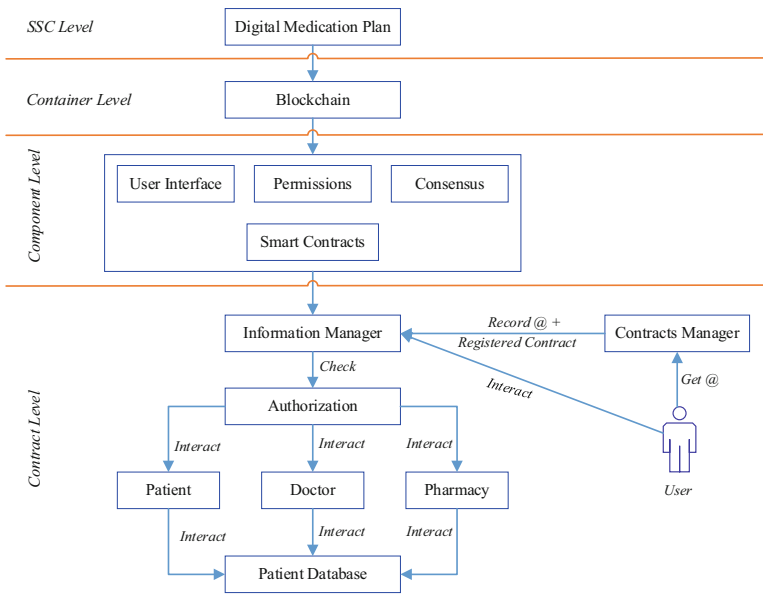


Fig. 2. SSC architecture

The SSC contracts are:

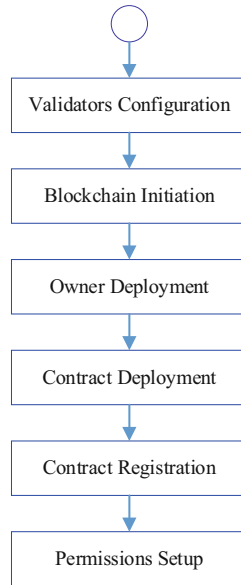


Fig. 3. SSC Setup flowchart

- *Patient Database*: defines a database contract that stores patients' information, such as prescriptions, and the doctor who prescribes every prescription.
- *Permissions Database*: defines a database contract that stores permissions.
- *Permissions*: is a Controller contract that imitates the interface with the Permissions Database.
- *Patient-Doctor-Consent*: The patient grants a particular pharmacy/doctor permission to sell/prescribe drugs.
- *Prescription-Patient-Consent*: The doctor prescribes a particular drug. The presence of the Prescription-Patient tuple is examined versus this variable.
- *Contracts Manager*: called CM and includes a set of contracts. The remaining contracts are linked to the CM or are sub-classes of the CM-Activated class.
- *CM-Activated*: defines the contracts Base class.
- *Patient*: is an Application Logic Contract that handles patients' claims like prescriptions retrieval, consent-level modification for some Doctor-Prescription tuple, etc.
- *Doctor*: is an Application Logic Contract that handles doctors' claims such as new patient insertion and prescription confirmation.
- *Pharmacy*: is an Application Logic Contract that handles pharmacies' claims to validate a prescription eventually. It is performed if the pharmacist wants to sell a prescription to a patient.
- *Information Manager*: This application logic contract handles user interactions, presents one contact point for users, and controls all their permissions.
- *Information Manager Activated*: This contracts Base class only allows the Information Manager to call them, and it is a subclass of the CM-Activated.

- *Contract Provider*: this is an interface that allows getting contracts from CM.

Before implementing the application in the real world, we should configure the Blockchain. The configuration comprises the generation of public/private keys for every node. Then, the designer launches his initial node to create the genesis file. This later saves the required information for the Blockchain setup. The designer registers the private keys. Finally, the flowchart in Fig. 3 is executed. We configure the validators; we start the Blockchain and then the transactions. The designer installs the contracts manager and all remaining contracts, registers them with the contracts manager, and establishes the permissions for the pharmacies, doctors, and patients.

Blockchain Data and Variables: Considering requirement R1, the Blockchain does not store the plaintext data used to identify the user to forbid the Blockchain participants from perceiving particular patient medications. Therefore, all plaintext prescriptions are recorded in smart contracts.

Framework and Management Support: The smart contracts alone make the SSC incomplete, and it needs the Blockchain and key management to complete it. Furthermore, establishing a centralized or distributed agreement is needed to allow doctors and pharmacists to join the network. Thus, a consensus algorithm is used. There are various consensus algorithms [12]. In our case, we selected the Proof-of-Authority consensus algorithm to determine reliable bodies for transaction validation. If pharmacists and doctors are likely to modify the history of transactions, then a set of governing authorities (such as insurance companies being used as third-party or a separate data center kept secured on the server) are designated.

Specifically, the smart contracts control mechanisms, and the Blockchain permissions layer are more than sufficient for the SSC validation. Nevertheless, it is recommended to set up a Decentralized Autonomous Organization, or any other organizational structure, to endorse onboard users and prescriptions. Furthermore, we need to audit pharmacies and doctors formally to analyze particular actions and prescriptions on the Blockchain. Thus, Eris-db by Monax represents the appropriate, quite well-designed platform that is still not error-free and an open-source Blockchain [18]. The SSC smart contracts are utilized without modifications. Eris-Db supports the permissioning layer and incorporates the Inter-Planetary-File-System, which allows the storage of huge amounts of data (for instance, the complete medical health records).

To initiate an Eris-Db Blockchain, a Docker container is configured to ensure the compatibility of the context where the entire package exists. After that, the first users' keys are created and stored in the genesis Json-file. An end-to-end encrypted messaging service is employed during the transmission of the key, and the users have distinct rights. For the DMR, different cloud instances (such as Digital Ocean, Amazon Web Services, etc.) are configured to operate as validators to allow pharmacies, doctors, and patients to have thin client nodes. Thus, avoid dedicating permanently powered-on devices to guarantee Blockchain continuation. To prevent deception and impose know your customer regulations and guidelines, an authority is required to supervise that:

- Each patient has a single account in order to avoid hiding prescriptions from pharmacies and doctors. This is achieved by enforcing the encrypted storage of all registered accounts. These accounts are managed by the organization that issues the accounts.
- Each doctor is licensed, and each pharmacist possesses a real pharmacy. These issues are addressed with the help of the accounting departments in the related country. This information is not private, as it does not cause security problems.

4 System Evaluation

This section uses a descriptive evaluation method to evaluate the proposed SSC architecture [20]. Furthermore, functional testing is executed on SSC through an online compiler, and the smart contracts are implemented in Solidity.

An IT artifact is evaluated based on several factors: usability, reliability, performance, accuracy, consistency, completeness, functionality, the fitness of purposes, etc. Nevertheless, since Blockchain technology is innovative, the previous factors cannot be used to evaluate the artifacts. Brown [20] asserts that the descriptive evaluation is applicable only if the technology used is particularly novel and the existing approaches are infeasible. Therefore, the DMR is evaluated by mean of two approaches of the descriptive evaluation theory:

- *Scenarios Construct*: Thorough scenarios about the artifact to illustrate its advantages.
- *Informed Argument*: Apply the information from pertinent literature (e.g., knowledge base) to establish strong arguments about the artifact's advantages.

All functional requirements in Table 3 are fulfilled, and Table 4 shows the reasons for satisfaction.

The predominant Non-Functional Requirement of the SSC is the patient data security defined in R1. Despite that, the medication disclosure is not addressed in the proposed solution. Theoretically, if the system is designated for use by a few people, and a hacker attacker knows these people, thus the matching between the Blockchain addresses and physical identities is more probable. However, the data is valuable for many patients and should not be revealed easily. In both cases, the requirement R1 is not violated.

Since the SSC contains two different and independent levels of permissions (permissioned Blockchain and smart contracts), there is no need for extra security measures to grant the network access; thus, this satisfies requirement R2. Since the SSC uses Blockchain, and if more than two-thirds of the validators are generous, the data (prescription, purchase place and time, Etc.) storage is considered very safe and immutable. A supplementary events recording is included in the smart contracts, possibly provoking a different system to generate duplication in the records storage. Thus, the requirement R3 is satisfied.

The smart contracts are designed in a modular style with a precise contract manager. Thus, all SSC modifications are necessary to invoke the CM. Thus the modifications are hidden from the users and applications interacting with the Blockchain application as the interface contract addresses (Information Manager) are never changed.

Consequence: According to performance (as to privacy and security), completeness, functionality, the artifact, and rationality, there is a convincing argument for DMR usage.

Table 4. Functional Requirements Evaluation.

Actor	Traceability	Justification
Patient	1.1	The function <code>getPrescriptions()</code> of Information Manager allows the registered patient to access his prescriptions
	1.2	Satisfied in the component and contract layers
	1.3	The consent of patient access to particular prescriptions is ensured by the two functions <code>setPrescripConsent()</code> and <code>setConsent()</code>
Doctor	2.1	The functions <code>checkPrescription()</code> , <code>getPrescriptions()</code> , and <code>addPrescription()</code> of Information Manager allow knowing registered doctors
	2.2	The Blockchain Secure Messaging Service allows the verification of patients' and doctors' identities
	2.3	The function <code>getPrescriptions()</code> allows the doctor to identify the correct patient
	2.4	Satisfied in the component and contract layers
Pharmacy	3.1	The <code>purchase()</code> function allows the pharmacist to check the patient's prescription. This function triggers the permission database contract
	3.2	Satisfied in the component and contract layers

5 Conclusion

This paper presented a proof-of-concept application developed to act as a DMP in a completely decentralized manner. An SSC was implemented to manage patient privacy information to ensure network security. The programming language Solidity was used along with consented Blockchain framework and cryptographic tools. The application evaluation ensured that all system requirements were fulfilled and all research questions were answered in addition to the application framework. Despite this fact, it is worth mentioning that there are no assertions on the security outside of the SSC as there are different ways to steal private keys (account password reset by phone).

The research objective is to figure out a particular problem in the healthcare domain, which can be generalized to other sectors such as mobile phone operators, internet providers, banks, etc. We proposed an application that allows users to record their private information and then share it with different partners in an extremely controlled way.

Future work: As Blockchain technology is increasingly employed in public and private sectors, the understanding of Blockchain as a part of cryptocurrency should be publicized. In the current research context, multiple features need additional improvement. For instance, it introduces a new function for automatic control of medications versus databases of familiar dangerous or undesirable effects. Also, creating a complete Blockchain-based digital healthcare application includes vaccinations, drug plans, etc. On the other hand, further research is required in decentralized computing appropriate to Blockchain technology, particularly in lightweight protocols and consensus algorithms

for Internet-of-Things applications. The Proof-of-Work identifies the consensus problem, but its computational cost is considered high in the Bitcoin system. Consequently, solving this problem securely, reducing the computational cost, and minimizing the shortcoming of Proof-of-Stake algorithms will be important findings.

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Digital CSR and Corporate Sustainability Moderated by Perceived Technological Environmental Uncertainty: Empirical Evidence

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Abstract. This study investigates the nexus among digital corporate social responsibility (CSR) practices and corporate sustainability as well as the moderating impact of perceived technological environmental uncertainty in this context. It provides empirical evidence from the Jordanian market. To achieve the study's purpose, 170 e-survey questionnaires were emailed to all Jordanian corporations listed on the Amman Stock Exchange. In the research letter, we invited the respondent to be the chief executive officer (CEO). Using a partial least squares structural equation modeling (PLS-SEM), the results show that corporate sustainability is positively affected by digital CSR practices and that the relationship between digital CSR practices and corporate sustainability is positively moderated by perceived technological environmental uncertainty. Finally, this study has immediate impact for a wide range of managers, decision-makers, consultants, and policymakers.

Keywords: Sustainability · CSR · Environmental uncertainty · Organizational theory · Jordan

1 Introduction

Corporate social responsibility (CSR) is a widely debated term in economic and management sciences [1–3], with corporations facing pressure from diverse interest groups demanding that they be socially responsible [4]. According to the findings of CSR research, adopting CSR assumptions and acknowledging the importance of community and environmental responsibility [5] provides the prospect of sustainable growth of businesses in diverse sectors [6, 7].

Corporations all around the world are transitioning toward more inventive social responsibility in order to confront environmental and social concerns while also adapting to global standards as well as local circumstances and demands [8]. These concerns have increased the ambiguity and complexity of CSR, putting additional requirements on corporations to demonstrate their responsible conduct [9]. These concerns have also led corporations to implement digital CSR practices compatible with societal digital changes [10], where corporations modify their CSR in step with the transition of society and stakeholders into digital environments. Digital CSR is the use of a technology or platform to enable a corporate's commitment to doing good to go even further [9]. It comprises bringing CSR operations, administration, and reporting online, allowing corporate programs to be more scalable and successful [11].

Active digital CSR practices have assisted corporations and stakeholders in standing out in extremely difficult circumstances and gaining clients' confidence, loyalty, and strategic partnerships [10]. As a result, corporations must carefully build their digital CSR practices, employing technologies to develop sentiments of trustworthiness and connection that promote client involvement and strengthen business image while also maintaining the chances of survival [12]. However, despite the widespread adoption of CSR practices, the effects of digital CSR have not been thoroughly supported and the existing understandings on the effects of digital CSR are based on evidence of offline CSR impacts [9, 10]. The importance of digital CSR activities in helping corporations to obtain acceptability and sustainability has not been widely explored. Thus, the purpose of this study is to investigate the influence of digital CSR practices on corporate sustainability. This paper presents empirical evidence from an emerging market (the Jordanian market), since prior research has shown that the level of CSR activities in emerging markets remains low when compared to developed markets.

The tremendous shift to digitization has spawned brand-new business environment features and creative methods of performing functions and practices, necessitating a re-examination of classic management ideas and approaches in the new digital world [9]. According to the literature, most researchers investigate how corporate pressures impact offline CSR under normal situations. Several studies also demonstrate that these pressures have an impact on the adoption of various information technology (IT) applications [12]. Despite a growth in digital CSR literature, research remains restricted and limited [10, 12]. Therefore, this study looks at the moderating impact of perceived technological environmental uncertainty on the nexus among digital CSR practices and corporate sustainability.

2 Literature Review and Hypotheses

CSR refers to a corporation's operations that are related to its considered societal responsibility [13]. Previous literature defines CSR as focused on building a social, economic, and environmentally sustainable business culture and operations [11]. Recently, a digital transformation has permeated numerous parts of society and its activities and thus, corporations have recognized the usefulness of digital platforms in setting up and executing CSR activities [14]. The communication threshold at which corporations establish and perform CSR activities utilizing online applications is characterized as digital CSR [15].

Digital CSR comprises a wide variety of activities and practices, including providing information on social, ethical, and environmental policies in order to satisfy the expectations and requirements of society as well as increasing corporations' CSR efforts and activities [9]. It also encompasses a wide variety of online behaviors (e.g., supporting and founding web philanthropic and digital societal initiatives as well as financing digital societal practices) [11, 12].

However, the operations and practices of a corporation are influenced by a variety of internal and external variables [15]. To sustain the legitimacy of its existence and ensure its continuation, a corporation must comply with these variables in its practices and operations, including CSR [13]. Previous research has found that these restrictions play a significant part in corporations undertaking and conducting CSR to fulfill social and environmental needs as well as the needs of other stakeholders [16, 17]. While internal variables are still being researched, research on the external forces that shape CSR is largely based on organizational theory [18].

2.1 Digital CSR and Corporate Sustainability

The term "sustainability" refers to a corporation's long-term ability to survive and thrive based on its flexibility [19]. The idea of sustainability comes down to accomplishing three core goals: economic, social, and environmental [4]. Corporations undergo transformations as a result of socially responsible acts and the adoption of the concept of sustainability, such as the development of new goods, services, technology, and distribution channels [9]. Therefore, previous literature notes that CSR is required for long-term development [4]. Social responsibility and long-term development are intertwined and represent the interconnectedness of economic, social, and environmental systems [6].

Corporations are frequently engaged in sustainability through conveying knowledge generation, knowledge management, and exchanging information about practices via digital networking. Previous studies show that corporate performance is positively influenced by digital CSR practices [20], image, and reputation as well as attractiveness [21]. They have documented that digital CSR improves client happiness and loyalty [10]. Incorporating sustainable activities into social responsibility strategies immediately translates into reporting non-financial information based on long-term goals [4]. As a result, social responsibility (whether offline or digital CSR) should be regarded as a part of the idea of sustainability. However, the direct impact of digital CSR practices on corporate sustainability has received little attention. Therefore, this study developed the following hypothesis:

H1. Digital CSR practices positively affect corporate sustainability.

2.2 The Role of Technological Environmental Uncertainty as a Moderator

Sustainable growth is a long-term approach for gaining new development avenues for a corporation [22]. In uncertain times, sustainability is the road to stability and risk reduction [4]. External variables that are unprecedented have long been viewed as a danger to corporate sustainability [17, 23]. However, the expansion of the digital economy has decreased the environmental uncertainty caused by shifting market demand, and

therefore lowered the risk. Although new digital technologies have demonstrated operational and economic benefits, they can also have unintended environmental and societal effects [24]. This study looks at this context by investigating how corporations might perceive technological environmental uncertainty to achieve digital CSR practices and then achieve corporate sustainability. Digital CSR is described as a corporation's ability to incorporate digital technology in their CSR performance [25]. As a result, we analyze the interaction (moderation) between digital CSR practices and perceived technological environmental uncertainty in order to determine corporations' ability to achieve sustainability. Furthermore, no empirical study has investigated the indirect (moderating) influence of perceived technological environmental uncertainty on the relationship between digital CSR practices and corporate sustainability; thus, this study investigates this context using the following hypothesis:

H2. Perceived technological environmental uncertainty positively moderates the link between digital CSR practices and corporate sustainability.

3 Research Methodology

3.1 Population and Sampling

All Jordanian corporations listed on the Amman Stock Exchange (ASE) at the end of 2022 are included in the study population, totaling 170 corporations (96 financial corporations, 41 services corporations, and 33 manufacturing corporations). This study employs a comprehensive survey method that includes all members of the study population.

3.2 Research Instrument Design

The current study employs the quantitative approach, as it depends on testing hypotheses after gathering data from the study's target corporations. This study employs an e-survey questionnaire using Google Forms to collect its data. This study's e-survey questionnaire is separated into three sections. The first is a cover letter, and the second consists of three paragraphs describing the responders' characteristics (job title, experience and educational level) and three paragraphs describing the corporate profile (the sector, age, and size of a corporation). In the final section, the study variables are measured.

Initially, the emails and phone numbers of the targeted corporations were acquired via the corporations' own websites and the ASE database. Then, because the corporation is the unit of analysis, we sent one e-survey questionnaire with a research letter to each corporation, totally 170 e-survey questionnaires. In the research letter, we invited the respondent to be the chief executive officers (CEOs) because of their extensive understanding of the corporate performance and practices such as CSR practices [8]. Next, the targeted corporations were contacted by phone to urge them to respond. We received 78 replies (a 45.9% response rate) after two weeks in January 2023. To enhance the response rate, we re-sent the questionnaire and letter and phoned the targeted corporations who had not responded. We received 49 new responses after another two weeks, ending up with 127 valid responses (a 74.7% final response rate) for analysis.

3.3 Variables Measurement

Using a 7-point Likert scale (where answers ranged from 1 meaning “strongly disagree” to 7 meaning “strongly agree”), this study adapted the measurement of each variable from previous studies. Table 1 shows the measurement of each variable in the study model.

Table 1. Measurement of Each Variable

Variable	Code	Items	Source
Digital CSR practices	DCSR	6 items	[8, 11, 26]
Corporate sustainability	CS	7 items	[8, 27, 28]
Perceived technological environmental uncertainty	PTEU	4 items	[29, 30]

Two corporate profile characteristics (the age and size of a corporation) are included as control variables in the research model analysis. The literature argued that the age and size of a corporation have an impact on CSR practices and sustainability. For example, Badulescu et al. [31] document that the smaller a corporation is, the less probable it is to engage in CSR. Additionally, Wickert et al. [32] find that large corporations frequently prioritize CSR implementation but smaller corporations are less engaged. Additionally, Shrivastava and Tamvada [33] state that sustainability signals have varying effects on corporations based on their age and size. Finally, the age and size variables were measured using four size groups based on the number of employees [34] and three age groups [35], respectively.

4 Data Analysis and Results

We use partial least squares structural equation modeling (PLS-SEM) to analyze the data because it suits small sample sizes [36]. PLS-SEM also provides better estimates for complex models (e.g., moderator variables) [37].

4.1 Common Method Bias and Multicollinearity

Kock [38] argues that common method bias (CMB) will exist when the variance inflation factor (VIF) is greater than 3.0. In this study, the maximum inner VIFs in model 1 and model 2 are 1.007 and 1.037, respectively. Moreover, these VIF values are lower than 3.3. Therefore, CMB and multicollinearity do not exist in our work [39].

4.2 Measurement Model Assessment

The standardized root mean squared residual (SRMR) is 0.058 in model 1 and 0.065 in model 2. As these values are lower than 0.08, the data responds well to the proposed model. Table 2 shows that all outer loadings are higher than 0.6, composite reliability (CR) values >0.7 , and average variance extracted (AVE) values >0.5 (see Appendix 1). These values provide a high convergent and reliable validity [40].

Table 2. Scale evaluation and HTMT

Variable	Items	Outer loadings range	CR	AVE	HTMT		
					DCSR	CS	PTEU
DCSR	DCSR1 to DCSR6	0.839 – 0.884	0.949	0.758	1.000		
CS	CS1 to CS7	0.657 – 0.768	0.880	0.512	0.444	1.000	
PTEU	PTEU1 to PTEU4	0.759 – 0.831	0.877	0.641	0.061	0.474	1.000

Discriminant validity is checked by the heterotrait-monotrait ratio (HTMT). Table 2 shows that HTMT values do not exceed the threshold of 0.85 and all of the constructs guarantee discriminant validity [39].

4.3 Structural Model Assessment

The structural model is used to check the hypothesis. Figure 1 and Table 3 show that DCSR positively affects CS (model 1: $\beta = 0.412$, $p = 0.000$; model 2: $\beta = 0.406$, $p = 0.000$). Next, Fig. 1 and Table 3 also show that the relationship between DCSR and CS is positively moderated by PTEU ($\beta_{\text{DCSR} \times \text{PTEU}} \rightarrow \text{CS} = 0.230$, $p = 0.000$; see also Fig. 2). Additionally, the research uses some indicators to guarantee the acceptance of the hypothesis, for example, R^2 , effect size (f^2), 95% of confidence interval (LLCI: lower-level confidence interval; ULCI: upper-level confidence interval). Following that, R^2 and f^2 are greater than 0.1 and 0.02 respectively, ranging between LLCI and ULCI excluding 0 (see Table 3). There exists a good relationship between endogenous and exogenous variables. Therefore, hypotheses *H1* and *H2* are accepted.

Table 3. Hypothesis testing results

Hypothesis	Model 1 (DCSR: IV, CS: DV)		Model 2 (added PTEU as moderating variables into Model 1)	
	β (P-value)	95% CI LLCI-ULCI	β (P-value)	95% CI LLCI-ULCI
Direct effects				
<i>H1</i>				
DCSR \rightarrow CS	0.412 (0.000)	0.282–0.569	0.406 (0.000)	0.281–0.541
PTEU \rightarrow CS	0.400 (0.000)	0.276–0.536	0.400 (0.000)	0.274–0.536
Moderating effect				
<i>H2</i>				
DCSR \times PTEU \rightarrow CS			0.230 (0.000)	0.094–0.334
Control variables				
AGE \rightarrow CS	0.029 (0.745)	–0.140–0.193	0.066 (0.406)	–0.097–0.219
SIZE \rightarrow CS	0.058 (0.522)	–0.112–0.238	0.102 (0.148)	–0.031–0.241
Maximum inner VIF	1.007		1.037	
R ²	0.175		0.403	
F ² (DCSR \rightarrow CS)	0.205		0.275	
F ² (DCSR \times PTEU \rightarrow CS)			0.089	
SRMR	0.058		0.065	

4.4 Robustness Check

The moderating effect of PTEU on the relationship between DCSR and CS was the main objective of this study. Therefore, we double-check the results from PLS-SEM by using the 4.0 PROCESS integrated into the SPSS 26.0 software, applying model 2 with 95% of the confidence interval and 5,000 bootstrap samples. We show the analysis results in Table 4.

With $\beta = 0.246$, $t = 3.344$, $p = 0.001$, and ranging between LLCI and ULCI excluding 0 (see Table 4), the PTEU positively moderates the relationship between DCSR and CS. This analysis fully supports the results from PLS-SEM.

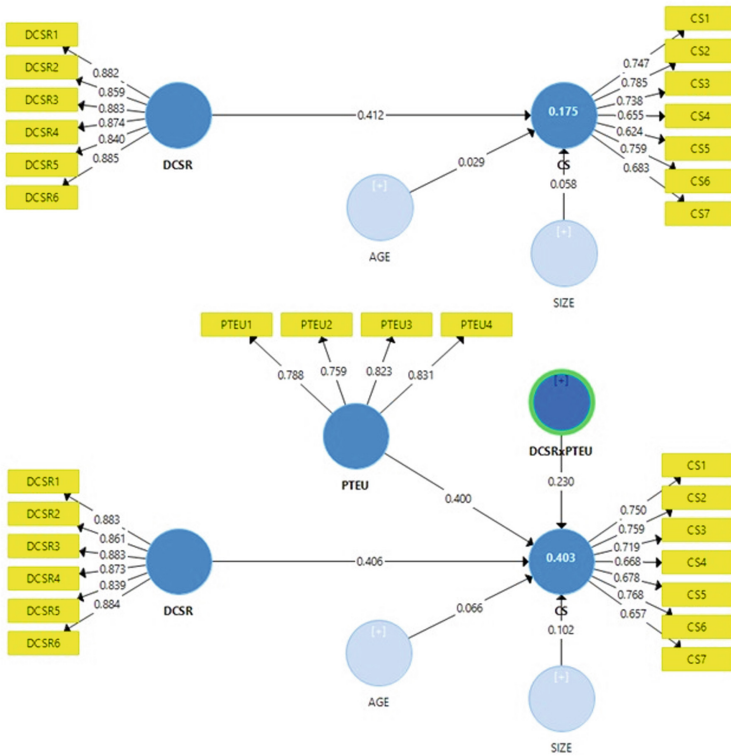


Fig. 1. Path analysis (Model 1 and Model 2)

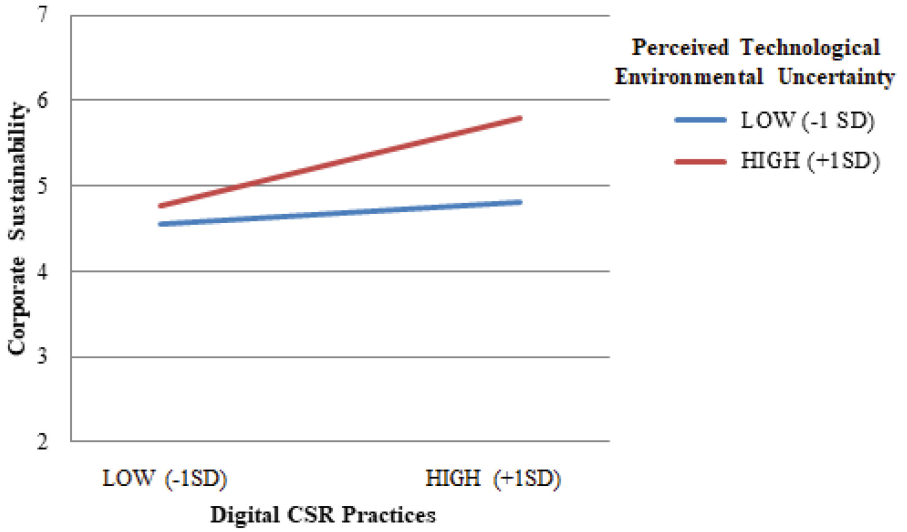


Fig. 2. Interaction term of DCSR with PTEU on CS

Table 4. Model 2 (4.0 process-interaction)

Variable (DV: CS)	Coefficient (β)	SE	t	p	LLCI	ULCI
Constant	6.626	1.531	4.327	0.000	3.595	9.656
DCSR	-0.695	0.298	-2.330	0.022	-1.286	-0.105
PTEU	-0.761	0.377	-2.021	0.046	-1.507	-0.016
Interaction term DCSRxPTEU	0.246	0.073	3.344	0.001	0.100	0.391
R ²	0.374					
F-statistics	24.528					

5 Conclusion

Motivated by the growing interest among corporations and decision-makers in how digital CSR practices can help improve corporate sustainability, this study sheds light on the nexus among these two phenomena. Additionally, it investigates the moderating role of perceived technological environmental uncertainty on this nexus. This study provides empirical evidence from the Jordanian market.

This study acknowledges the positive effect of digital CSR practices on corporate sustainability. This result could be explained because digital CSR practices contribute to increase brand identification and positive brand attitudes as well as improve client confidence and loyalty and, therefore, corporate sustainability is positively affected [9, 10, 12]. The literature also documents that digital CSR practices positively contribute to increased corporate performance by improving corporations' images, reputations, and attractiveness [20, 21].

Moreover, the results of this study show that perceived technological environmental uncertainty positively moderates the nexus among digital CSR practices and corporate sustainability. Consequently, corporations may benefit from perceptions of technological environmental uncertainty in order to improve their digital CSR practices and thus their sustainability. This conclusion is backed up to some extent by previous research [4, 22, 25].

Finally, by understanding the impact of the adoption of digital CSR practices for sustainability-related goals, this study has immediate impact for a wide range of managers, decision-makers, consultants, and policymakers. However, these phenomena can be further examined in the future by looking at the internal and external factors that influence the internal corporate environment and practices, such as governance and other environmental uncertainty factors. Furthermore, because this study looked at these phenomena in the Jordanian market, future work may look at the study context in different markets, therefore confirming or refuting the results of this study.

Appendix 1. Scale Evaluation

Variable	Items	Code	Outer loadings	CR	AVE
Digital CSR practices (DCSR)				0.949	0.758
	To what degree do you believe digital techniques/solutions/platforms help your corporation to:				
	Inform the public about CSR efforts and activities	DCSR1	0.883		
	Interact and work with people of society	DCSR2	0.861		
	Support the activities of the society that promote quality of life and well-being	DCSR3	0.883		
	Contribute to volunteer societal initiatives	DCSR4	0.873		
	Increase understanding of stakeholders' requirements and expectations	DCSR5	0.839		
	Increase societal awareness and knowledge of hazards and safety precautions during emergencies	DCSR6	0.884		
Corporate sustainability (CS)					
	To what degree do you believe that adopting and implementing CSR using digital techniques, solutions, and platforms help to:			0.880	0.512
	Ensure a long-term reputation	CS1	0.750		
	Provide a long-term competitive edge	CS2	0.759		

(continued)

(continued)

Variable	Items	Code	Outer loadings	CR	AVE
	Maintain the corporate's growth	CS3	0.719		
	Build long-term ties with stakeholders and the general public	CS4	0.668		
	Increase client satisfaction	CS5	0.678		
	Increase societal acceptability and legitimacy	CS6	0.768		
	Increase performance	CS7	0.657		
Perceived technological environmental uncertainty (PTEU)	Our sector's software updates are extremely predictable	PTEU1	0.788	0.877	0.641
	Hardware opportunities in our business are fairly predictable	PTEU2	0.759		
	Technological advances in our sector are fairly predictable	PTEU3	0.823		
	Changes in technology in our sector over the next three years are extremely foreseeable	PTEU4	0.831		

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Impact of Dynamic Capabilities and Organizational Agility on the Competitive Performance: The Mediating Role of Organizational Learning

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Abstract. This research attempts to ascertain the mediating role of organizational learning between dynamic capabilities, organizational agility and competitive performance in the Jordanian commercial banks. Findings from partial least square structural equation modeling revealed that dynamic capabilities and organizational agility have a significant impact on competitive performance. Furthermore, the finding that organizational learning partially mediates the effects of dynamic capabilities, organizational agility and competitive performance suggests that the ability to learn is a crucial component of the bank's competitiveness. The current research provides new insight on how banks can develop and leverage their dynamic capabilities, agility and learning to enhance competitive performance.

Keywords: Competitive performance (CP) · Dynamic capabilities (DC) · Organizational agility (OA) · Organizational learning (OL)

1 Introduction

In today's rapidly evolving environment, characterized by unpredictable changes, banks must be able to explore opportunities and capitalize on market shifts and avoid threats facing to survive [44, 63]. In order to stay competitive and succeed in the long term, banks must be able to quickly adapt to changes in the industry and take advantage of new opportunities as they arise. This requires a high degree of agility, as well as the ability to identify and respond to threats in a timely and effective manner [73]. Moreover, the knowledge-intensive nature of the banking industry underscores the importance of fintech innovation and organizational learning.

Banks must be able to stay up-to-date with the latest emerging. Cutting-edge technologies and fintech development in their industry, and to leverage new emerging artificial intelligence applications and banking models in order to stay ahead of the competition. To survive and thrive under rapid changes, banks need to develop dynamic capabilities skills to create, expand and adjust the ways they provide smart banking and financial services [33].

Dynamic capabilities have been viewed as an organization's ability to adopt and respond to changes in the external environment [43, 74]. In the case of banks, this means being able to quickly adjust their services in response to changing customer needs, emerging, smart technologies and new market trends. DC include the sensing, seizing and transforming opportunities to a new products and services [71, 75].

Organizational agility is closely related to DC and refers to a firm's ability to respond quickly and effectively to changes in the market [11]. Research has shown both DC and OA are significantly related to CP. While DC and OA have been extensively studied in the context of the banking industry, there has been relatively little research on how OL mediates their relationship [46, 47].

Understanding how OL mediates the relationships between DC, OA, and CP in the banking industry is important for several reasons. First, it can help banks to identify the specific mechanisms by which they can improve their performance and maintain their competitive edge in the market. Second, it can help researchers to develop more comprehensive and accurate models of the competitive performance in the banking industry. Thus, the current research has contributed to the existing literature in several ways. First, it has expanded our understanding of the specific routines by which banks can improve their competitive performance and maintain their competitive edge in the market. Second, it has provided insights into how banks can develop and leverage their dynamic capabilities and OA in order to improve their performance. Finally, it has highlighted the importance of OL as a key mediator of these relationships. Overall, the current research has made a valuable contribution to the research by filling an important research gap a providing new insights into the relationships between dynamic capabilities, organizational agility, organizational learning, and competitive performance in the banking industry.

2 Literature Review

2.1 Dynamic Capabilities

In recent decade, dynamic capabilities concept has attracted much attention as a key factor in competitiveness and Innovative performance [55, 73, 78]. Researchers have sought to understand how firms integrate, build, and reconfigure their internal competencies and external resources [21, 28, 76]. Dynamic capabilities comprise the three main dimensions: sensing, seizing and transforming [9, 83]. Sensing involves recognizing business opportunities and identifying changes. The seizing dimension taking advantages opportunities and leveraging possibilities on how rapidly responding to markets [36, 75]. It involves taking advantage of opportunities and making the most of them. This includes rapidly developing and implementing innovative products, services, and business models in response to changes in the market. Transforming refers to continuous renewal, modification, and change in response to new challenges and opportunities. This requires continually improving and evolving its existing capabilities and processes, as well as developing new ones as needed to meet changing market demands. Thus, DCs are not just a single capability, but rather a set of interrelated dynamic capabilities that work together to help firms adapt to changes in their market. These capabilities are built

upon the firm's routines, procedures, and processes which provide the foundation for the firm's ability to sense, seize, and transform [17, 62, 71, 74].

2.2 Organizational Agility

Organizational agility (OA) has its roots in the concept of DC as well as related concepts such as organizational adaptability and flexibility [23, 24, 67]. Firms must be agile and able to handle extreme changes in the market and business environment [47, 67]. That is, in today's fast-paced and rapidly changing environment, firms must be agile and adaptable in order to remain competitive and successful. This is particularly true in industries that are undergoing significant disruption or transformation, such as the banking industry. An agile bank is one that is able to respond quickly and effectively to change in its market, whether those changes are driven by shifts in customer needs and preferences, changes in digital technology or other external factors. This requires a culture of innovation and willingness to take risks in order to gain a competitive performance [24, 31]. Organizational agility as a dynamic capability supports the proactive identification of opportunities and fosters banks' capabilities to adjust by responding efficiently and reshaping the industry [32, 80]. While OA is conceptualized by Lu and Ramamurthy [47] as enterprise capacity to best deal with the sudden and unexpected changes, Chakravarty et al. [14] argue that OA is an ability to seize market opportunity and then allow organizations to adjust their strategies. OA can have twofold impacts; market capitalization and operational adjustment agility [46, 47]. Externally, market capitalization agility refers to a firm's ability to respond quickly and effectively to changes in market conditions. Banks that are able to adapt quickly to these changes are often able to maintain or increase their market share and profitability. Internally, operational adjustment agility refers to a firm's ability to adapt its internal processes and structures in response to changes in the market or industry. This might include changes in the way that work is organized or changed to the bank-supply chain. Overall, a bank that is agile in both external and internal operations is better positioned to respond to changes in the financial and banking industry and maintain competitive performance. By being flexible and adaptable, banks can stay ahead of the competition and position themselves for long-term success.

2.3 Organizational Learning

Organizational learning (OL) is one of the prominent concepts for firms that want to remain competitive in business [10, 16]. OL refers to the process by which firms acquire and develop new knowledge, skills, and competencies through both internal and external learning [6]. However, some authors view OL as a changing behavior, while others emphasize the acquisition of knowledge and insights [6, 66, 82]. From the perspective that views OL as a change in behavior, the focus is on the ways in which firms modify their actions and behaviors in response to opportunities or challenges. While the perspective that emphasizes the acquisition of knowledge and insight suggests that OL is a cognitive process that involves acquiring new knowledge and integrating them into existing knowledge resources. This view argues that OL is a dynamic process based on knowledge, which implies among individuals, groups, action teams, and organizational levels

[39, 51]. It involves knowledge acquisition, knowledge assimilation and knowledge transformation as well as knowledge exploitation to enhance competitive performance. Empirical studies the relationship between OL and CP. Research has shown that both DC and OL are significantly related to CP [54, 64]. For example, a study by Oh [54], found that feedback learning flows are strongly mediated between learning stocks and performance, while the findings of Migdadi [49] study suggest that OL influences innovation and innovation affects performance. Overall, OL and DC are the most crucial dynamic capacity that a firm need to acquire competitive performance.

2.4 Competitive Performance

Competitive performance (CP) refers to the degree in which a firm act better than its main competitors in the market or industry [50, 60]. It is a firm's ability to achieve and sustain a competitive advantage over its rivals, or the ability to earn better than the average return on investment [68, 81]. However, CP construct can be measured in various ways, such as market share, profitability, revenue growth, customer satisfaction or brand reputation. That is, CP is relative to the performance of competitors in the same market or industry and reflects a firm's ability to outperform or meet or exceed the standards set by its rivals [2, 59, 70]. Furthermore, CP is influenced by a range of factors, including a firm's ability to learn, organizational agility, its internal dynamic capabilities, knowledge absorptive capacity and its strategic positioning. The ability to build and leverage dynamic capabilities and organizational agility through OL is also critical for achieving and sustaining CP, as it enables firms to respond quickly and effectively to changes in the business environment, and to capitalize on new opportunities [13, 15, 18, 37]. In short, achieving CP involves a combination of dynamic capabilities, organizational agility and organizational learning that led to business excellence, and a continuous focus on innovation, customers need, and market trends.

3 Research Model and Hypothesis

The current research model that drawn upon the dynamic capabilities view and OA aims to investigate the causal relationships between DC, OA, OL, and CP. The underlying argument is that when DC and OA are combined with the support of OL, firms can achieve sustainable competitive performance. DC enable firms to sense, seize and transform resources and capabilities in response to changes in the business environment. OL reflects a firm's ability to quickly and effectively respond to changes and uncertainties in the market. By combining these two capabilities, firms can gain a competitive performance. OL plays a mediated role in supporting and enhancing both dynamic capabilities and organizational agility. Through the acquisition, sharing and utilization of knowledge, firms can develop their capabilities, improve their agility, and enhance their CP.

Therefore, the current research model proposes that DC and OA have a direct and positive impact on CA. In literature research has shown that both OA and DC have a positive impact on CP [29, 53]. Al-sarairah et al. [5] study found that strategic agility mediates the relationship between lean production and sustainable performance. While Teece et al. [77] findings confirmed that DC are crucial factors to enhance OA required to gain competitive advantage. Thus, from the forgoing literature review, we hypothesize:

H1: Dynamic capabilities positively impact competitive performance.

H2: Organizational agility positively impact competitive performance.

Moreover, the research model grounded on the mediating role of the OL between DC and OA and CP as previous studies revealed that fostering OL can have impactful effects on the firm's dynamic capabilities and agility [7, 56, 66]. Some studies asserted that OL capabilities are antecedents of innovation and performance [40, 57].

Thus, we hypothesize the following:

H3: Organizational learning mediates the relationship between dynamic capabilities, organizational agility and competitive performance

4 Research Sample and Data Collection

To test research hypothesis, we collected data from a sample of commercial banks in Jordan. We targeted banks for important reasons; First, banking sector has been a leading industry in the Jordanian service-based economy. Second, banking industry is a dynamic context to examine agility, learning and capabilities. Third, it is highly competitive and early adopters to cutting-edge business technologies. Using data obtained from commercial banks across-sectional design study was conducted and survey questionnaires were distributed to 13 banks. The targeted unit of analyst includes banks directors' managers, heads of departments, consultants, data analysts, and IT professionals. All measurement scale was anchored in a five-point Likert form. To operationalize and measure the research's constructs, the authors adopt well-validated established scales from previous research. DC was measure using measurement scale proposed by Li and Liu [45] and Jantunen et al. [38]. OA construct scale was adopted from Cegarra-Navarro et al. [12] and Darvishmotevali et al. [19]. Hung et al. [35], scale was adopted to measure organizational learning. Finally, this research measured CP using 5 items adapted from Li and Liu [45] and Cegarra-Navarro et al. [12].

Usable survey questionnaires were eventually received from 426 respondents, representing 13 commercial banks. The research unit of analysis includes 426, of whom 5(1.2%) CEO, 9(2.1%) deputy CEO, 24(5.6%) Managers, 171(40.1%) heads of department and 33(7.7%) consultants and IT professionals who were randomly selected. Among the respondents 58.7%, were male and 41.3% were female. The majority of the respondents were less 30 years old (10.1%) 30–40 years old (17.4%), 41–50(62.9%) and more than 50 years (9.6%). The majority of the respondents were (9.6%) diploma, (77%) bachelor, (11%) master and (2.3%) PHD. In terms of years of experience, they were less 5 years (8.9%), 5–10 years (11.5%), 11–15 years (7.7%), 16–20 years (37.8%) and above 21 years (34%).

5 Data Analysis Results

For data analysis partial least squares structural equation modeling was used to examine causal relationships in the research model [65]. The first test was carried out to assess the SEM reflective measurement model in terms of indicator reliability, composite reliability, convergent validity and discriminant validity tests. Table 1 shows indicator reliability Cronbach's alpha and composite reliability values are above the 0.702 threshold. The average variance extracted (AVE) was used to assess convergent validity. The threshold for acceptable (AVE) is 0.50 [30].

Table 1. The Measurement Model

Construct	Code	Loading	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
Competitive Performance	CP2	0.717	0.775	0.847	0.526
	CP4	0.724			
	CP5	0.740			
	CP6	0.743			
	CP7	0.701			
Dynamic Capabilities	DCS2	0.850	0.700	0.809	0.586
	DCS4	0.712			
	DCZ1	0.728			
Organizational Agility	OA1	0.775	0.797	0.868	0.622
	OA2	0.778			
	OA3	0.827			
	OA4	0.771			
Organizational Learning	OL5	0.772	0.799	0.869	0.624
	OL6	0.746			
	OL7	0.800			
	OL8	0.837			

Discriminate validity was assessed through three techniques: Cross-loadings, Fornell-Larcker's criterion. Table 2 shows the Fornell-Larcker criterion.

Fornell and Larcker [26] Suggested that each construct (AVE) should be compared to the squared inter-construct correlation of that same construct and all other construct in the proposed research model. The shared variance all constructs should not be larger than their (AVEs) [30], which was confirmed by results in Table 2.

Table 3 illustrates cross-loadings on their constructs and the other constructs in the research model. Outcomes show that all items loaded substantially more strongly on their latent constructs. All factor loading has higher value on their constructs than the other constructs and, thus the discriminant validity is achieved at the level of item loadings.

Table 2. Fornell and Larcker's Criterion

	Competitive Performance	Dynamic Capabilities	Organizational Agility	Organizational Learning
Competitive Performance	0.725			
Dynamic Capabilities	0.548	0.766		
Organizational Agility	0.569	0.509	0.788	
Organizational Learning	0.572	0.421	0.605	0.790

Table 3. Cross Loading

Construct	Competitive Performance	Dynamic Capabilities	Organizational Agility	Organizational Learning
CP2	0.717	0.297	0.421	0.426
CP4	0.724	0.398	0.355	0.357
CP5	0.740	0.353	0.388	0.432
CP6	0.743	0.440	0.492	0.476
CP7	0.701	0.484	0.391	0.372
DCS2	0.513	0.850	0.428	0.373
DCS4	0.325	0.712	0.376	0.296
DCZ1	0.397	0.728	0.365	0.291
OA1	0.473	0.433	0.775	0.437
OA2	0.423	0.431	0.778	0.503
OA3	0.426	0.344	0.827	0.500
OA4	0.472	0.396	0.771	0.466
OL5	0.457	0.301	0.423	0.772
OL6	0.382	0.325	0.444	0.746
OL7	0.438	0.328	0.493	0.800
OL8	0.519	0.372	0.541	0.837

The Structural Model

The structural model in this research, including predicted path coefficients (β) and the values of path coefficients of determination. (R^2) explains the variance explained in the endogenous constructs [30]. The (R^2) value for organizational learning was (0.383), while it was (0.471) for competitive performance. Figure 1 shows, the structural model results.

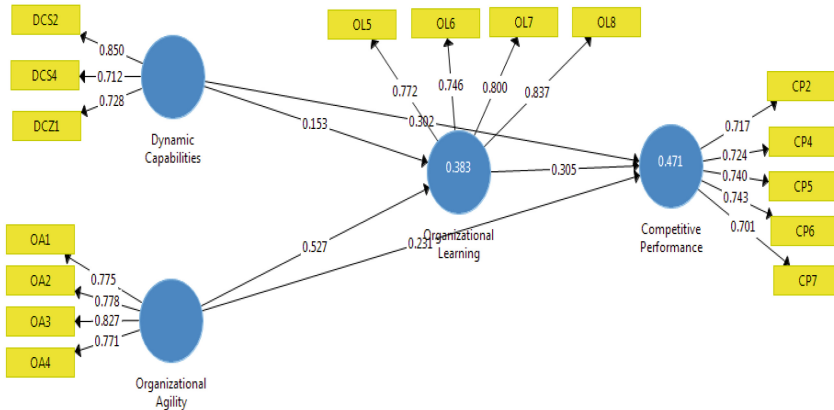


Fig. 1. The Structural Model Results

The impact of dynamic capabilities and organizational agility on competitive performance was significant ($\beta = 0.302, t = 4.743, p < 0.000$; $\beta = 0.231, t = 3.361, p < 0.001$). Thus, H1, H3 can be supported. The impact of dynamic capabilities and organizational agility on organizational learning was significant ($\beta = 0.153, t = 2.551, p < 0.011$; $\beta = 0.527, t = 6.304, p < 0.000$). Thus, H2, H4 can be supported. The impact of dynamic capabilities and organizational learning on competitive performance was significant ($\beta = 0.153 \square 0.305, t = 2.511, p < 0.012$). Thus, H6 can be supported. However, the impact of organizational agility was insignificant and organizational learning on competitive performance was significant ($\beta = 0.153 \square 0.305, t = 2.511, p < 0.002$). Thus, H7 can be supported. The impact of organizational learning on competitive performance was significant ($\beta = 0.305, t = 4.321, p < 0.000$). Thus, H5 can be supported. Table 4 presents the outcomes of the hypotheses that were tested.

Table 4. The Structural Model Results

	Path	Standardized Coefficient (Beta β)	T-Value	P-Value (sig)	Hypothesis Results
H1	Dynamic Capabilities \square Competitive Performance	0.302	4.743	0.000	Supported
H2	Dynamic Capabilities \square Organizational Learning	0.153	2.551	0.011	Supported
H3	Organizational Agility \square Competitive Performance	0.231	3.361	0.001	Supported
H4	Organizational Agility \square Organizational Learning	0.527	6.304	0.000	Supported
H5	Organizational Learning \square Competitive Performance	0.305	4.321	0.000	Supported
H6	Dynamic Capabilities \square Organizational learning \square Competitive Performance	0.153 \square 0.305	2.511	0.012	Supported
H7	Organizational Agility \square Organizational learning \square Competitive Performance	0.527 \square 0.305	3.043	0.002	Supported

6 Discussion

This research aimed to investigate the impact of dynamic capabilities, organizational agility, and organizational learning on the competitive performance in Jordanian commercial banks. The findings indicate the significant impacts of DC and OA. The findings in line with the study of Gyemang and Emeagwali [29] and Tsou and Chen [78]. According to Eikelenboom and de Jong [20] study DC have significant impact on firm's performance. Dynamic capabilities lead to strengthen situation in the market and achieve competitive performance [8, 41, 55].

However, our findings varied slightly from those of the Garrido et al. [27] results. They indicated that the three dimensions of DC behaved in distinct ways. While seize has a positive relative with the firm performance, sensing and reconfiguration have a negative relationship with the firm performance. Moreover, Hernández-Linares et al. [34] study found that the only sensing and coordination contribute capabilities to improving firm's performance.

Besides that, the findings demonstrated that OA positively influenced competitive performance. That is, Jordanian commercial banks are able to identify opportunities in the market and promptly address customers' needs to achieve effectiveness and high performance. Tallon and Pinsonneault [72] explained that OA has a positive impact on firm performance. While Mehdibeigi et al. [48] findings revealed that customer knowledge positively influences on organizational agility, and that customer knowledge via organizational agility has a significant positive impact on the organizational effectiveness. Ravichandran [61] and Abuanzeh et al. [1] confirmed that agile organization can response quickly to the changes around, and agility has a positive impact on competitiveness. Akkaya and Qaisar [3] study is also found a significant relationship between organizational agility market performance, dynamic capabilities and market performance. The finding also illustrates that OA acts as a moderator between DC and market performance. Similarly, the findings revealed that OA significantly associated with DC and CP consistent with previous studies findings [4, 12, 42].

Nevertheless, OL partially mediates the relationship between the DC, OA and CP. The finding consistent with [52, 54, 58, 79]. The finding is also in line with Farzaneh et al. [22] result which indicated that OL is significantly related with DC and innovation performance. While Ferreira et al. [25] study confirms OL culture has a substantial and considerable moderating influence on both competitiveness and performance, as well as reinforcing the impact of DC on innovation. Finally, the finding of this research consistent with Soomro et al. [69] study which indicated that organizational innovation and OL have a positive impact on organizational performance.

7 Implication and Limitations

The current research has several implications. First, this research addressed the ability of DC and OA to predict CP. Second, the finding empirically indicated that OL capabilities significantly related to DC, OA and CP. Thus, by investigating the mediating role of OL, this research fills that gap in the existing literature. Third, it provides valuable insight to the banks top management that wish to address their CP by enhancing their DC, OA and OL. Finally, the current research provides new insight on how banks can leverage their dynamic capabilities, agility and learning capacity to gain competitive performance in the banking industry. However, there are several limitations. The research was based on a cross-sectional design. Consequently, it makes difficult to discern causal relationships among variables in the long time. A longitudinal study may provide further useful information on how banks managers and knowledge workers perceive dynamic capabilities and competitive performance over time.

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Industry 4.0 Technologies and Environmental Performance: The Moderating Effect of Coercive Power

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Abstract. The current study aimed to identify the impact of the big data analytics and internet of things on environmental performance in the manufacturing firms operating in Jordan, as well as to identify the moderating effect of coercive power. Structural equation modelling is used through the Smart-PLS program on a sample of 329 participants. Empirical results showed that each of all hypotheses is accepted. In general, this study made a theoretical and managerial contribution to the industry 4.0 and sustainability literature.

Keywords: Industry 4.0 technologies · environmental performance · coercive power · big data analytics · Internet of things

1 Introduction

In the era of Industry 4.0, organizations are exposed to a wide range of environmental pressures, which make these organizations more aware of providing customers with new value by enhancing their competitive capabilities. Currently, there is a qualitative transformation in determining and exploiting competitive power sources and thus firms' capability to extract information and vision from these data will lead to creating sustainable competitive advantages for enhancing business value [1]. Organizations and firms' capability to access and process big data will enhance manufacturing firms' capabilities for innovation and sustainable manufacturing [2]. Organizations' orientation to use Industry 4.0 technology in facing environmental risks and pollution has become a necessary and strategic requirement to achieve environmental and organizational goals. A set of previous literature showed the importance of Industry 4.0 technology in promoting environmental integration and improving organizational capabilities in facing pollution and reducing waste [3], and managing operational processes sustainably. The interest of scholars and practitioners in using this technology to raise the environmental performance level has formed a wide and important area for discussion. Firms adopting this technology work to use big data and artificial intelligence systems in developing sustainable infrastructure for these firms by collecting relevant data and analyzing them to reach new and improved solutions to environmental problems [4].

Industry 4.0 technology, such as the Internet of Things and big data analytics, provides a set of technical and organizational practices and procedures contributing to raising the environmental performance level by improving the accuracy of control over materials used in production and inventory [5] and providing Transportation Systems Management with the best solutions that reduce energy use and waste [6] enhancing the environmental performance of these organizations. Digital transformation initiatives play a role by relying on Industry 4.0 technology in manufacturing and production to move from the concept of a linear economy to a circular economy [7], focusing on providing capabilities and practices that support the optimal use of natural and organizational resources, maximizing environmental benefit, which leads to enhanced environmental performance [8]. A set of previous prior works confirmed the importance of firms' environmental performance as one of the indicators of organizational superiority [9]. The interest of manufacturing firms in strengthening their competitive position requires more work on environmental aspects and economic aspects [6]. Consequently, measuring the environmental performance of these firms is a very important strategic requirement.

However, the importance of Industry 4.0 technology in enhancing environmental performance, institutional pressures, in particular coercive power, can play a role in enhancing the environmental performance of manufacturing organizations by encouraging organizations to move toward sustainable technological and organizational practices [10]. Leading to improve the environmental performance level.

Coercive power plays a necessary and important role in firms' implementation of mandatory environmental laws and regulations that oblige these firms to preserve the environment [11]. From this point of view, coercive power can have an important impact in promoting the use of Industry 4.0 technology to maximize performance environmental.

The manufacturing sector in Jordan occupies an advanced position in the Jordanian economy [1]. It is considered one of the sectors most interested in promoting environmental activity and adopting Industry 4.0 technology. Therefore, this paper aims to study the direct effects of both big data analytics and the Internet of Things on environmental performance and explore the moderating effect of coercive power in the relationship between big data analytics and the Internet of Things on environmental performance.

2 Literature Review, and Research Model

2.1 Big Data Analytics, the Internet of Things and Environmental Performance

Environmental performance can be described as a set of results that can be measured through the effective management of environmental activities [12]. Environmental management in companies provides the necessary support to implement collective organizational efforts to achieve environmental goals [9], enhancing environmental performance.

Environmental performance can be measured by firms' capability to use their resources efficiently and how they deal with waste and environmental issues and their behavior toward situations that need intervention to preserve the environment [13] Environmental performance can also be measured by the extent to which organizations use remanufacturing, reuse, and recycling practices [3], which enables achieving sustainability in operational activities.

The importance of Industry 4.0 technologies has been widely recognized in the literature, in particular in enhancing and improving environmental performance. Big data analytics and Internet of Things solutions are among the technologies that have the most impact on the supply chain and organizational and environmental performance of organizations [7, 11, 14]. The Internet of Things technology can be described as a set of sensors and objects linked together in the Internet to collect data in manufacturing systems [15]. Internet of Things solutions can be widely used in all industrial machines and equipment in one network to manage them efficiently [16].

Manufacturing firms that use the Internet of Things solutions can work accurately on monitoring and scheduling in material handling and inventory control operations [14] and collecting appropriate data in the supply chain, allowing for increased transparency in the transfer of information across the chain's parties, leading to improving the quality of environmental information [17], which improves these firms' environmental performance. The Internet of Things can also increase control over the flow of materials and inventory through distribution channels by raising visibility and preserving the environment from pollution and increasing capacity for waste management.

Big data analytics can be defined as a set of technological and organizational solutions that include collecting, analyzing, and processing a set of data that is a large volume and includes many unfamiliar hidden patterns that can improve the quality of decision-making [18]. Big data and its analysis have become an interesting topic recently in the field of sustainability of supply chains and manufacturing. This technological system provides a wide range of algorithms and analysis systems that help firms make appropriate environmental decisions [19], and the ability of this technology to support environmental innovations, reduce waste, and enhance production efficiency, leading to improved environmental performance.

Consequently, the following hypotheses can be assumed:

H1 Big data analytics positively affects environmental performance.

H2 The Internet of Things positively affects environmental performance.

The Moderating Effect of Coercive Power:

From the point of view of institutional theory [10], institutional pressures, in particular coercive power, play an important role in facilitating Industry 4.0 technologies adoption [20]. Coercive power includes pressures that arise due to government-supported regulatory bodies, policies, and procedures [21], leading to adjustments to the environmental firms' businesses by relying more on digital transformation initiatives and Industry 4.0, which improves the environmental performance of these firms. The response of organizations to coercive power is very important for business sustainability. Firms will not be able to work in a dynamic business environment without taking into account coercive considerations, which help organizations to be highly compatible with their external environment, allowing them to work within specific standards and patterns [22].

Existing works such as [20, 23].have proven the importance of coercive power in promoting the adoption of Industry 4.0 technologies. Coercive power helps encourage investment in new technology and support the necessary infrastructure for this

technology, which contributes to enhancing organizations' capabilities for innovation, environmental design, and development [10], thus maximizing environmental performance.

Consequently, the following hypotheses can be assumed:

H3 Coercive power moderates the effect of big data analytics on environmental performance.

H4 Coercive power moderates the effect of Internet of Things on environmental performance.

3 Research Methods

Sampling and Data Collection:

The sample for this research study is comprised of all manufacturing firms operating in the Hashemite Kingdom of Jordan. This sector was chosen because it is distinct from other industrial sectors as a knowledge-intensive sector and it is a worldwide driver of innovation.

The research unit of analysis includes 329 department heads, professionals, and knowledge employees randomly selected from these firms. Table 1 lists the demographic characteristics of the study sample.

Table 1. Demographic variables profile

Demographic Variables	Category	No	%
Gender	Males	189	57
	Females	140	43
Age	Less than 30 years	33	10
	30–45 Years	240	73
	46 years and above	56	17
Job position	Top management level	9	3
	Middle management level	89	27
	Operational management level	231	70
Total		329	100

Instruments Developing:

The items used to measure constructs were developed by referring to relevant existing and published works, which were previously tested in these works. All items and responses were rated using a five-point Likert scale from “1 = strongly disagree” to “5 = strongly agree”. The items of Internet of Things and big data analytics constructs were measured

through the study of [19], and coercive power through the study of [22], while items of environmental performance were re-adapted from the study of [9], all items were reflective with 18 items.

4 Data Analysis Results

The Measurement Model Analysis:

This work employed the Partial least squares-Structural Equation Modeling (PLS-SEM) approach to test the reliability and validity of measurement tools and test hypotheses [24].

The PLS-SEM approach is one of the most efficient and powerful methods in dealing with multivariate analysis, especially when breaching assumptions related to the normal distribution of data, linearity or dealing with complex and timely models such as moderating and mediating models [25].

Reliability was evaluated using the Composite Reliability (CR) criterion, convergent validity using the Average Variance Extracted (AVE) criterion, and factor loadings. Given Table 2, all criteria required for evaluating the measurement model were met [24].

Furthermore, discriminant validity was evaluated using the Hetero Trait-Mono Trait (HTMT) criterion, one of the advanced methods for measuring discriminant validity, as all values were less than (0.85), indicating that the conditions for discriminant validity are fulfilled (see Table 3).

The Structural Model Analysis and Discussion

The current paper aims to test the direct causal effects of the Internet of Things and big data analytics on environmental performance through two hypotheses, H1 and H2, and test the moderating effects of coercive power through H3 and H4. To test these hypotheses, the bootstrapping procedure was used 5000 times using PLS-SEM to properly estimate the model. According to the results presented in Table 4, the percentage of variance in environmental performance was 63.7%, indicating that exogenous constructs were able to explain a large part of the variance in environmental performance, indicating that the statistical model is acceptable and satisfactory.

All hypotheses were supported because all the linkages were positive and statistically significant. Both the Internet of Things and big data analytics had a positive effect on enhancing environmental performance, as the results were ($\beta = 0.310, p < .001$; $\beta = 0.265, p < .001$). This result is consistent with the results of current works in the literature [14, 17, 19]. Illustrating the importance of industry 4.0 technologies in promoting manufacturing environmental practices to reduce harmful emissions into the environment and reduce waste of resources and energy, improve manufacturing efficiency, leading to enhancing environmental performance.

Table 2. Reliability and convergent validity for exogenous and endogenous constructs

First-order construct	Item	Factor loading	AVE	Composite reliability
Internet of things	IoT1	0.781	0.582	0.847
	IoT2	0.742		
	IoT3	0.779		
	IoT4	0.748		
Big data analytics	BDA1	0.739	0.654	0.883
	BDA2	0.866		
	BDA3	0.864		
	BDA4	0.759		
Coercive power	CP1	0.764	0.573	0.870
	CP2	0.716		
	CP3	0.780		
	CP4	0.804		
	CP5	0.718		
Environmental performance	EP1	0.739	0.615	0.889
	EP2	0.781		
	EP3	0.846		
	EP4	0.744		
	EP5	0.808		

Table 3. Discriminant validity (HTMT scores)

Constructs	1	2	3	4
1. Environmental performance				
2. Coercive power	0.841			
3. Big data analytics	0.818	0.794		
4. Internet of things	0.843	0.795	0.830	

Furthermore, the results of this paper supported both H3 and H4, which test the moderating effects of coercive power. The results of the interaction between coercive power, the internet of things, and big data analytics were positive and statistically significant ($\beta = 0.163, p = 0.003; \beta = 0.143, p = 0.012$). These results are consistent with the relevant literature in institutional theory, which views coercive power as a power affecting the adoption of Industry 4.0 and sustainability practices, which improves the environmental performance of these firms [10, 20, 23]. In addition, coercive power can drive senior management in these firms to actively use Industry 4.0 technologies to reduce manufacturing environmental risks.

Table 4. Structural model

Hypothesis	Paths	Std. Beta	Std. Error	t-value	p-value	BCI LL	BCI UL	Remark
H1	BDA → EP	0.265	0.081	3.273	p < .001	0.093	0.413	Supported
H2	IoT → EP	0.310	0.078	3.994	p < .001	0.166	0.470	Supported
The moderating effect								
H3	BDA*CP → EP	0.143	0.057	2.526	0.012	0.037	0.258	Supported
H4	IoT*CP → EP	0.163	0.055	2.975	0.003	0.061	0.277	Supported

5 Conclusion, Implications and Limitations

The main objective of the current study was to verify the existence of a positive and direct impact of the Internet of Things and big data analytics on environmental performance and test the moderating effect of coercive power in these relationships. To achieve these goals, cross-sectional data were collected through a questionnaire distributed to employees in administrative positions in manufacturing firms in Jordan. The data were analyzed by the PLS-SEM method and all hypotheses were supported.

This paper had a set of new theoretical contributions that had not yet been tested in the previous literature, especially in the context of emerging countries. Furthermore, this paper can develop new perceptions of the extent to which Industry 4.0 technologies contribute to supporting the environmental path in manufacturing firms, which achieves the highest financial returns and improves the environmental performance level by reducing the negative effects of the activities of various manufacturing firms.

This paper also contributed a new addition to the literature by studying the institutional pressures represented by coercive power. The results reached were consistent with the institutional theory, which views these forces as greatly affecting the adoption of new technology, which contributed to a greater understanding of institutional motives and how to adapt with them to create an innovative environment that guarantees interest in Industry 4.0 technologies and their use in advancing environmental performance positively.

On the other hand, this paper had a set of administrative and practical contributions that may be useful to the managers of these firms. Industry 4.0 technologies can be used effectively by these firms to support environmental decision systems and managers can increase interest in adopting this technology at all operational level to ensure the highest possible opportunities from environmental organizational activities. Managers should focus on investing in this technology and the necessary infrastructure, with attention to training employees effectively to use this technology in environmental practices.

This paper calls on public policymakers to develop government legislation and legal regulations that allow facilitate the introduction of Industry 4.0 technology in various industrial fields and support Industry 4.0 technology by raising customs restrictions or reducing taxes on firms that support this technology. It is also important for managers in these firms to meet the needs of stakeholders to respond effectively to these coercive powers.

However, the importance of the theoretical and practical contributions of this paper and its coverage of many research gaps, like many studies, suffers from some limitations, which can be addressed by conducting more research in the future. The study was conducted on the manufacturing firms sector in Jordan without taking into account the manufacturing variations between these firms and studying one country. Consequently, in the future, it is useful to conduct studies on homogeneous sectors and a group of countries. Furthermore, cross-sectional data were collected through a questionnaire to test hypotheses in the current study, so this study calls for conducting future studies that take into account the use of multiple methods in data collection. Finally, this paper suggests conducting more studies in the future that take into account other institutional powers that affect firms and the importance of studying the effects of intellectual capital and innovation in the future.

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Women Empowerment in the Age of Social Commerce: An Empirical Study

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Abstract. This study aimed to explore the drivers of social commerce adoption and women empowerment during covid-19 pandemic. Data were collected from a sample of 223 participants, using Structural equation modeling through the Amos program for analysis and testing the research model and hypotheses. Empirical results showed that hedonic motivations, utilitarian motivations, and social support positively affected social commerce adoption among women during the COVID-19 crisis. The results also revealed that social commerce adoption positively affected women's empowerment during the crisis This study made a theoretical and managerial contribution to the social commerce adoption and women empowerment literature.

Keywords: Social commerce adoption · Hedonic motivations · utilitarian motivations · social support · Women empowerment · Covid-19 pandemic

1 Introduction

It is known that the COVID-19 pandemic has led to a significant change in the digital transformation concept. The pandemic has changed the use of digital solutions, which helped to spread them significantly. The percentage of digital solutions and social media use has increased by 61% compared to previous rates [1]. The COVID-19 pandemic played a pivotal role in changing the traditional business scene to the electronic business scene unprecedentedly [2]. These environmental changes, represented by the health disaster that swept the world countries and the complex social and economic conditions that several individuals around the world suffer from, have led to increased pressure on women to work to pay off multiple living obligations [3]. This made it a challenge for women to provide suitable work that helps meet their daily needs.

Numerous previous works showed the importance of information technology in changing the life course of individuals, especially women. Information technology provides and creates opportunities for women to start their entrepreneurial projects, which would enable them to solve the problem of unemployment and start a decent life for themselves and their families [4]. Information technology plays an important role in changing

the lives of individuals and women in particular by developing their competence and forming new growth opportunities for the growth and development of society.

Digital platforms have played a significant role in attracting women to work through electronic and social commerce [5]. These platforms provide women with new job horizons and business opportunities away from traditional jobs, allowing for greater women's empowerment in society. Social commerce is an effective and unprecedented way to empower women economically by starting projects independent of others, which improves their level of innovation and increases their chances of productivity in society, helping women seize great opportunities to achieve a balance between their traditional routine work at home and also interest in achieving economic returns that enable them to lead a decent life for themselves and their families.

At present, the most popular electronic means of communication are social media tools, the most used tools in marketing and promoting new ideas and projects [6], helping women access resources more easily and communicate with individuals and organizations related to financing entrepreneurial and small projects, and exchanging knowledge and experiences with all different parties such as peers or stakeholders, significantly empowering [5]. However, the importance of the COVID-19 pandemic as a major driver for increasing women's use of social media, many motives can be explored and investigated behind women's adoption of social commerce. Previous studies in the literature examined these motives from a range of different angles such as women's rights, science psychology, sociology, economics, and business. Through these different angles, scholars discussed the motives and determinants that make women more empowered while studying the challenges and barriers that may limit women's empowerment in society. In recent times, it has become necessary to understand the opportunities and constraints that may limit or encourage the adoption of information technology for women. Based on a deep review of previous works and studies, there is a lack of studies that investigate the determinants of social commerce adoption for women and there is no empirical evidence on the importance of women's creative potential, which could encourage an increase in women's empowerment in society.

Based on the previous introduction and identifying research gaps, this study aims to explore the determinants of social commerce adoption among women by focusing on women's hedonic motivations, women's utilitarian motivations, and social support and study the effect of social commerce adoption on women's empowerment.

2 Literature Review, and Research Model

2.1 The Role of Women's Hedonic and Utilitarian Motivations

The issue of women's development and empowerment is one of the interesting topics in the past years. Women's empowerment can be described as the woman's ability to increase self-reliance without relying on others, meaning that the individual ability of women to organize themselves, support their rights, and use the available resources to eliminate their dependence on others and reach actual and realistic desired results. Women's empowerment includes a set of economic aspects and social and psychological results that make women able to organize and drive themselves to achieve the highest possible results [5].

Electronic applications, in particular social commerce tools, play a positive role in achieving women's empowerment [5, 7]. The current literature reveals an unprecedented role for these applications in driving women to use electronic and social commerce through these means and benefiting from these applications by presenting new entrepreneurial projects [6]. Although numerous previous studies emphasize the importance of electronic applications, especially social media applications, in promoting and empowering women, there is more interest in identifying this role by focusing on key issues such as social and gender issues [8].

Social commerce can be described as the use of social media with its various platforms to conduct and present various commercial transactions [9]. Social commerce emerged through the increased interaction of e-commerce practices with social media, which provided an opportunity to benefit from these practices in enhancing the economic security of women and empowering them in society.

In the context of social commerce, utilitarian and hedonic motives play a major role in understanding attitudes and behavioral intentions [10]. These motives are the most widely used motives for explaining behavior and intention to purchase in e-commerce and social commerce practices.

The concept of hedonic motivations is described as a group of motives associated with a positive emotional sense, a sense of contentment, and [11]. Much literature has confirmed the importance of social media in enhancing pleasure among users, which enhances their sense of satisfaction, adventure, and suspense when using social media [8]. Thus, hedonic motivations may enhance social commerce adoption among women. [12] Viewed that women adopt using social commerce to feel respect and self-esteem from others. Therefore, hedonic motivations motivate women for non-financial reasons when adopting social commerce, such as increasing the level of happiness and engaging in fun and interesting adventure experiences, and the ability of social commerce to provide new opportunities for women to meet new individuals by increasing social communications, leading to an increase in their level of happiness.

However, the importance of hedonic motivations in promoting women's adoption of social commerce, the COVID-19 pandemic has highlighted the important role of women in overcoming economic and social problems, which made these platforms more capable of promoting gender equality and thus improving the standard of living. Consequently, it can hypothesize:

H1: Women's hedonic motivations positively affected social commerce adoption during the COVID-19 crisis.

Furthermore, the literature confirmed the decisive and positive role of utilitarian motivations in women's adoption of social commerce. Utilitarian motivations are rational motives studied in a goal-oriented manner that focus heavily on added value [13]. The results are evaluated based on the benefits that can be gained from the work or the task [14]. Many scholars argue that social commerce adoption is primarily supported by the pursuit of utility or utilitarian values. Utilitarian motivations focus on the perceived value before an individual adopts social commerce.

Scholars confirm that social commerce has great benefits for women in terms of increasing income and empowering women socially. Social commerce enables women to work on economic investment and not neglect their classic role and family responsibilities [15].

Social commerce and social media platforms had a role in empowering women to contribute to improving the income and well-being of their families during the outbreak of the COVID-19 pandemic [16]. E-commerce enabled women to work on exploiting the pandemic to enhance their economic and social activity from home, supporting the resilience of the family during the crisis. Therefore, the following hypothesis is proposed:

H2: Women's utilitarian motivations positively affected social commerce adoption during the COVID-19 crisis.

Social support is one of the main determinants of social commerce [17]. Social support can be described as the product of interaction between the individual and other individuals who are ready to help and provide direct or indirect support through emotional or informational support or sharing knowledge with them [18]. Thus, emotional support is a core social value that social media and social commerce platforms can support [17].

Women, especially business women, need social support to complete their professional careers. Social support enhances women's self-confidence, which increases their enthusiasm to implement their business on the ground [19]. In addition, social support is necessary to increase women's sense of community acceptance of their goals and actions. Social support and an influx of resources, information, knowledge, and ideas intensify the sense of mission competence and strength needed to empower women to adopt social commerce. Based on the results of [20], social support was important during the COVID-19 pandemic in improving the ability of women to establish their projects, in particular, projects related to social commerce. Thus, social support has contributed to strengthening women's ability to adopt social commerce during the COVID-19 pandemic. Therefore, this study hypothesizes:

H3: Social support positively affected social commerce adoption among women during the COVID-19 crisis.

2.2 Social Commerce Adoption and Women's Empowerment

Many current works in the literature have supported the importance of providing women opportunities to develop their personal businesses and entrepreneurial projects that enable them to work in a dynamic business environment smoothly and effectively [17]. Despite the importance of this for women, the COVID-19 pandemic posed many challenges in terms of the business environment, which led to many social and economic challenges [16]. Empowering women and allowing them to form themselves and improve their learning and growth will enhance economic development and reduce unemployment rates [4], especially in developing countries and contexts.

Studies and research in this field have proven the importance of social media and social commerce in developing and promoting women's empowerment. Social media helps break down the restrictions and barriers that prevent women from starting their businesses [5] and helps them quickly access resources and financing opportunities. Social media can help women to reshape operations and accelerate the pace of business transactions by reaching the largest possible number of customers [21], helping empower

women by creating real investment opportunities for them that enrich them from working in a routine job while not neglecting them to do housework and family duties. Therefore, social commerce platforms can provide great opportunities for women to start their projects and obtain projects with fewer risks, especially in times of health disasters such as the COVID-19 pandemic. Therefore, it can propose:

H4: Social commerce adoption positively affected women's empowerment during the COVID-19 crisis.

3 Research Methods

3.1 Sampling and Data Collection

This paper relied on a convenient non-probability sampling method, one of the most efficient ways to reach a larger number of participants, especially when targeting a specific group or segment of the population. The paper targeted women who use various social media platforms to sell or produce goods or services to achieve returns or financial profits.

An electronic questionnaire was distributed to the study participants. This study faced a set of barriers when collecting data because there is an obvious lack of empirical evidence about social commerce in Jordan, leading scholars to search through various social media platforms, especially Facebook because of its great spread in Jordan.

After distributing the questionnaire to the sample, 235 responses were collected and used in the analysis (see Table 1).

Table 1. The profile of the participants

Age	No	%
<25	52	22
25–40	166	71
>40	17	7
Education		
Diploma or less	36	15
Bachelor	189	80
Postgraduate	10	4
Experience		
<2	58	25
2–4	156	66
>4	21	6
Total	235	100

3.2 Instruments Developing

The quantitative approach was relied upon to develop the study hypotheses and design the electronic questionnaire to implement the empirical part of the study and collect primary data. In developing the questionnaire items, the study referred to previous relevant studies and adapted them to suit the context and culture of Jordan. 20 items were developed by referring to study [10]. to develop the items of women's hedonic motivations and women's utilitarian motivations, and the study of [17, 20]. to develop social support items, while social commerce adoption items were developed by referring to the study [15, 20] and finally women's empowerment items were adapted by referring to the study [5].

4 Data Analysis Results and Discussion

The Amos software and Covariance Based-Structural Equation Modeling (CB-SEM) were employed as statistical tools to assess the measurement and test the structural model and hypothesized paths.

4.1 The Measurement Model

The measurement model was verified by measuring the convergent validity and reliability. By reference to Table 2, it is clear that the values of factor loadings and average variance extracted AVE were higher than (0.50), indicating that the empirical results have confirmed the convergent validity in study constructs. Furthermore, the composite reliability and Cronbach alpha values were calculated and were higher than (0.70). Regarding the discriminant validity test, the HTMT test was employed to verify the presence of divergence and statistical differences between the constructs used in the study. According to Table 3, all values were less than (0.85), indicating that all the constructs are statistically different [23], meaning that there is an acceptable discriminant validity.

Since CB-SEM was used in testing hypothesized linkages, the model fitness was verified by conducting the confirmatory factor analysis (CFA) method, as all model fit indices had good results expressing the model fitness between the default model and the empirical data (X^2/df 2.362; CFI = 0.945; TLI = 0.933; RMSEA = 0.076; SRMR = 0.051).

Table 2. The results of testing validity and reliability

Constructs	Cronbach's α	CR	AVE	FL
Women's hedonic motivations	0.887	0.889	0.668	0.714–0.866
Women's utilitarian motivations	0.873	0.877	0.643	0.718–0.848
Social support	0.898	0.901	0.697	0.744–0.897
Social commerce adoption	0.844	0.847	0.693	0.774–0.861
Women empowerment	0.868	0.871	0.650	0.753–0.891

Table 3. The results of testing discriminant validity

	HM	UM	SS	WE	SCA
HM					
UM	0.742				
SS	0.701	0.66			
WE	0.79	0.76	0.75		
SCA	0.703	0.699	0.693	0.713	

4.2 The Structural Model

The current study aimed to identify the motives and drivers of social commerce adoption among women in Jordan and the causal relationship between social commerce adoption and women's empowerment. Hypotheses were tested using the Amos software, one of the most powerful statistical methodologies in dealing with different statistical models [24].

Before starting hypothesis testing, all statistical assumptions were met, such as the absence of multicollinearity in independent variables, and the data were distributed normally [24]. Table 4 presents the results of hypothesis testing, as the four hypotheses were accepted and supported and all hypothesized paths had positive and statistically significant relationships. H1, H2 and H3 were accepted and the results were as follows ($\beta = 0.375$, $p < .001$; $\beta = 0.279$, $p < .001$; $\beta = 0.307$, $p < .001$). These results indicate that women's hedonic motivations, women's utilitarian motivations, and social support positively affected the adoption of social commerce business during the COVID-19 crisis. This result agreed with a set of results of previous works and studies in the literature [6, 8, 17], showing the positive importance of these motives as main and necessary drivers in adopting the social commerce of women in Jordan, especially in times of health disasters such as the COVID-19 pandemic.

In addition, H4 was accepted, which examined the empirical relationship between social commerce adoption and women's empowerment. The results were ($\beta = 0.958$, $p < .001$), and thus the adoption of social commerce plays an effective role in enhancing the level of women's empowerment by accelerating the pace of financing and access to the largest possible number of customers and access to all countries of the world without restrictions or borders, and this result is consistent with previous studies that emphasize the importance of adopting social commerce in promoting women's empowerment [4, 17].

Table 4. The results of testing the hypotheses

Hypothesis	Paths	Std. Beta	Std. Error	t-value	p-value	Note
H1	HM → SCA	0.375	0.082	4.319	p < .001	Supported
H2	UM → SCA	0.279	0.089	3.535	p < .001	Supported
H3	SS → SCA	0.307	0.054	4.387	p < .001	Supported
H4	SCA → WE	0.958	0.098	11.289	p < .001	Supported

5 Conclusion, Implications and Limitations

The main objective of this study was to identify the motives and determinants of adopting social trade for women in Jordan and identify the positive effects of adopting social commerce on women's empowerment.

This paper had several new contributions to the literature in terms of contributions to theory and practical contributions. First, the current paper could bridge the research gap about studies related to the adoption of social commerce and women's empowerment because there is a clear lack of empirical research that studies these relationships, especially in developing countries. Second, this paper had an important contribution, which is identifying the motives for adopting electronic commerce and empowering women during the COVID-19 pandemic. This pandemic played a major role in promoting the use of social media, in particular for commercial purposes.

Furthermore, this paper had practical contributions, as women entrepreneurs can benefit from providing their services more and more widely through using social media. This paper also recommends women working in the field of social commerce use social commerce applications in advertising and selling their products. In addition, this study recommends that policymakers and managers in social media firms and social commerce platforms encourage women to access these platforms and use them to promote their products and enable their access to various resources.

From a methodological perspective, this paper had a set of limitations that could be addressed through future studies. The study relied on cross-sectional data and an online questionnaire. Therefore, it will be necessary to conduct studies in the future that use other methods of data collection. A group of motives was also studied to find out the determinants of social commerce adoption and other motives such as self-efficacy were neglected. Consequently, it is important to conduct studies in the future that take into account the search for other motives in adopting social commerce.

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Cutting-Edge Business Technology Which Creates Business Disruption While Supporting the Sustainable Development Goals of the United Nations

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Abstract. Industry 4.0 had brought changes in the business industry. Cutting-Edge Business technology has enabled the emergence of the business disruption phenomenon. The key to disrupting the existing market is also gaining a greater purpose through supporting the Sustainable Development Goals of the United Nations as part of the business model. This paper proposes that in addition to the implementation of cutting-edge business technology, it is necessary to have a noble purpose and develop a flourishing (Arabic: Barokah) business. This concept is ensuring that the more the companies are doing business, the more they are doing good to the world. What matters is not to be the best in the world but to be the best for the world. The limitation of the paper lies in the descriptive approach. In the future, empirical research on the flourishing business phenomenon should be further explored.

Keywords: Creating shared values · Cutting-edge business technology · Disruptive innovation · flourishing business · Sustainable-development-goals

1 Introduction

The term disruptive technology began to emerge in 1997 when Clayton Christensen first expressed the term in his famous book “The Innovator’s Dilemma” (Christensen, 2013). This expression emerged when Christensen dissected and researched why businesses that were once successful but over time eventually no longer lead the market due to the invention of cutting-edge business technology. The results of studies from various industrial sectors led to one conclusion. Industries that failed to maintain their supremacy fell because they were unable to anticipate and capitalize on the new wave of cutting-edge business technology. Technology, according to Christensen, is divided into two categories (Christensen, 2013): Technologies that simply support business continuity (sustain) and technologies that break down (disrupt). Sustaining technology relies on incremental improvements, whilst disruptive technology was mostly created through cutting-edge business technology; digitalization and cloud computing are some examples.

Various new businesses have disrupted industries that previously dominated the market. For example, the presence of a new service business model based on sharing economy (SE) that offers application-based service. Some see the SE as a means to address environmental and socioeconomic issues such as pollution, interpersonal connection, resource availability, and poverty (Hamari et al., 2016). These advantages are realized through the shared consumption idea, in which people rent out their assets, services, and skills to another party without relinquishing ownership of such entities (Retamal & Dominish, 2017). When such a concept is combined with an adequate mechanism to match available supply and demand, it has the potential to help maximize the utilization of a scarce resource to its full potential (Allen & Berg, 2014). Recognizing the benefits that the SE has offered to individuals and society, both financially and non-financially (Retamal & Dominish, 2017), a large number of SEs have been founded around the world, demonstrating an increasing trend – particularly in the developing world. An example could be seen from Gojek (The Indonesian transportation platform). In this new business model, Gojek, without vehicle assets, has dominated the public transportation market and beat the taxi companies that had previously dominated the transportation services market. Another example from the world of services can be seen in the Air BnB service. Air BnB comes with a business model that offers choices not only to get accommodation but also to experience being part of local cultures. This has disrupted the supremacy of the hospitality business, which has minimal exposure to local culture. When talking about products, Netflix is often used as an example of an innovative contemporary product that disrupts traditional markets. Initially, Netflix only targeted a niche market without trying to introduce a mass service to serve everyone. Netflix started its business by targeting a target market that so far had not been looked at by other video rental service providers. Netflix's first breakthrough was eliminating the need to personally come and select the videos to rent through a delivery service. But in its development, Netflix is developing web technology so customers can enjoy the video choices they want at affordable prices by subscribing. Of course, this has disrupted the traditional video business market, so picking up videos in rental shops is now a thing of the past. This development has disrupted the business, and it is possible through the adoption of cutting-edge technologies. In this paper, the scope of cutting-edge technologies is looking at digitalization, big data analytics, and cloud computing, which had enabled the business to disrupt the market.

2 Theoretical Background

The concept of Industry 4.0 was first introduced in 2011 at the Hannover Fair in Germany. The term was coined to describe the ongoing transformation of traditional manufacturing and industrial processes through the use of advanced technologies (Karabegović, 2018). While there is no specific start date for Industry 4.0, it is generally considered to have emerged in the early 2010s as a response to the increasing digitization of industrial processes and the growing demand for greater efficiency and flexibility in manufacturing. Today, Industry 4.0 is a major trend in the business sectors, and it is expected to have a significant impact on the global economy in the coming years. Christensen (1997) develop the concept of disruptive innovation. Researchers more recently argue (Markides, 2006) that the disruptive innovation concept needs to be explored further.

Kawamoto and Spers (2019) shared important and possibly related facts about some of the criticisms of disruptive innovation, which concluded that even with the frequent use of the term, the theory's concepts are not always applied consistently. Some concepts focus on the impact of the innovations as opposed to novelty. Famous examples such as Uber, which has already caused significant changes in the taxi industries of several cities around the world and is frequently referred to as a disruptive innovation, do not fit into the concept proposed by original Christensen's concept.

Ponkin et al. (2020) described examples of disruptive innovation and show the origins and genesis of the concept at hand. The researchers reveal the main characteristics that distinguish disruptive innovation from other innovations but acknowledged that there is a very fine line between which technology that could be considered disruptive and which technology could not be considered disruptive.

A significant number of cutting-edge technology innovations have a beneficial impact on individuals, organizations, and or communities. To achieve resource-efficient and user-friendly production solutions, intelligent and precise equipment is required. By boosting production and supplying personalized items on demand, Industry 4.0 is projected to gain from new technologies and applications. Globally, major companies are eager for new opportunities in cutting-edge technologies that can help them streamline operations and minimize costs. The adoption of new cutting-edge business technologies to enhance, change, or even disrupt business models, from operations and strategic perspectives to gain competitive advantage is well established in the literature (Saebi, Foss, and Linder 2019).

3 Discussions

Cutting Edge Business Technology takes many forms and patterns. All of them have the potential to disrupt traditional markets. In the picture (Fig. 1), the various models known today are depicted. The subscription or the subscription model is the model chosen by Netflix. Meanwhile, Spotify uses the Freemium model. Free for basic services but paid for premium services. There is also an unpaid concept because those of you who join have become the product itself. This is exemplified by Google and Facebook. Others become marketplaces by providing facilities for sellers and buyers to meet by charging commissions for each transaction. Some take the sharing economy model by providing temporary access, such as gojek, air bnb, grab, and other similar services. By paying rent through the principle of sharing economy, these platforms may enjoy temporary access, so they can provide services without having to own them. There is also the Hypermarket Model, by providing large-scale market power, sometimes even at below-market prices, to beat the competition, as Amazon does. There are also those who disrupt the market because their products provide a special, unrivaled experience for users, such as Tesla and Apple. Another form is the ecosystem model, which extends its influence to embrace vendors and suppliers or provide products that support each other to increase its overall value. These are just a few examples of digital business models that have the potential to disrupt markets, as seen in the image (Fig. 1 shows an example).

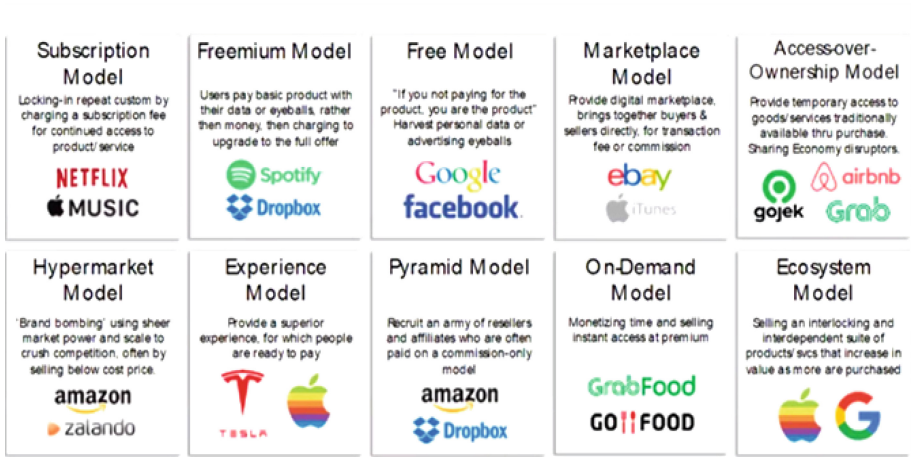


Fig. 1. Disruptive Business Model. Source: Jo Coudron, Dodo Von Peteghem: Digital Transformation

It can be seen that by using cutting edge business technology which disrupt the market, the biggest taxi companies, Uber or Gojek, does not have a single taxi. The largest lodging company Air BNB does not own a single inn. Companies that provide the largest telecommunication facilities such as WhatsApp do not have telecommunication infrastructure. Alibaba's biggest retailer does not have any inventory. Facebook as the largest media company does not have the slightest content. Netflix as a giant film company does not have a single cinema theater. And Google as a company's largest software vendor does not have a single application. This is summarized in the (Fig. 2, as a Business Paradox).



Fig. 2. Business Paradox. Source: Jo Coudron, Dodo Von Peteghem: Digital Transformation

Businesses Supporting the Sustainable Development Goals

Discussions about digital business disruption have been widely studied in various forums and writings. But furthermore, there are additional sides to disruptive business that are rarely discussed. In this session, the author will specialize in business models that are disruptive and at the same time, transformational because they carry the sustainable development goals proclaimed by the United Nations. Reuter (2022) investigated the role of business model design through a qualitative, inductive case study of the business model of a UK-based digital platform. The researcher discovers that managers' emphasis on either the redistribution or accessibility design theme influences environmental and financial value creation, respectively, and that a hybrid business model (i.e., realizing both for-profit and for-purpose value creation) is dependent on their integration. Platform organizations can increase integration thanks to two managerial drivers: strategic synergy and dynamic coupling. This research contributed to the literature on hybrid business models, paradox, and business models for sustainability by arguing that by integrating different design motifs inside hybrid business models, digital platforms can not only produce but also actively manage the environmental problem. In this model, the business no longer only prioritizes its power to disrupt the stability of existing products but goes one step further; the company further questions every business model it will carry out. This business model has been radically and innovatively designed in such a way that it reflects the Corporate Shared Values (Indrajaya, 2020). In this age of information disclosure, every step and strategy of the company is under the sharp scrutiny of influencers, NGO activists, environmental activists, and social observers. When a company is judged to be only concerned with its own coffers by exploiting the environment and other resources, influencers will play their power of influence and will affect market sentiment, and the company's reputation can be threatened.

The role of business for the common good is now an important thing in the eyes of stakeholders. The business models of business people who disrupt the market become very innovative and even radical, so that the more they do business, the greater the social impact and blessings they spread. If previously Corporate Social Responsibility (CSR) was considered as an activity that disbursed and emptied the company's financial coffers, now the social and environmental aspect has become the strategy of the company and is part of the company's model. The term, as discussed above, is corporate shared values. Just take the example of decacorn Gojek. Now the asset valuation is no longer labeled Unicorn 1 billion USD but it is already Decacorn above 10 billion USD. And this business model has been proven to help their partners to get a source of income. There are so many drivers, motorbike owners, and various other professions that have been supported by Gojek. In the SDG term, it has support the SDG no 1 No Poverty.

Google also has a business model that has helped so many small businesses with the google business model. Not to mention that Google also provides various other free services that make things easier, such as Google Translator, Google Map and many other services that have helped various small and medium business units to grow and take part, and all of these services are available for free. The more benefits that Google spreads for free, the more Big Data it can collect from the traffic it creates. And the higher the traffic of these visitors, of course, will be a source of increasing financial revenues from Google. So it is no wonder that the adage "the more you give the more you receive"

arises. Various new theories emerged such as “You Get What You Give” (Proserpio, Xu & Zervas, 2018) and other forms of “The Giving Theory”. This exactly reminds us of the noble values that have been instilled in us as religious beings. Help others, spread blessings, then we will reap blessings many times over. Religious teachings universally teach this theory of blessing by making assumptions about it. As an example, we take a parable from the Koran: The parable (income issued by) people who spend their wealth in His way is similar to a seed that grows seven grains, in each one a hundred seeds. Allah multiplies (rewards) for whom He wills. And Allah is almighty (His grace) and all-knowing.” (Al Baqarah (2): 261).

Globally and hand in hand, companies around the world are trying to solve global issues proclaimed by the United Nations through the Sustainable Development Goals or what are known as the Sustainable Development Goals (SDGs) which contain 17 noble values that must be achieved in 2030.

Business people who are members of the Global Forum are supporters of the SDGs from the United Nations. They claim to be supporters of Business as an Agent of World Benefit. This requires a new breakthrough which states that innovation in the form of technological disruption alone is not enough. But furthermore, these innovations must also support the concept of sustainable development (sustainable innovation). Changing a business model that breaks the previous business establishment must also be accompanied by an understanding of the noble values of sustainable development goals which are also part of their business strategy.

This is the challenge for today’s businessmen. Not only looking for innovative cutting-edge business technology model ideas that are able to disrupt the market but also business models that are innovative and support global issues in the form of support for sustainable development issues. The companies with high commitment toward sustainability will radically change their business model, so that positive social and environmental impacts are part of their business model. CSR is no longer a burden, social aspect becomes part of the business model, so that the more they do business activities, the more the companies are making social impacts. This changes the totality of the way business people saw the concept of CSR. Not as part of expenses, but as part of a business strategy. Business becomes abundant and a source of blessings. Not only for the company and its employees, but also for partners, for vendors, for suppliers, for the community, society, even the environment and all their stakeholders. This radical innovation is possible with the cutting-edge business technology as the enabler.

As discussed above for the Decacorn Gojek case, in running its business, Gojek partners with motorcycle taxi drivers, masseurs, salon workers, and various other professions. By making the micro business players as business partners, the more social impact Gojek has created while doing its business. This positive social impact has a Word of Mouth (WOM) effect. With WOM, the business becomes viral, and it becomes a free advertising that ensures a very rapid growth of the company. This does not only apply to businesses like Gojek, but also applies to various other businesses. The more they innovatively and radically change their business model to give social impact and implement the environmentally friendly concept, the more they are supporting the noble values as carried out in the Sustainable Development Goals, the wider the promotion that will spread out their positive reputation. Word of mouth will go viral, and their business

ecosystem will be supported by the stakeholders. The business becomes “Flourishing” or in the Arabic word Barokah.

Businesses as an agent for mutual benefit (Business as an agent of world benefit) was initiated by Prof. David Cooperrider, the author of the Appreciative Inquiry approach (Grieten et al., 2018). The mindset of this approach is based on the belief that focusing on strengths and positives will speed up the performance improvement process, rather than focusing on problems and other negatives. The main message is that focus and energy need to be directed to things that are useful and valuable, especially supporting values that are believed together in order to maintain the sustainability of the only planet we have together.

In the future this auspicious business model will disrupt the market. There will be public awareness that this planet earth is limited, if everyone does not take part in how to prevent the exploitative behavior of business people, then our children and grandchildren will no longer be able to enjoy this planet earth in the future. This awareness will disrupt the pattern of consumerism in the future, people will consciously choose products that carry noble values. We all hope that businesses that disrupt exploitative businesses that have dominated the market before are businesses that are able to radically and innovatively change their business models so as to support noble values. So that the term business that is abundant and spreads blessings is no longer just a hope.

4 Conclusion and Recommendation

The cutting-edge business technologies are currently implemented, developed and adopted by businesses around the world. In this paper the focus is toward businesses with digitalization, artificial intelligence, and implementing the industry 4.0 digitalization phenomenon. This cutting-edge business technology has the potential to disrupt the market.

The concept of sustainability has become increasingly important in today’s world. As we face growing environmental challenges and the need for more responsible business practices, sustainability has become a key driver for innovation and growth. One of the most significant ways in which sustainability and cutting-edge business technology intersect is through the development of sustainable business models and practices. Business technology has advanced tremendously in recent years, providing new tools and resources for companies to create more sustainable operations.

Sustainable business practices can help companies reduce their environmental impact, lower costs, and improve their brand reputation. By leveraging cutting-edge technologies, businesses can better track and manage their environmental impact, optimize energy use, and reduce waste. This descriptive literature review research needs more empirical follow-ups. The empirical research on disruptive innovation supporting the Sustainable Development Goals of the United Nation should be conducted to show the potential competitive advantage of this model. In the future, more research should be conducted on the significant technology in this area which is the Internet of Things (IoT). IoT devices can monitor and collect data on a wide range of environmental factors, such as air quality, water usage, and energy consumption. This data can be used to develop more efficient and sustainable operations, allowing companies to reduce waste and conserve resources. In order for business to be sustainable in the long future, cutting-edge

business technology should be the enabler to develop an efficient business model where the social and environmental impacts are embedded in the business model.

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Applying the Stimulus-Organism-Response Framework to Investigate Influencer Attributes on the Intention to Purchase Electric Vehicles

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Abstract. Social media influencers have recently had a significant impact on customer purchase journeys. Consumers rely on influencers' opinions to determine the acceptance of new technology, including Electric Vehicles (EV). Environmental concerns caused by Internal Combustion Engine (ICE) vehicle's carbon emissions and limited availability of fossil fuels drive the necessity of EVs' high adoption rates to replace ICE vehicles steadily.

This paper observes the influence of automotive influencers' attributes on EV purchase intentions. We proposed the S-O-R Framework to assess cognitive and affective aspects by examining Influencer's Expertise, Trustworthiness, and Attractiveness as Attributes. Performance Expectancy, Effort Expectancy, Hedonic Motivation, and Price Value are then provided as cognitive components of UTAUT2, which was incorporated into this research. Quantitative research was performed with 363 respondents and tested with SEM PLS. The study confirmed the significant implication of Influencer attributes, while Price Value is not positively associated with EV's Attitude Toward Use.

Keywords: electric vehicles · influencer attributes · purchase intentions · stimulus organism response framework

1 Introduction

Indonesia's Automotive Industry has been growing by 5% annually, ranked second in ASEAN and 14th worldwide in 2021 [1]. The significant production and sales of conventional fossil vehicles are followed by substantial energy consumption and harmful carbon emission [2]. ICE vehicles raise the problem of polluted air and energy scarcity, reflected by inevitable crude oil import starting in 2004 [3]. 50% of air pollution in large cities was contributed by ICE Vehicles, potentially reducing life expectancies by up to 1.2 years and causing major respiratory problems [4, 5]. Electric Vehicles (EV) are suggested as a solution to the carbonization issue and Indonesian dependencies on fossil energies. EV is defined as vehicle that runs on batteries rather than gasoline and uses electric motors instead of Internal Combustion Engines [6]; further categorized into Battery Electric Vehicles (BEV), Hybrid Electric Vehicles (HEV), Plug-in Hybrid

Electric Vehicles (PHEV), and FCEV [7]. Environmentally, EV is expected to contribute 30%–50% decarbonizations and 40%–60% fossil energy efficiencies compared to conventional vehicles [8]. However, in reality, the EV adoption rate by 2022 was 1%, which was far from satisfactory despite the government's efforts and strategy to accelerate EV adoption [9].

Information collection is one of the essential stages in consumer purchase intention and buying decision [10]. In accordance with this, Indonesia owns substantial social media penetration reaching 68.9% of the total population [11]. Among the social media users, 34.5% are following the influencer, which is ranked among the fourth highest follower worldwide for the 16–64 years segment [11]. Influencers are defined as people who actively produce content, publish their personal stories or product reviews, and are frequently chosen to serve as brand ambassadors due to their intense consumer engagement [12].

Influencer credibility was reported to impact subscribers' purchase intention [12, 13]. Based on Nugroho [14], in 2017, 74% of Indonesian consumers performed self-research for two months before purchasing a car, including watching influencers' reviews on social media, especially YouTube channels, with 54% of consumers [15]. According to Business Insider, Schomer [16] has stated that annual company expenditure in influencer marketing exceeds \$15 billion by 2022. That phenomenon reveals the term influencer marketing; the research shows a significant increase in recent years [12].

Considering that influencers and EV are both emerging topics, this research focused on how influencer attributes influence the purchase intentions of EV. EV purchase intention has been investigated with various models such as the Technology Acceptance Model (TAM) [17, 18], Technology of Planned Behavior (TPB) [2, 19], UTAUT [20], and Integrated Model [21]. To investigate the adoption intention of EV, researchers have also observed using various variables, e.g., Brand Attitude [22], environmental awareness [23], and religious values [24], etc. Referring to Lee [25], who observed the Influencer effect on impulsive buying behavior in Live Streaming Commerce using the S-O-R framework, this research adopts similar models to study EV purchase intention by observing the impact of the perceived trust from influencers' attributes and Attitudes Toward Use. Lee [25] observed Perceived trust and Influencer attributes as affective aspects and perceived usefulness as cognitive aspects. In this context, this study has two objectives:

1. How influencer's attributes affect EV's purchase intention, affectively through Perceived trust observed from three influencer attributes; Expertise, Trustworthiness, and Attractiveness. This study also investigates the cognitive aspects through Attitude Toward Use observed from Performance Expectancy (PE), Effort Expectancy (EE), Hedonic Motivation (HM), and Price Value (PV).
2. Introduce the theoretical framework of S-O-R in the research of influencer marketing to have a holistic study of EV purchase intention to support EV adoption rate increase.

2 Literature Review

2.1 Attribute Influencer

Godey [26] define social media influencers as opinion leaders with broad knowledge and influence to impact people's behavior, decision-making, and consumer behavior in their social media scope. Duh [27] mentioned that marketers and influencers have a mutual relationship in advertising their products or service. Duh [27] also stated that influencers are categorized into micro-influencer, macro-influencer, and mega-influencer. Influencer attributes theory has been defined in many academic works of literature. In the Automotive Influencer context, this research refers to Ohanion Credibility Model (Expertise, Attractiveness, Trustworthiness) [28] as Influencer Attributes.

2.2 Attitude Toward Use

Attitude Toward Use is the most influential factor in EV intention study [21]. In the integrated model analysis, Attitude Toward Use was defined from UTAUT2 variables: Performance Expectancy, Effort Expectancy, Hedonic Motivation, and Price Value. As a result, in this paper, we exclusively refer to the four variables listed above, rather than other variables in UTAUT 2, as essential factors in EV purchase intention, as observed in [21].

Perceived Trust

Wang [29] defines perceived trust as how consumers perceive the product as reliable and safe. Zhang [30] investigated the relationship between performance and attribute information positively associated with perceived trust. Hence, in this research, we narrow the scope with attribute information of influencers.

EV Purchase Intention

Marketing stimuli and other stimuli impact consumer behavior by playing a part in the purchase decision process [31]. Purchase Intention occurs when a customer is motivated by external circumstances and decides on purchases based on their personal qualities and decision-making processes [10].

Zhang [30] investigated a positive relationship between Perceived Trust and EV's adoption intention, while Gunawan et al. [21] explain a positive connection between Attitude Toward Use toward Intention to Use. Therefore, this paper will investigate both aspects of EV's Purchase Intention in the context of Influencer attributes implications.

S-O-R Framework

Stimulus-Organism-Response (S-O-R Framework), first introduced by Woodworth [32] and further known as Mehrabian Russel Model in 1974, explain the stimulus that affects the cognitive and affective response to study the consumer behavior mediated by the organism. Stimuli refer to external factors which influence organisms or consumers. S-O-R Model was developed to be a framework to study external stimuli implications toward the response of consumer behavior. The S-O-R framework was employed in this study because it has the advantage of studying human behavior by categorizing the stages of behavior creation, which helps us understand how purchasing behavior is created [33, 34].

3 Hypothesis

Under the S-O-R framework, Influencer's Expertise, Trustworthiness, Attractiveness, EV's Performance Expectancy, Effort Expectancy, Hedonic Motivation, and Price Value will affect EV's Purchase Intention through Perceived Trust and Attitude Toward Use.

When creating content regarding EV, automotive influencers have a more profound understanding, referred to as expertise. The trustworthiness of an influencer is measured by how objective they are when explaining the EV features. Influencers' expertise, experience, and knowledge in a specific area construct credibility, trustworthiness, and goodwill [35]. Ohanian [28] defines trustworthiness as the degree of acceptance and confidence from the audience about the speaker's message. Trustworthiness is critical in social media influencer marketing and relates to how audiences perceive speakers' honesty [2]. According to Djafarova and Rushworth [36], social media influencers are more significantly influenced by their expertise and purchasing behavior than traditional celebrities. Additionally, Zhang [30] looked into information attribution as an outside factor influencing perceived trust. Concluding on the study mentioned, we propose a hypothesis:

H1: Expertise (EX) influences Perceived Trust (PT)

H2: Trustworthiness (TW) influence Perceived Trust (PT)

Sertoglu [38] state that attractiveness is seen as favorability in communicators' personality, and it is apt in the context of EV, and automotive topic in general. Attractiveness also defines influencer attributes that are part of information sources' attributes related to Perceived Trust [30]. Some of the indicators of the Influencer's attractiveness in the measurement are described by influencer's personality. Based on this reason, we generate hypothesis as follows:

H3: Attractiveness (AT) influences Perceived Trust (PT)

Based on Yuen [39], individuals will be encouraged to use products when they believe in the performance of the technology to deliver benefits for their lives: the better product performance, the more favorable people to use the product [40]. Gunawan et al. [21] specifically investigated that Performance Expectancies positively impact Attitude Toward Use of electric vehicles. Based on mentioned evidence, we construct a hypothesis:

H4: Performance Expectancy (PE) influences Attitude Toward Use (ATU)

In his explanation, Venkatesh et al. [40] define the concept of Effort Expectancy as the effort required to grasp and become skillful in using technology. Similar to Performance Expectancy, Effort Expectancy was also constructed from Technology Acceptance Model. Thus, the convenience of utilizing technology will impact a positive attitude. In the integrated model for examining EV's use intention, Effort Expectancy positively affects Attitude Toward Use [21]. Refer to previous explanation, we develop the hypothesis as follows.

H5: Effort Expectancy (EE) influences Attitude Toward Use (ATU)

The next hypothesis development is related to Hedonic Motivation. Referring to Venkatesh et al. [41], Hedonic Motivation is related to happiness or pleasure in using technology and tends to disregard rationality aspects. Hedonic motivation is associated with satisfaction, emotions, pride, and other subjective sense [42]. Accordingly, Gunawan et al. [21] observed that Hedonic Motivations affect attitude toward use in a positive way. Therefore, we built hypothesis as follows:

H6: Hedonic Motivation (HM) influence Attitude Toward Use (ATU)

Price Value plays an important role in technology adoption. Venkatesh [40] described that Price Value surpassing consumer expectations would lead to certain satisfaction levels. Individual will perceive negatively if they have negative perception about the price of the product, hence will bring less interest in technological adoption [43]. Thus, we develop a hypothesis as follows:

H7: Price Value (PV) influences Attitude Toward Use (ATU)

Consumers have limited knowledge about performance and characteristics because EV are new technology and part of energy efficiency innovation [44]. In general, they exhibit a wait-and-see attitude believing that EVs come with higher financial risks, battery-charging risks, performance risks, and other concerns [45], although in the current EV industry, those concerns have been addressed very well. However, Raimi and Leary [46] figured out that information asymmetry could lead to bias in understanding and trusting EV's technology. Therefore, information quality becomes an important factor and an effective way to help Individuals gain an understanding and trust in EV, which then leads to a higher purchase intention and adoption rate of EV to resolve health, environmental, and energy issue [30]. Refer to described explanation, we propose the hypothesis as follows:

H8: Perceived Trust (PT) influence Purchase Intention (PI)

Ajzen [47] explained about Attitude Toward a behavior mentioning that when individual asses positively toward a product or service, the higher possibility of their behavior adopting it. Gunawan et al. [21] figured out that ATU is the most influential factor in EV's intention to use in integrated model analysis. Thus, we propose the hypothesis.

H9: Attitude Toward Use (ATU) influences Purchase Intention (PI)

4 Research Methodology

Research framework is described in Fig. 1. As quantitative research, data analysis is executed with SEM PLS method utilizing SMART PLS software. Outer measurement and Inner measurement will be checked simultaneously. Validity and reliability are confirmed by 33 respondents. The questionnaire was written in Indonesian with five points Likert scale and spread online. Prior to survey distribution, a questionnaire was carefully reviewed by an expert Lecturer in the Industrial Engineering field. The survey was conducted from January 18 to March 19, 2023, in five major provinces in Indonesia; DKI Jakarta, West Java, Banten, Central Java, and Yogyakarta Province. To ensure

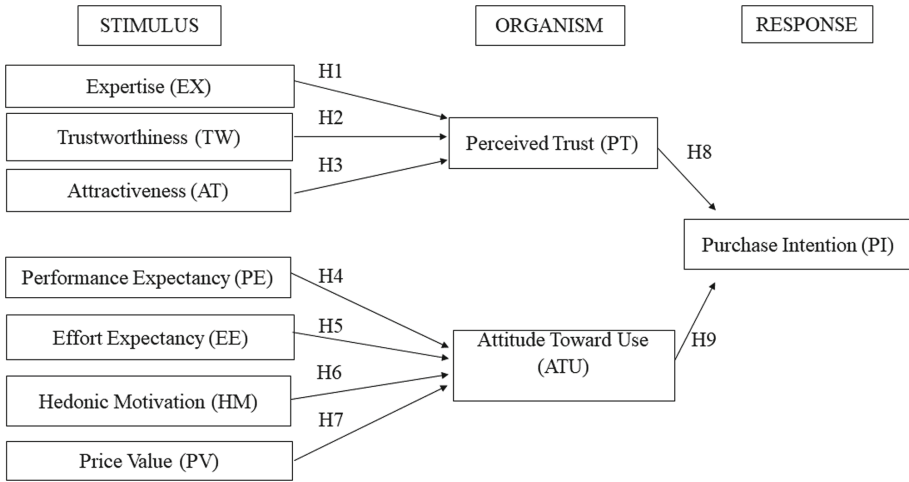


Fig. 1. Research Framework

only people with suitable criteria answered, we assigned three screening questions; 1) Have you ever watched Influencer videos about EV on social media? 2) Are you above 18 years old? 3) Are you interested in purchasing EV in the future? In case the respondent answered “No”, they could not continue filling out the questionnaire.

As measurement indicators, survey questions were referred from previous literature with some adjustments in EV and automobile influencer context. Measurement of Expertise, Trustworthiness, and attractiveness was adopted from [25, 27, 48]. Attitude Toward Use and four variables’ Performance Expectancy, Effort Expectancy, Hedonic Motivations, and Price Value indicators referred to [21]. Perceived trust measurement is based on Zhang [30]. While Purchase Intention refers to [21, 25, 30, 48]. This study successfully collected 363 questionnaire responses with characteristics shown in Table 1.

5 Findings

5.1 Assessment of Outer Model

This research utilizes PLS-SEM to test the theory with two steps. First, the outer model is evaluated to ensure that the measurement models meet the threshold of validity and reliability. Next, the structural theory is tested by measuring how constructs are related to each other [49]. The outer model measurement is defined as a measurement to test the validity and reliability between measured variables with certain indicators. To meet the validity and reliability requirement, Hair [49] recommended that the Final Factor loading threshold is 0.7 for Cronbach’s Alpha (CA) and Reliability (CR), while the Final AVE threshold is 0.5. In Table 2, measurement with factor loading less than 0.7 is eliminated. After elimination, all constructs fulfill the validity and reliability.

Table 1. Respondent characteristics

Characteristics	Category	Freq	%
Gender	Male	289	80%
	Female	74	20%
Age	18–25	127	35%
	26–39	173	48%
	40–55	60	16%
	Above 56	4	1%
Location	DKI Jakarta	112	31%
	West Java	93	26%
	Banten	45	12%
	Central Java	28	8%
	Yogyakarta	34	9%
	Others	51	14%
Education	Senior High School	91	25%
	Associate Degree	82	23%
	Bachelor's Degree	158	44%
	Master's Degree	29	8%
	Doctoral Degree	3	1%

In Table 3, discriminant validity was observed with the Fornell-Larcker criterion, which requires that the square root of a construct's average variance must be larger than the correlation between the construct and any other construct. The results show that all value is within the required standard, therefore the assessment is fulfilled.

5.2 Analysis of Structural Model

To check and validate the hypothesis, structural model analysis is performed with P Values and T statistics. Hair [50] indicated common critical value (t value) for significance level 5% is 1.96. In marketing, usually, the significance value is assumed to be 5% [50]. Thus with 5% level significance (α 5%), when T statistic > 1.96 and P Values < 0.05, the hypothesis is supported. Thus, H1, H2, H3, H4, H5, H6, H8, and H9 hypothesis is confirmed, while H7, which explains the relation between Price Value and Attitude Toward Use is not supported in this research (Table 4).

Model fit is analyzed with Standardized Root Mean Square Residual (SRMR) < 0.01 and Normal Fit Index (NFI) between 0 and 1 [51]. This research shows SRMR Estimated model is 0.09 and NFI 0.681 thus, the model fit meets the threshold. R^2 is the percentage of variance in the exogenous variables explained by the endogenous variables. The R^2 indicated 53.4% for ATU, 54% for PI, and 26% for PT.

Table 2. Validity and Reliability Analysis

Construct	Indicator	Final Factor Loading	CA	CR	Final AVE
Expertise	EX1	Eliminated	0.704	0.835	0.628
	EX2	0.766			
	EX3	0.819			
	EX4	0.791			
Attractiveness	AT1	0.782	0.735	0.834	0.557
	AT2	0.735			
	AT3	Eliminated			
	AT4	0.749			
	AT5	Eliminated			
Trustworthiness	TW1	0.738	0.738	0.835	0.558
	TW2	0.733			
	TW3	0.759			
	TW4	0.759			
Performance Expectancy	PE1	0.834	0.713	0.840	0.637
	PE2	0.741			
	PE3	Eliminated			
	PE4	0.816			
Effort Expectancy	EE1	0.717	0.740	0.836	0.561
	EE2	0.736			
	EE3	0.728			
	EE4	0.812			
Hedonic Motivation	HM1	Eliminated	0.796	0.867	0.620
	HM2	Eliminated			
	HM3	0.749			
	HM4	0.749			
	HM5	0.816			
	HM6	0.833			
Price Value	PV1	0.802	0.820	0.880	0.648
	PV2	0.804			
	PV3	0.83			
	PV4	0.784			
Perceived Trust	PT1	0.791	0.736	0.850	0.654

(continued)

Table 2. (continued)

Construct	Indicator	Final Factor Loading	CA	CR	Final AVE
	PT2	0.824			
	PT3	0.811			
Attitude Toward Use	ATU1	Eliminated	0.763	0.849	0.584
	ATU2	0.734			
	ATU3	0.788			
	ATU4	0.776			
	ATU5	Eliminated			
	ATU6	0.76			
Purchase Intention	PI1	0.755	0.815	0.871	0.575
	PI2	0.802			
	PI3	0.802			
	PI4	0.715			
	PI5	0.714			

Table 3. Discriminant Validity

Fornell-Larcker Criterion Result										
	AT	ATU	EE	EX	HM	PI	PE	PT	PV	TW
AT	0.746									
ATU	0.462	0.764								
EE	0.561	0.468	0.749							
EX	0.568	0.467	0.500	0.793						
HM	0.344	0.619	0.342	0.322	0.788					
PI	0.449	0.722	0.488	0.437	0.584	0.758				
PE	0.509	0.664	0.500	0.457	0.627	0.684	0.798			
PT	0.464	0.651	0.459	0.423	0.504	0.592	0.637	0.809		
PV	0.308	0.480	0.333	0.305	0.528	0.522	0.461	0.565	0.805	
TW	0.628	0.426	0.544	0.550	0.412	0.422	0.536	0.438	0.467	0.747

Table 4. Structural Assessment Results

	T Statistics (O/STDEVI)	P Values	Path Coefficient (β)	Result
H1: EX \rightarrow PT	2.581	0.010	0.184	Supported
H2: TW \rightarrow PT	2.234	0.026	0.183	Supported
H3: AT \rightarrow PT	3.128	0.002	0.244	Supported
H4: PE \rightarrow ATU	5.727	0.000	0.356	Supported
H5: EE \rightarrow ATU	3.024	0.003	0.156	Supported
H6: HM \rightarrow ATU	4.244	0.000	0.282	Supported
H7: PV \rightarrow ATU	1.815	0.070	0.115	Not Supported
H8: PT \rightarrow PI	2.721	0.007	0.210	Supported
H9: ATU \rightarrow PI	9.612	0.000	0.585	Supported

6 Conclusion and Discussion

This study aims to investigate EV marketing strategy to boost EV adoption rates by focusing on influencer attributes. Marketing contents are associated with how to influence purchase intention, cognitive, and affective states [52]. Through the literature review, a full framework is exercised by examining influencer attributes variables, i.e., expertise, trustworthiness, and attractiveness, as well as variables on acceptance and use of technology, i.e., Performance Expectancy, Effort Expectancy, Hedonic Motivation, and Price Value. In addition, under the S-O-R framework, Perceived Trust and Attitude Toward Use were identified as cognitive and affective states. Finally, responses are observed using the model to understand how the content delivered by the influencer could influence consumer purchase intention on EV.

Under the empirical study, the research outcome shows that Perceived Trust and Attitude Toward Use positively affect the intention to purchase EV. Influencer Expertise, trustworthiness, and attractiveness positively affect perceived trust. While under the variables in acceptance and use of technology, Performance Expectancy, Effort Expectancy, and Hedonic Motivation positively affect Attitude Toward Use. However, Price Value does not positively affect Attitude Toward Use in the EV influencer context.

To increase EV's purchase and adoption rate, the government takes several measures, for example, tax reduction, and certain traffic restriction waivers. However, EV's adoption rate average in Indonesia remains at 1%, whereas in most country is 5% on average. As proposed in this study, Influencer marketing is expected to offer powerful approaches to how manufacturers and governments engage with consumers. The result of this study supports our hypothesis that the affective side, influencer attributes, their expertise in explaining EV, influencer's trustworthiness in delivering the features of EV, and influencer attractiveness while creating the content have a significant impact on consumer perceived trust, thus positively affect consumer intention in purchasing EV in the future. On the Attitude Toward Use aspects, Price Value is not supporting the hypothesis. Meanwhile, other constructs; PE, EE, and HM proved to affect Attitude

Toward Use in the EV Influencer context significantly. Price Value may indeed still not significantly affect the cognitive state of Attitude Toward Use, due to the EV price range is still considerably high in Indonesia. Research in China conducted by Cui [53] also shows negative impacts between price and purchase intention, but positively affected by social influence, environmental concern, self-esteem, and openness.

Implication for Future Studies

Our research gives several implications for influencer marketing topics and EV purchase intention. In observing EV purchase intention, we use a broader point of view of the model that considers both affective and technical aspects of the S-O-R model. It allows the future researcher to refer to both non-technical factors, such as the communicator's attributes, and how they influence consumers' perceived trust in EV as new technology. Since influencers are important in the digital marketing world, we contribute the research related to influencer marketing as a theoretical implication for further research. Future research can look into other stimuli, such as recent trends in digital marketing, to build EV purchase intention utilizing a holistic framework. EV adoption intention research could be one of the most important studies to help decarbonization and combat climate change.

Implication for Practice

To accelerate the steady growth of EV number usage, aside from battery charging and safety improvement, an effective approach should be considered. Our research deliberately narrows the topic to influencer attributes impact, offering an alternative to manufacturers and industry in developing marketing tactics. For the influencers, it gives the insights that they should always review and improve their Expertise, Trustworthiness, and Attractiveness level since consumers are significantly affected by those attributes.

Limitation

The study's limitation is that we did not ask respondents how frequently they watched the influencer delivering EV's content. Several respondents may just watch once. This research did not identify the last time the content was watched. Another limitation is that this study is conducted in Indonesia. Some demographic characteristics that may influence the overall result, such as the Price Value viewpoint and the product variety of EVs at the time of the survey.

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Using Business Intelligence Tools in Accounting Education

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Abstract. This study aimed at surveying the beliefs of academics about the benefits and challenges of using Power BI as a sample of business intelligence tools in accounting education. A survey of 60 faculty members in the faculty of business et al.-Zaytoonah university of Jordan revealed that developing the data interpretive ability, data gathering skills, and problem-solving skills are the most important benefits that could be gained from using Power BI in accounting education. The main challenges that could face the dissemination of Power BI tool in accounting education include resisting the change learning type, poor experience in the BI tools for faculty members.

Keywords: Business Intelligence · Power BI · Accounting Education · Jordanian Universities · Jordan

1 Introduction

Technological advancements, digitalization and automation have led to generating huge volumes of data. Data is today's oil where the world is creating 2.5 quintillion bytes of data per day and the number is increasing [1] in the past data was gathered by backend offices and spread sheets but now a days data can be acquired from numerous sources; the Internet, social media and communication apps. This means that businesses now have to deal not only with the volume of data but also with the variety and velocity of it.

With this volume and velocity of data, and business managers being always interested in real time analytics [2], it has become essential to have new technologies to store, utilize, analyze and convert this data into information through which efficient decisions can be made and achieve success and development to the organization. Big data stored within various platforms has no value without having a technology that helps to mine information from this big data and using it in business planning and forecasting [3]. Hence, organizations are increasingly in a need for business intelligence (BI) and data analytics tools [4]. Organizations use BI tools to perform data analytics and visualize it in a faster and easier way and make better data driven decisions [1]. BI systems include; data gathering, integration, storage, representation and knowledge management [1]. Current marketing, performance, and key performance indicators tools of BI enable users to select, filter, compare, visualize and analyze data according to their needs [5].

Accounting traditionally included recurring and rule-based tasks which makes it easy to be automated, this continuous digitalization and automation of accounting increases the volume of data used in both financial and managerial accounting [6], as well as, big data analytics converts accounting into a provider of high-quality data derived from structured financial and unstructured non-financial data [7–9]. This calls for an upgrading of the accounting profession and professionals themselves [9] and a change in accountants' tasks [10]. Most of the available BI tool are self-service BI, in 2011, TDWI (provides educational research on data and BI) defined self-service BI as: “the facilities within the BI environment that enable BI users to be more self-reliant and less dependent on IT firms” [1]. This means that accountants need to possess new and advanced technological skills [11]. Companies now are investing in training their employees to become more data driven and get able to compete in today's digitalized environment [12, 55].

MCvay et al. [13], mentioned that one of the main objectives of accounting education is to prepare undergraduates with technical competencies to become successful professional accountants. However, in today's digitalized working environment, skills required from accounting graduates differ from other business professionals, digitalization has led to changing tasks and demanding new IT skills which are now a competence [56]. Graduates will need IT skills to handle BI tools, to check data sources quality and adequacy, analyze patterns, and visualize reports for end-users [14]. Accounting scholars and researchers are conscious of the technological development and the need of graduates to fill the skill gap [15], Hence, they recommend to adapt accounting curricula [16]. The need of IT skills is being repeatedly discussed in the accounting education literature [8, 14, 17–19].

The (AACSB), which is responsible of developing the standards of business schools and accounting programs accreditation, has issued its standard (A7) which encourages universities to implant more technology and analytic skills within the accounting curricula. AACSB A7 indicates that data creation, mining, storage, sharing, analytics, and reporting are all essential skills, The AACSB suggested an interdisciplinary approach to develop IT skills instead of separate (AIS) courses [20].

Also, The Pathways report issued by The American Accounting Association (AAA) indicated the influence of technology and analytics on businesses and urged to modify accounting education to contain those recent fields [21, 57]. Moreover, The AAA held a conference titled, “Accounting IS Big Data.”.

The Association of Accountants and Financial Professionals in Business indicated in 2017 that the lack of currency of accounting curricula and the skills gap has increased over time, accounting graduates are being unable to see the “big picture”, their skill-sets are limited to simple calculations, journal entries, tax and capabilities without any reflection on the entire organization's operations [22]. In addition, PwC (2015) recommended more skills including research skills, programming languages to be taught at all levels in accounting programs [23, 24]. Many accounting research journals, and professional firms have published special issues, white papers or case studies to investigate the influence of analytics and data on accounting [25].

All of the previous, put a burden of identifying and prioritizing the new required skills on business schools and researchers in order to properly implement them within the accounting curricula while staying in balance between these new skills and the

traditional accounting knowledge. The purpose of our study is to determine what are the benefits and challenges of infusing the Power BI software in the accounting curricula, as an example of Business Intelligence (BI) and data analytics tools, from the perspective of the academic staff of the business schools in Jordan. This will give an insight for accounting departments and future faculty members on how to create their teaching materials to enhance these skills specifically highlighted as important by the professionals, researchers and business and accounting associations.

Microsoft and Tableau are clearly the leaders in providing Analytics and BI Platforms, we chose MS Power BI in our study as it is an easy tool to start with, especially when having an experience working with MS Excel [1]. MS Power BI is a good example of the BI tools that enables users to export, filter, and create visual graphical presentations and reports using a company's raw data without being altered. The management can generate customized reports and real-time information fast and with the minimal efforts since data does not need to be manually updated [3].

2 Literature Review

With today's constantly evolving technologies, accountants' tasks and required skills have obviously changed. This issue has been a place of interest in the prior and current accounting (education) literature. Moll & Yigitbasioglu, Oesterreich et al. and others examined the impacts of digitalization and technologies and urged researchers to consider their ramifications for the future of accountants and the profession in order to determine what new tasks and skills are required by the accounting profession [6, 8].

Many authors indicated that processes automation, big data and analytics, and the increased interaction between employees and software solutions within the company and with suppliers or customers to make financial decisions, all of which have driven the transformation in the accounting field [26, 27]. This will modify accountants' activities and roles, they will need new skills and qualifications [28], and will add to the responsibilities of the accounting departments for handling and using data [6]. The increased amount and complexity of data will require highly qualified employees [29].

Vasarhelyi and co-researchers discussed the different data sources and uses in the accounting profession and composed an overview of the linkages between big data and accounting. However, they did not suggest or prioritize what approaches to follow to train future accountants [30]. Schneider and others examined specific accounting tasks that include inference, prediction, or assurance and which may be influenced by data analytics. They laid out some potential research questions that aim to assess how the profession would be affected by data analytics [31]. Accounting research also provided examples of using analytics in accounting. Fisher and others discussed text analytic techniques where accountants can benefit from text-based documents [32]. Debreceeny & Gray described how data mining can be used to detect fraud from journal entries [33]. These examples indicate to the potential pervading impact of big data and analytics on accounting.

A qualitative case study by Kajava aimed to evaluate the post-implementation benefits of BI tools on businesses performance and efficiency. The results indicated that the researched company has become able to analyze, present and review its products and

services in order to satisfy the market needs. It could improve its cash flows, profitability and solve its accounts receivable problems through using MS Power BI to create the necessary reports from Google Analytics and Xero [3].

Riggins & Klamm stated that accountants should develop their skills of using BI tools to be able to create dashboards, decide which information can be provided to which end-users, and spread awareness of the proper utilization of BI-tools [34]. Authors [14, 35, 36], see that accountants should possess a basic understanding of programming languages and coding to adapt BI-tools to their individual requirements and get insights from the data base, as well as, detecting trends and creating visualizations.

McVay et al. [13], Jones & English [37], Matlay & Westhead [38], stated that accounting education must enrich students with overall business skills and competencies, and enhance their abilities of problem-solving and critical analysis, rather than emphasizing solely on pure accounting knowledge. Al-Htaybat [16] also predicted that technological developments, in particular automated and integrated workflows, will result in transformative impacts on accounting practices and profession. Mandilas et al. [39], Rubin & Dierdorff [40] say that accounting education and curricula must satisfy these needs of the current changing and highly demanding business world under the digitalization era.

Leitner-Hanetseder and co-researchers conducted a structured literature review included 24 articles and concluded that accounting education literature emphasizes the importance of implanting advanced IT skills into accounting programs Including data analytical skills, (data storage and retrieve, using BI-Tools, understand and interpret results for decision making). The authors recommend to implement such important IT skills in two courses; process automation and business data analytical. However, they mentioned four main factors that may facilitate or obstruct this implementation; (1) constantly evolving technologies, (2) faculty's financial resources, (3) the missing of the training concepts by the students, (4) the need for an interdisciplinary faculty staff [14].

A study by De Lange, et al., found that 46.9% Of the participating professional accountants, in the Asia-Pacific region, had CPD (continuing professional development) activities in the areas of IT or software and hardware skills during the last 12 months [41]. Another survey study of 342 accounting professionals conducted by Brink & Dale Stoel, used previous research work on business analytics education to determine and evaluate the required analytic skills for the profession. Results revealed that accounting professionals are more involved in making data-driven decisions and more concerned of data communication and interpretation skills than the technical skills required to perform data analytics. This implies that the role of accounting professionals lies in being an intermediary to interpret and communicate the results of data analysis between "data scientist" and information users. Hence, the study suggests that faculty members may adjust their accounting curricula and classroom materials in a way that increases student's familiarity with data analytic tools whether by teaching, for example, advanced MS Excel features or data visualization tools like MS Power BI or Tableau [25].

Another study by Tan & Laswad, analyzed job announcements and highlighted the need for accounting professionals to have IT skills, it stated that the IT skills gap between accounting education and accounting profession should be filled up [19]. Previously, Excel skills were considered enough to close this gap, however, it's expected that the complexity of spreadsheets will increase due to the accelerating volume and variety of data.

Therefore, researchers like Brink & Stoel [25], Riggins & Klamm [34] recommended teaching BI-tools within accounting programs.

Cegielski and Jones-Farmer conducted a study to determine entry-level critical analytic KSAs using three methods: Delphi analysis with executives, jobs content analysis, and survey of business analytics practitioners. Researchers concluded that the accounting profession is different from other positions since it involves knowledge of business processing, auditing, tax law in addition to data analysis and technical skills including specific applications (Excel, SAS, Power BI, etc.), languages, and infrastructure elements. They think that these skills would be a subset of those required of data analytic professionals taking in consideration their priorities [42].

Reyad, et al., analyzed questionnaire responses of 668 undergraduate accounting students from Egyptian and Bahraini universities and found that critical thinking, problem solving, risk taking, and innovation are perceived as key skills. And this propose Some enhancements to accounting curricula [22].

Accounting research has concentrated on drawing the linkage between analytics and accounting without much work on suggested specific curricula enhancements. Lawson et al. considered quantitative and analytic skills as basic competencies required by accounting students and suggested a broad structure for accounting curriculum [43]. Pan & Seow [44], Ragland & Ramachandran [45], Janvrin et al., [46] suggested to enhance MS Excel, some database skills, and general IT skills and data visualization skills. PwC issued its white papers in 2015 which suggest that accounting curricula should enhance skills like data mining, data visualization, optimization, multivariate statistics and predictive technologies without identifying its priorities or providing a documentation that justifies the importance of these skills [24]. Accounting educators need additional details on what specific skills and their priorities to be able to embed them within accounting curricula.

However, Janvrin and Weidenmier Watson argue that the primary goal of accounting education when designing an accounting course integrated to teaching information and communications technology skills should remain the same, “create and communicate information to internal and external decision makers” [47]. McKinney, Yoos, and Snead also, ensure the need for accountants with big data skills but we should not forget to identify the required cognitive skills to perform effective big data analysis, accounting students must be trained as informed skeptics and able to understand the limits of “measurement and representation, subjectiveness of insight, statistics and integrating data sets, and the effects of underdetermination and inductive reasoning” [48]. In 2013, Bill C. Hardgrave stated that data analytics is becoming a core business discipline and business schools should start teaching it with a pragmatic approach. The author ensures that the goal should be enabling accountants to use common data analytics tools to communicate with the management and support decision making. However, this should not be overwhelming to accounting students, the goal is not to turn accountants into database experts or programmers [49]. A study by McKinsey Global Institute in 2016 insists that firms still need to train their employees internally for years to close the current skills gap even after the additional data analytics programs being offered by universities [50].

Sledgianowski, et al. suggested examples of how to include big data and information systems in accounting education. They demonstrated that some technological

competencies and skills can be developed through regular accounting courses within the curriculum, for instance, using data from databases for ratio analysis, using XBRL reporting to analyze tagged information, using structured and unstructured data to perform what-if analysis, using audit software, using big data to analyze tax information and other applications of programming languages and databases [51].

An article issued by the IAESB stated that there are different models for teaching information and communications technology ICT skills at universities; either within the accounting department, or through information system departments, or through one interdisciplinary department. These skills can be delivered via a separate degree program or through some designated core and elected courses within the program [52]. AACSB suggested an interdisciplinary approach to develop IT skills instead of separate (AIS) courses [20].

3 Methodology

The sample characteristics, data collection procedures, measurement of variables are described in this section.

3.1 Sampling and Data Collection

The target participants this study consisted of faculty members in Jordanian universities. The reason choosing this target population is the assumption that faculty members have a clear perception of the knowledge, skills and competencies that students possess as well as that they need during the learning stages. Each participant represents a unit of analysis.

We used an online questionnaire to collect data. It was pre-tested with an appropriate sample from the target participants, which was added later to the sample. The questionnaire was sent in February 2023 via email, Facebook, LinkedIn, and WhatsApp formal groups, to which 60 usable responses were received. The resulting sample is considered satisfactory.

Table 1 summarizes the participants' profile, which classifies the majority of participants are from accounting department, with the convergence of the percentages of scientific ranks participating in the survey. In addition, the sample was dominated by the "more than 15 years" of academic experience. In terms of professional experience, 25% of the sample lied in "More than 15 years" category, while 15% were without experience.

3.2 Questionnaire

This research is described as exploratory, to achieve the objectives of this study, following [58], a two-part questionnaire was used, the paragraphs of which were measured using the five-point Likert scale.

Table 2 shows the study variables, number of items used to describe them, and their sources. The paper used both the business education literature to build these items. The detailed description of the 25 items that were used to describe the study variables will come later in the results section.

Table 1. Participants' Profile

Respondents	N	%
<i>Specialization</i>		
Business administration	7	11.7
Accounting	35	58.3
Finance	7	11.7
MIS	4	6.7
Marketing	5	8.3
Others	2	3.3
<i>Total</i>	<i>60</i>	<i>100</i>
<i>Scientific rank</i>		
Lecturer	12	20
Assistant professor	20	33.3
Associate professor	16	26.7
Professor	12	20
<i>Total</i>	<i>60</i>	<i>100</i>
<i>Academic experience</i>		
5 years or less	8	13.3
6 – 10 years	16	26.7
11 – 15 years	13	21.7
More than 15 years	23	38.3
<i>Total</i>	<i>60</i>	<i>100</i>
<i>Professional experience</i>		
No experience	9	15
5 years or less	14	23.3
6 – 10 years	14	23.3
11 – 15 years	8	13.4
More than 15 years	15	25
<i>Total</i>	<i>60</i>	<i>100</i>

4 Results

4.1 Descriptive Statistics

The mean ratings of the benefits of using Power BI in accounting education are presented in Table 3. The highest benefit according to the sample responses is “Data interpretive ability” ($M = 4.10$, $SD = 0.78$) and the lowest benefit is “Code writing” ($M = 3.45$, $SD = 0.95$). On average, the suggested benefits of using Power BI in accounting education are perceived to score moderately high mean ($M = 3.88$, $SD = 0.82$).

Table 2. Sources of constructs' measures

Variables	No of items	Sources
Benefits of using Power BI in accounting education	16	(Brink & Stoel, 2018; Schoute, 2019; Cunningham & Stein, 2018)
Challenges of using Power BI in accounting education	9	(Rubocki, 2019; Carriere, 2022)

Table 3. Benefits of using Power BI in accounting education

Item	Mean	Std.Dev.
<i>Using Power BI as learning tool helps in developing:</i>		
Data interpretive ability	4.10	0.78
Data gathering	4.08	0.77
Problem solving skills	4.07	0.74
Business communication	4.00	0.69
Problem/process modeling	3.97	0.74
Data query skills	3.95	0.72
Data modeling	3.93	0.82
Data visualization	3.90	0.88
Business education	3.88	0.78
Data mining skills	3.88	0.85
Statistical methods	3.87	0.98
Research skills	3.82	0.81
Database skills	3.80	0.76
Software training	3.80	0.88
Systems infrastructure knowledge	3.58	1.03
Code writing	3.45	0.95

Table 4 presented the mean ratings of the challenges of using Power BI in accounting education. The respondents perceived that the highest challenge is “Resisting change in traditional stereotypical learning” ($M = 3.90$, $SD = 0.97$) and the lowest challenge is “Atypical of various analysis tools increase learning difficulty” ($M = 3.58$, $SD = 0.94$). On average, the suggested challenges of using Power BI in accounting education are perceived to score moderately high mean ($M = 3.76$, $SD = 1.00$) (Table 5).

Table 4. Challenges of using Power BI in accounting education

Item	Mean	Std.Dev.
<i>Using Power BI as learning tool has the following challenge:</i>		
Resisting change in traditional stereotypical learning	3.90	0.97
Poor faculty members' experience in the subject	3.88	1.06
Lack of faculty members' knowledge on the subject	3.85	1.02
Difficulty of learning Data Analysis Expressions (DAX)	3.82	0.93
Lack of readiness to learn	3.80	0.94
Difficulty of learning advanced data cleaning and processing tools such as Power Query	3.73	0.97
Poor technological background	3.65	1.09
Poor information related to data modeling	3.63	1.08
Atypical of various analysis tools increase learning difficulty	3.58	0.94

4.2 Univariate Analysis

Univariate analysis of the differences between the responses of the accounting and non-accounting specializations pertaining the benefits of using Power BI in accounting education was conducted, and the results of the independent sample t-tests are presented in Table 6. The results of the tests indicate the presence of statistically significant differences in “research skills”, “software training”, “database skills”, “systems infrastructure knowledge”, and “code writing”. Differences in “research skills” and “software training” are significant (at $p \leq 0.10$). “Database skills” is statistically significantly different (at $p \leq 0.05$). In addition, it is evident that “systems infrastructure knowledge” and “code writing” are significant (at $p \leq 0.01$).

On the side of the challenges of using Power BI in accounting education, it is evident that there are statistically significant differences in “poor technological background”, “poor information related to data modeling”, “difficulty of learning advanced data cleaning and processing tools such as Power Query”, and “atypical of various analysis tools increase learning difficulty”. Table 6 presented that “poor technological background” and “difficulty of learning advanced data cleaning and processing tools such as Power Query” are statistically significant (at $p \leq 0.05$), while “poor information related to data modeling” and “atypical of various analysis tools increase learning difficulty” are statistically significant (at $p \leq 0.01$).

Table 5. Univariate analysis for differences in Power BI benefits between accounting and non-accounting specialization

Item	Means		t-test for equality of means		
	Acc. (n = 35)	Non Acc. (n = 25)	Mean difference	t-value	Sig.
<i>Using Power BI as learning tool helps in developing:</i>					
Problem solving skills	4.03	4.12	-0.09	0.704	0.484
Business communication	4.03	3.96	0.07	0.000	1.000
Data interpretive ability	4.00	4.24	-0.24	1.000	0.321
Data gathering	4.09	4.08	0.01	0.843	0.403
Business education	3.91	3.84	0.07	-1.154	0.253
Problem/process modeling	3.91	4.04	-0.13	-0.351	0.727
Research skills	3.86	3.76	0.10	-1.747	0.086*
Data modeling	3.89	4.00	-0.11	-0.629	0.532
Software training	3.88	3.88	0.00	-1.762	0.083*
Data mining skills	3.94	3.80	0.14	-1.069	0.290
Data visualization	3.74	4.13	-0.39	-0.883	0.381
Database skills	3.74	3.88	-0.14	-2.053	0.045**
Data query skills	3.97	3.92	0.05	-0.536	0.594
Statistical methods	3.77	4.00	-0.23	-1.051	0.297
Systems infrastructure knowledge	3.51	3.68	-0.17	-3.134	0.003***
Code writing	3.45	3.44	0.01	-4.501	0.000***

Notes: * significant at ($p \leq 0.1$); ** significant at ($p \leq 0.05$); *** significant at ($p \leq 0.01$)

Table 6. Univariate analysis for differences in Power BI challenges between accounting and non-accounting specialization

Item	Means		t-test for equality of means		
	Acc. (n = 35)	Non Acc. (n = 25)	Mean difference	t- value	Sig.
<i>Using Power BI as learning tool has the following challenge:</i>					
Lack of readiness to learn	3.77	3.84	-0.07	- 1.657	0.103
Poor technological background	3.57	3.76	-0.19	- 2.495	0.015**
Poor information related to data modeling	3.60	3.67	-0.07	- 2.649	0.010***
Difficulty of learning advanced data cleaning and processing tools such as Power Query	3.66	3.84	-0.18	- 2.125	0.038**
Difficulty of learning Data Analysis Expressions (DAX)	3.71	3.96	-0.25	- 1.528	0.132
Resisting change in traditional stereotypical learning	3.94	3.84	0.10	- 0.799	0.427
Atypical of various analysis tools increase learning difficulty	3.51	3.68	-0.17	- 3.419	0.001***
Lack of faculty members' knowledge on the subject	3.77	3.96	-0.19	- 1.137	0.260
Poor faculty members' experience in the subject	3.77	4.04	-0.27	- 0.853	0.397

Notes: * significant at ($p \leq 0.1$); ** significant at ($p \leq 0.05$); *** significant at ($p \leq 0.01$)

5 Conclusion

Accounting graduates will need skills to handle BI tools, to collect, analyze, and visualize data. Accounting educators and researchers must be aware of the technological development and the need of graduates to fill the skill gap. Therefore, they must provide recommendations to update accounting curriculum. The purpose of this study was to survey the beliefs of faculty members in the faculty of business et al.-Zaytoonah university of Jordan about the benefits of using Power BI in accounting education, in addition to the challenges that could face this process.

Results show that the most benefits that could be gained from introducing Power BI in accounting curriculum are developing the data interpretive ability, data gathering skills, and problem-solving skills, in addition to other skills but at lower importance. It could be noticed that the abovementioned skills are part of the accounting profession, and the business intelligence tools may help in developing these skills. This is important for academics to take actual steps in developing and modifying accounting education.

The introduction of business intelligence tools in accounting education may face some challenges, the most important of which are resisting the change in traditional stereotypical learning, which became a fundamental type of learning process. Also,

poor experience in the BI tools for faculty members could be an important challenge, since they will be the main provider of knowledge. Another important challenge could be the difficulty of learning Data Analysis Expressions (DAX), which needs some code writing knowledge.

Another stream of analysis presented that there are differences of the faculty members in accounting department and the members in other departments in the faculty of business. These differences were significant for benefits such as developing research skills, software training, database skills, systems infrastructure knowledge, and code writing skills. In addition, there were significant differences in the responses about some challenges such as poor technological background, poor data modeling information, the difficulty of learning advanced tools such as Power Query, and atypical of various analysis tools. These differencing could be referred to the perceptions and knowledge of respondents about the background of accounting students.

These results may provide avenue for further research. For example, a national survey could be performed to include public and private universities to explore the differences between them. The survey could be extended to include professionals in addition to academics, to get insights about the market needs.

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The Role of Green Banking in Achieving Sustainable Development

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Abstract. this paper tries to explain the main essential concepts of Green Banking; in addition to the products as well as services under this concept; moreover, explains the role of Green Banking towards achieving sustainable development.

Design, Methodology, Approach- This paper depends on one main hypothesis that is; Iraqi Banks have the essential elements to adopt Green Banking. Certain Iraqi banks are involved in this study, and due to achieve the main object of this research, Greening Banking dimensions and indicators had been used to illustrate the extent of banks' environmental as well as social commitments.

Findings- The rank of environmental and social commitment of banks are really increased obviously with some banks especially those who encouraged by Central Bank of Iraq CBI and Iraqi Ministry of Finance.

Originality- Value- Green Banking concept is novel and due to rapid changes, that happened around the world in general and in Iraq in specific. Although many natural sources of energy, but unfortunately for many decades Iraq have been known as unilateral economy, and, it could be a good chance to search for this concept and serving banking literature with such papers like this to enrich the theoretical side and invest these theories and transfer them into action.

Keyword: Green Banking · Green Finance · Green Banks · Sustainable development · Environmental Sustainability

1 Introduction

Unfortunately, it is obvious that most of world have been suffered from the environmental; climate pollution in addition to resources exhaustion; that leads to economic decline as well. Moreover, the dynamic changes seem to be far from expectation, and still more efforts and sacrifices should be taken towards changing the reality.

Nevertheless, developing countries are suffered from many other threats, but these threats are rather complicated due to threats of climate change (global warming), pollutions, lack of geographical diversity, arable lands, elimination of forests, and the situation is more duplicated in Iraq, many climates serious dangerous changes happened

during last decades like desertification, high level of temperature; and dust phenomenon increased that led Iraq to be one of the five countries which effected by climate changes globally; and effects the survival there as well.

In this sense, sustainable development or sustainability is not a novel concept, because before many decades; the United Nations through the Oxford University Press announced its (*Brundtland Report in 1987*) where developed guiding principles were mentioned for sustainable of current needs without prejudice the future possibilities of change towards satisfying future needs (WCED 1987: 16).

Currently, certain dynamic processes have to be done among those developed countries; but without hard works and concentrated efforts the processes could be in vain! Banking sector in specific has a great obvious role towards balancing the environment due to the services, products, projects that absorb the unemployment and/or ensure the development sustainability movement.

2 Background

Green Banking concept refers to these services that are characterized as non-polluted services and all its processes' elements are characterized as environmentally friendly (Mehedi et al. 2017:3); meanwhile, these services have to protect environment so as natural resources and these kinds of banks could be named as (*Ethical Bank or Sustainable Bank*), in addition, green banking has a another great role in funding green projects, green industries as well (Bahl 2012:27), and Triodos Bank in Netherland that established in (1980) could be considered as the first bank in the world that discovered this concept (Yadav & Pathak 2013: 39).

Green Banks try to develop their current services and adding new ones with regard to the clients' needs such as; green loans for real state, green loans for cars, green credit cards, green saving account & withdrawal account, green stock markets, online services, mobile banking services, green insurance & green marketing (Bahl 2012:27); although in such cases, there is another opinion that supports the idea of having no affect for banks toward environment, but the fact is rather different because banks have many affected roles either internal and/or external effects (Tara et al. 2015:1032); the internal direct effects related to inter-business process in which banks try to reduce the pollution through online banking systems, reduce the use of electricity and other kinds of power resources; while the external indirect effects are related to clients themselves during their usages of banking products and services in a negative way that results the negative effect towards environment.

Adopting green banking system is developed through many strategies that suggested by (Agrawal 2014: 59) such as; objectives should be SMART, participating those shareholders and others in exchanging knowledge among societies to understand this concept and accept its ideas and themes; assessing the technology systems to serve the green banking systems, in addition to develop and achieve green policy to use those friendly technology systems to protect environment.

In this context, the green banking processes do not restricted with establishing environmentally friendly projects only, but it includes also aligning the environmental indicators with assessment and managing environmental risk and sustainability that related

to selected boundaries during banking processes such as; assessing the environmental risks to accept the loan request; then follow the environmental risks during withdrawal process; having certain claims toward the offenders; high level of responsibility of environment risk management, and finally having an action if any risk condition took place to protect the loan portfolio (Zhelyazkova & Kitanov 2015:311).

Thinking about the importance of green bank; means that this concept leads the interested searcher to think about sustainability development as well, due to the achievement of balancing those economic, social environments that raised accordingly. The instability and regular upside-down political issues have its side effect on both human and environment development (Murphy 2012: 15). Sustainability development concept focuses on three main dimensions; they are, *economic sustainability*, *social sustainability* and *environmental sustainability* (Mensah 2019:9). Figure 1 shows the integration of those dimensions as suggested by (Purvis et al. 2019:682).

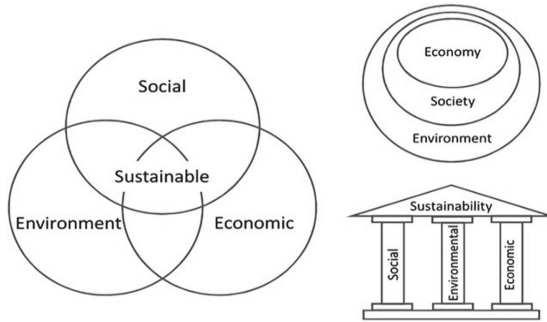


Fig. 1. Sustainability development Dimensions. Source: Variants of classical triple-bottom-line model (Purvis et al. 2019: 682).

Due to the mentioned facts, Central Bank of Iraq CBI seeks to publish the knowledge of the importance of green banks through supporting green funds and investments to clients to buy renewal energy systems to protect environment and achieve the sustainability as well (Abdullah & Hamed 2022: 178); in addition to solve any obstacles towards achieving sustainability through affiliating the management with sustainability development requirements (Bahera 2007: 3).

3 Related Literature Review

As far as researchers reviewed both articles, reports and studies that related to green bank concept; literature refers that most governments around the world are trying to transfer resources toward development and achieving sustainability through different initiations such as; *green bank Law in United State* and *Framework Law of reducing Carbon and Green Growth in South Korea*, moreover, such countries developed certain Ministries, organizations as well as in China were they create a *Ministry of Ecology & Environment* (Barua 2020: 115).

China experience becomes a special case to review and analyze *here*; due to the specific circumstances related to number of population and diverse of resources that China has which becomes an example of **SWOT** analysis for current paper, a struggle of how to overcome threats and transfer them into real opportunities, on the other hand how to support their strength sides to decrease their weaknesses, it considered as the largest source of greenhouse gas emissions, then USA; and air & water pollution regarded as a serious worried threats toward Chinese people and government as well, so before few decades, China announced many restricted boundaries to courage the green fundings and investment (Bai et al. 2013: 103).

In this context, Central Bank of China paid high attention towards the importance of green activities and exceed other countries in this field when reducing the profits of loans of specific projects that related to anti-pollution, moreover, China becomes one of the G20th countries in the world in which its efforts are focusing on four main categories; *R&D, monetary policy, the cooperation policies with financial policy; and leadership* (Barnes & Livingstone 2021: 5), and Fig. 2 illustrates the performance of certain countries toward green policies.

Rank	Country	Research and Advocacy (out of 10)	Monetary Policy (out of 50)	Financial Policy (out of 50)	Leadership by Example (out of 20)	Aggregate Score (out of 130)
1	China	10	16	23	0	50
2	Brazil	10	16	18	1	45
3	France	10	3	22	8	43
4	United Kingdom	10	4	19	5	38
5	European Union	10	2	15	6	33
6	Italy	10	2	15	4	31
7	Germany	10	1	15	3	29
8	Indonesia	10	1	8	2	21
9	Japan	10	5	4	0	19
10	Australia	10	0	4	1	15

Fig. 2. The performance of Central Banks of G20th countries according to Green Policies. Source: Barnes, David, Livingstone, Zack (2021). THE GREEN CENTRAL BANKING SCORECARD HOW GREEN ARE G20 CENTRAL BANKS AND FINANCIAL SUPERVISORS, Positive Money, England and Wales

In general, China started its steps of green banking milestones since 1995 and it made many updates till reaching the current situation; the following Table 1 explains these steps (Choi et al. 2020: 8).

Although many serious steps have been taken towards green banking projects and sustainable development such as following global principles like (The World Wildlife Fund, 2015: 45);

- equality principle, and United Nations program for environment,
- dividing industrial sector into harmful sectors and green ones,
- following the environmental & social global standards that aligned with credits,
- Chinese banks do not issue yearly environmental and / or social reports;
- and having a special council to control the loans for those factories that do not follow green banking systems; but still China especially (People's Bank of China) uses

Table 1. Green Banking Policy development stages in China

Date of issuance	Issuing organization	Name of policy document	Main contents
1995	PBoC	Notice on Issues Relating to Improving Environmental Protection in Credit Policy	Guiding banks on how to better include environmental variables in credit decisions
2007	EPA, PBoC, CBRC	Opinions on Implementing Environmental Protection Policies and Rules and Preventing Credit Risks	Guidelines on environmental risks' impact on credit rating of clients. First mention of "green credit" term
2007	CBRC	Opinions on Energy Efficiency and Emission Reductions in Credit Extension	Specific guidance on how banks can contribute to national environment goals
2012	CBRC	Notice on Issuing Green Credit Guidelines	First comprehensive policy promoting greening of banks
2013	CBRC	Notice of Submission of Green Credit Statistics	Establishment of CBRC statistics system for 21 main banks
2014	CBRC	Notice of the Key Performance Indicators of Green Credit Implementation	Establishment of quantitative and qualitative indicators for assessing performance
2016	CBRC, PBoC, MEP, CSRC, CIRC, NDRC, MOF	Guidelines for Establishing the Green Financial System	Comprehensive policy on green financial system as a whole
2017	PBoC	Notice Regarding Promoting Credit Asset and Collateral in Central Bank Evaluation	Financial incentives for green banking in PBoC standing- and medium-term lending facility
2018	PBoC	Chinese Monetary Policy Implementation Report Q4 2017	Inclusion of banks' green performance into MPA
2019	PBoC	Guidelines on High Quality Development of the Banking and Insurance Industries	Instructions on how to include environmental, social, and governance factors in credit

Source: Choi et Al.,2020, Green Banking in China – Emerging Trends With a spotlight on the Industrial and Commercial Bank of China (ICBC)CPI Discussion Brief August 2020, p: 9

pressure policy to push organizations and financial institutions to discover and find new sources to fund those green banking projects (Choi et al. 2020:8); Fig. 3 shows the development of China towards green banking project adoption and renewable energy as well.

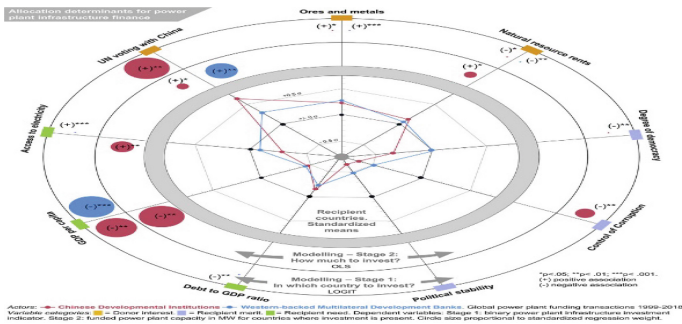


Fig. 3. China green finance growth indicators Source: Sauer et al. 2022; Determinants of Chinese and Western-backed development finance in the global electricity sector, P: 1230–1252.

4 Research Methodology

In order to examine the hypothesis “*there is awareness of the importance of adopting green banking in Iraqi Banks to effect the environment positively*”.

The researchers **follow the five banking indicators of Global Monetary Fund** to measure the banking activities especially those that related to environment and society (Shershneva & Kondyukova 2020:5) (Fig. 4);

- social and environmental standards in banking sector
- green investment standards in crediting processes
- environmental & social risk assessment of crediting process
- official reported data of social and environmental activities for commercial banks
- adopting environmental & social standards in banking legislations.

Unfortunately, only banking branches of Kurdistan region (North of Iraq) have been adopted *here due to the lack of certain process in other branches in Iraq*; such as Rafidain Bank, Al Rashid Bank, Ashur International Bank, and Credit Bank of Iraq, the common situation in Kurdistan is rather suitable to adopt those five indicators of **GMF**, especially for those that related to environment, risky assessment and social indicators.

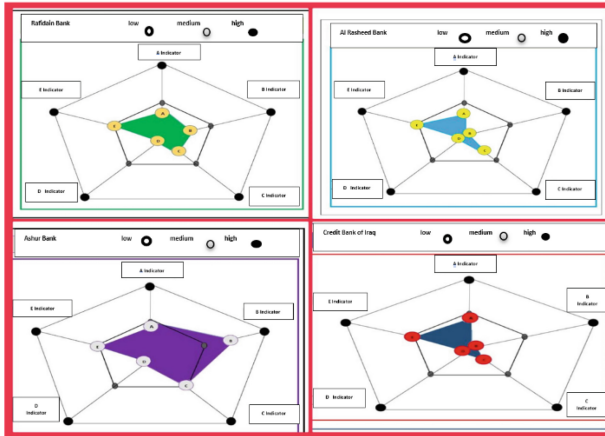


Fig. 4. Green Banking Indicators' Results Source: all data are registered through the interviews, and other web data.

5 Results and Discussion

Analyzing data illustrates many interested results as listed below: unfortunately, the worst indicator is that all studied banks have no global standardization to follow, they followed only local Iraqi standards.

- All studied banks do not submit any yearly reports that includes environmental, social or sustainable issues.
- Only Ashur & Rafidain banks support clients with green loans to buy solar energy systems with low rate of profit.
- Ashur bank is very active towards sharing knowledge of green banking importance among its employees through many training courses and workshops.
- High level of responsibility towards society.
- Central Bank of Iraq CBI and Federal Board of Supreme Audit have their regular assessment on all banks.
- Rafidain and Al Rashid Banks suffered from many international sanctions due to the War of 1990.
- Still, all studied banks use the traditional paper office systems in their transactions.
- Unfortunately, most of Iraqi banking staffs have no idea at all.
- All banks still have low number of ATMs.
- Banks are interested in risks during grants credit to clients.
- Ashur bank participates “*Alq Baghdad initiation*” to develop and afforestation public squares in Baghdad.
- Unfortunately, banks have no systems of renewable energy to supply their buildings, they still use “*fossil fuels*”.

With reference to those results, researchers argue that there is a lack of understanding this concept, and meanwhile banks have to take their serious action with high responsibility towards environment and society as well to share the knowledge of both green

banks & sustainable development through many physical or virtual training courses, arranging practical workshops to treat these concepts with high attention; nevertheless, banks suffered from the lack of using high qualified technologies and even most of their staffs are not familiar with latest technologies, that means many hard efforts and sacrifices have to be done to reach the level of having positive actions towards green bank and sustainable development. Meanwhile, as results shown that CBI & Ministry of Finance in Iraq are interested in social responsibility, and this fact could be an opportunity to overcome the weaknesses of neglecting environment.

In brief, investing in the intellectual capabilities of new generation of graduate students and analyzing the theoretical experiences of expertise either from local universities and institutes and/or from global ones could be a great chance to pave the path toward sustainable development by translating those written theoretical manuscripts into practical sustainable projects to serve both environment and society.

6 Conclusions, Limitations and Further Research

Still, banking system in Iraq has a long path to pass and united efforts between both CBI and Ministry of Finance should be taken to adopt green banking, in addition Iraqi banks have to participate their staffs with many different kinds of training courses that related to green banking, sustainable development importance and follow the global latest technologies; in addition to, encouraging banking staff as well as clients to use online banking system to complete their financial transactions.

Many limitations are considered here, *for place and time one*; It confines only on those Iraqi banks in Kurdistan region either public or private banks i.e., (Rafidain Bank, Al Rashid Bank, Ashur International Bank, and Credit Bank of Iraq) regardless the other regions either in Baghdad or South region of Iraq; while the time of gathering data and analyzing them estimated within three months only.

While another practical implication could be characterized as (*an adventure*) because the phenomena would be confined with certain circumstances that affiliate only for that region rather than others; so

Thus, researchers notify that still banking systems have to enrich with many studies, researches and articles that show the importance of these novel concepts and raising the idea that green banking considered as an opportunity to compete and sustain in a right way.

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Betting on ESGs Impacts Long-Term Market Value. The Case of European Energy Firms During COVID-19 and Ukraine Armed Conflicts

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Abstract. The present study evaluates how environmental, social and governance (ESG) as well as corporate social responsibility (CSR) contribute to firms' resiliency and ability to overcome crises. Taking as a standing point the triple bottom line theory, the analysis is focused on Germany and Spain, two of the most affected nations considering COVID-19 pandemic and Ukraine armed conflicts. In this context, the companies studied operate in the energy industry, being an essential economic activity and one of the hardest hit by both crises. Following a quantitative -shareprice evolution- and qualitative -ESG adoption by companies- analysis, main findings show that sustainable business models and an adequate ESG Management, help companies to be more resilient in a scenario of crisis. Findings contribute to re-evaluate the post-modern World economy together with filling some research gaps. Future recommended research would include analyzing other combinations of crisis-country-sector analysis.

Keywords: sustainability · green investment · ESG · CSR · energy

1 Introduction

There has been a growing concern regarding business operations' impact on the environment and society, following specific studies that show earth is warming at an unprecedented rate and that causes loss of biodiversity, negatively impacting human, flora and fauna's health [1]. The triple bottom line theory (TBL), tackles this issue by evaluating how firms that include people and planet in their strategic design can positively impact business returns. In balancing people, profit and planet, these organizations are able to obtain a long-term value creation framework that consolidates competitive advantages and supports sustainable development.

In this context, the financial sector has shifted to support companies that have people and the planet at the core of their projects, financing areas such as renewable energies. Results have shown that by doing so, financial entities could reduce their default risk as well as positively impact the financial entity's performance [2]. Investors are also aware

of the importance of this topic and therefore, supporting the transition to a sustainable economic model can benefit both the financial industry as well as addressing climate change. Similar positive findings were also evidenced in other areas related to people and planet, such as reducing climate change, protecting the environment or ensuring gender equality. Hence, creating a holistic perspective including environmental, social and governance aspects (ESG) allows firms to achieve and sustain development in the long-run [3] and [4].

Furthermore, investors can benefit from financing firms that consider ESG variables, as their portfolios showed greater returns [6]. Additionally, some studies concluded that ESG commitment is a driver of market profitability for investors, while [2] and [7], proposing models to include ESG in investment decisions. By studying a sample of firms in the period between 1991 and 2012, [8] evaluated the impact of CSR on a firm's level of distress risk. The study included the 2008 financial crisis, and concluded that better CSR performance through specific ESG policies increases a company's credibility and reputation, making them more creditworthy and therefore facilitating access to better financing tools. The authors identified a need for further information to be gathered for firms operating in contexts of hardship. This research gap was also identified by [5], as well as the impact of ESG strategies in improving the business operations and resilience to meet changing environments.

Following on the research gaps and recommendations identified by [5, 6, 8] and [9], the present paper brings light on post-COVID scenarios and Ukraine armed conflict hardship contexts. Based on TBL, the paper explores the long-term impact of people-profit-planet commitments and ESG strategies, and how they contributed to the firm's ability to overcome two contexts of hardship. The concrete case of the Ukraine armed conflict is analyzed with a focus on German and Spanish energy firms and their performance in the stock market, corporate reputation and overall performance.

Firstly, the theoretical framework and hypotheses are derived in the Literature Review section. Secondly, the data collection and empirical analysis is described, together with the methodology. Thirdly, detailed results are presented, as well as contributions to academia and practice. Managers can gain a better understanding on how to design sustainable business models to gain resiliency and long-term development. Meanwhile policy makers can obtain a greater insight into creating policies that support ESG investment while academia can further enlarge into the applicability of TBL in contexts of hardship.

Finally, the study concludes by addressing main limitations and suggestions for future research in this area. To the author's knowledge, there are no empirical studies testing these effects, particularly in a double context of hardship. This will be our contribution.

2 Literature Review

The present study is based on triple bottom line (TBL) theory, which considers people, profit and planet should all be taken into consideration when designing business models. By doing so, a business can achieve and sustain development in the long-run [3, 4]. This is especially true for firms operating in nations where governments have supported energy transition into renewable sources as well as having a strong focus on social wellbeing.

In particular, the EU framework within the EU nations, the Spanish government has established a National Integrated Energy and Climate Change Plan (PNIEC due to its acronym in Spanish). This framework, aligned with the EU's action plans, outlines clear plans and actions to be carried out between 2021 and 2030 [16]. The main objectives included: increasing the real-time usage of renewable energy to reach 42%, reducing emissions by 21% with respect to 1990 levels, improving energetic efficiency by 39,6%, and, from the total electricity mix consumed, 74% being renewable sources.

In the case of Germany, the country created the Renewable Energy Sources Act in 2000 to boost the development of renewable sources, providing substantial compensation for renewable electricity through feed-in-tariff mechanisms [17]. Their target included reducing carbon emissions to 40% by 2020 in comparison with 1990 levels. However, changes in the feed-in-tariff methodology reduced the rate at which the country advanced, together with the increase of industry capacity and power. While the transition created positive results, the country was still highly dependent on fossil fuels with the highest percentage being coal, the most carbon-intensive source.

The soar of the virus SARS-COV-2 at the end of 2019 had an immediate and negative effect on supply chains in all industries, including energy and those carbon-dependent business models. The situation created difficulties throughout 2020 and 2021, impacting multiple industries and areas around the globe. The phenomenon was studied within the TBL theory by several authors who evaluated ESG and CSR strategies as tools to help improve firms' capacity to face contexts of hardship. The research conducted by [9] concluded that sustainable business models improved firms' resilience, ability to adapt to change, and in the end, reduce the negative impact on market performance. Authors also identified the need to re-evaluate the consistency of these results after the COVID crisis to confirm whether the positive resiliency effect is sustained over time.

As Russia invaded Ukraine on February 24th 2022, the international sanctions on Russian firms created a greater stress in the energy sector, as Russia is a major exporter of oil and gas. This situation increased the uncertainty in all financial markets yet due to geographical and trade links, European markets were hit the hardest. Considering the Ukraine armed conflict took place right after the outbreak of COVID-19, both force majeure events combined significantly impacted business operations in Europe.

Recent studies have analyzed this phenomenon by evaluating the impact of the Russian invasion of Ukraine on cumulative returns on global stock market indexes [8]. Results showed that since February 24th 2022, in general, there was a negative cumulative abnormal return. In addition to the impact on companies themselves, other studies identified these same companies had high potential to improve reconstruction in conflict areas, as well as building economic development through a consolidated CSR policy and ESG strategies [10]. Hence, firms can play a social role as a peacebuilder by incorporating employees from war-torn regions or establishing programs for refugees, among other actions. In some cases, the expats leaving conflict zones are highly-skilled individuals who can bring significant value to the firm, leading to a win-win situation [11, 12].

To the author's knowledge, there is still a lack of information on how this situation can affect companies with different degrees of ESG implementation. Additionally, there is a need for further light on the impact on firms operating in the energy sector in Europe, which has been one of the most affected by the conflict and the pandemic. Following the

recommendation by [8] and [9] to re-evaluate and bring light on post-COVID scenarios, together with the research gaps identified by [5] and [6], this study focuses on testing three main hypotheses in the mentioned double context of hardship:

H1: Following sustainable management models helps firms to improve their resilience when facing multiple global crises

H2: Adequate ESG management in high-exposure environments positively impacts firm's ability to manage multiple crises

H3: Long-term ESG management positively impacts firm's ESG risk rating

3 Methodology

To assess the above mentioned hypotheses and shed light on the gaps identified by previous literature, a mixed quantitative and qualitative approach was used. Spain was one of the two countries that were first hit by the spread of the virus, and severely impacted in terms of health and socio-economic impact.

At the same time, Germany was also one of the nations that suffered significantly from the pandemic. According to detailed data retrieved [18], countries bordering Russia as well as former USSR nations were the ones with the highest degree of dependency. Following these, Germany stands out as one of the nations with significant links, close to 30% in terms of total imports of energy-related products from Russia. Because of the previous and taking into account the large requirements of energy input Germany has to support its vast industrial sector, the Ukraine armed conflict significantly impacted the nation (Fig. 1).

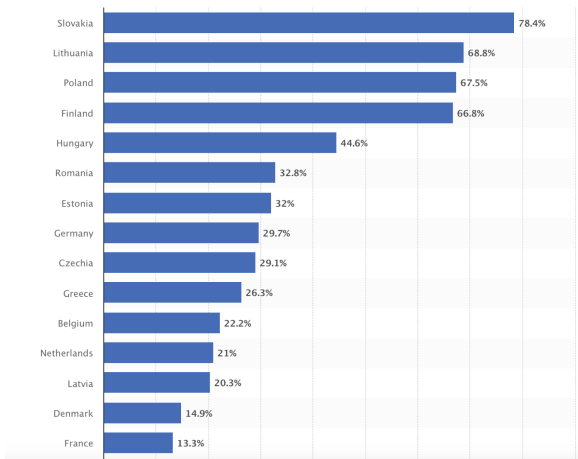


Fig. 1. Share of Russian products in total oil and petroleum product imports in the European Union (EU) and the United Kingdom (UK) in 2020 by country [18]

Data from firms operating in the energy sector in Spain and Germany was obtained from the Spanish and German stock markets (IBEX-35 and DAX respectively). This

information was complemented with the data published by the platform Sustainalytics, which collects information on the key ESG aspects of companies for investors. The information detailed by this organization has been compiled for companies in the Spanish and German energy sector. Following this combined methodology also implemented in [6] as well as the future lines of research addressed by these authors in conjunction with [10] and [11] the present study evaluates firms within the context of the European Union (EU) as it is a geopolitical context taking a strong approach towards ensuring sustainable growth and individual's wellbeing. Because of this, the firms herein analyzed are:

Endesa (energy): The company, a subsidiary of the Italian company ENEL, is devoted to energy generation from diverse sources, focusing its business activities in Spain, Portugal and North of Africa [19]. The company is also involved in the supply of electricity and gas to other European countries[20]. It is one of the largest electricity providers in Spain, currently transitioning into other sources of energy [21].

Enagas (energy): Is a Spanish company with three main business activities: deployment, operation, and maintenance of gas infrastructures, mainly focused in Spain but also in Italy, Greece, Albania, Mexico, Peru and Chile [22].

Iberdrola (energy): Is a Spanish company mostly focused on production of energy from renewable sources. The company is also involved in the purchase and sale of energy on wholesale markets [23], with more than 38,000 MW of renewable capacity installed worldwide [24].

Naturgy (energy): Is a Spain-based group conveying activities in the supply, liquefaction, regasification, transport, and storage of natural gas in Spain, LATAM and internationally [25].

Repsol (energy and petrol): The company is mainly focused on hydrocarbons, transiting from non-renewable into renewable energy business by diversifying its business and expanding into more sustainable models. Their target is that 45% of the energy generation by 2030 will be through low carbon generation sources [26].

REE (energy-electricity): A partly state-owned company, the firm is the sole carrier and operator of the Spanish electricity system, while also providing consultancy, engineering, and construction services [27].

Solaria (energy-electricity) Is a Spanish company focused on the development and generation of solar photovoltaic energy in Southern Europe [28].

E.ON: The company offers retail distribution and energy networks operating in Germany, Eastern Europe, Sweden and Turkey [29].

RWE: The firm focuses its business on power generation from renewable and non-renewable sources, promoting renewables in the UK, USA, Europe and Turkey [23].

4 Results

4.1 ESG Risk Exposure and Management in Traditional Energy Firms

Overall the Spanish firms herein studied have a high exposure in terms of ESG variables. This is due to numerous reasons, for example they operate in countries with low transparency (according to Transparency International Rankings) such as the LATAM or MENA regions. Because of this, the company's management has undertaken several

steps in order to strengthen the firm’s Corporate Governance, improve their CSR with specific ESG strategic approaches. As a result, [35] has considered Spanish energy companies with a Strong Management of ESG materials. The overall ESG Risk Rating is medium and Spanish firms are ranked lower than German ones.

In Fig. 2 the results from Iberdrola are portrayed, which is a company that is considered to have high exposure and overall medium risk, being ranked 92 out of 673 firms in the Utilities sector at a global scale. This measurement considers 1 the lowest risk and 673 the highest, being the greatest exposure at which a Utility company could be subject to based on a lack of adequate ESG policies. Meanwhile the results for RWE AG are shown, where the firm has obtained an ESG risk rating 2.7 points higher than Iberdrola. Both firms are considered by markets to be at a high exposure, taking into consideration company-specific factors, the industry and sub industry.

As both companies have the same degree of exposure, it is important to evaluate the difference in results in terms of ESG risk rating within the industry. Iberdrola is ranked 92 within the global industry group, which is significantly lower than the 120 position occupied by RWE AG, as evidenced in Fig. 2. In spite of both firms being considered to have a strong managerial approach towards ESG matters and their risk management plan being good, the risk ranking determines the degree of robustness of the ESG programs, practices, policies and overall governance and compliance approaches.

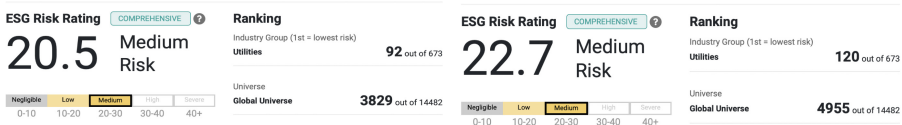


Fig. 2. RWE’s vs. Iberdrola’s ESG Risk Rating [30, 31]

Comparing E.ON with REE, which is a utility company offering similar services in the national sphere and with international exposure, the results from REE are significantly better than E.ON’s, being ranked with a low risk rating with an overall scoring of 10.7 in spite of being considered a firm with medium ESG exposure, as is the case of E.ON. In addition, REE ranks 6 out of 673 companies included worldwide in the Utilities industry group, being one of the lowest in terms of ESG risk. E.ON is ranked 132 out of 673, implying the ESG strategies being implemented by E.ON do not address the ESG risks as well as the ones implemented by REE, as seen in Fig. 3.

This is due to the strong ESG management approach, thorough analysis and data gathering and constant improvements in their strategic design to ensure sustainable development. In addition, the firm is in alignment with supporting Spain’s energetic transitioning, and Spain has been one of the nations that passed more regulations to limit energetic usage and shift the energy matrix into a fully green one.

Furthermore, firms herein studied, both in Spain and Germany, have had a direct approach towards contributing to alleviating the impact of the Ukraine war on people. In some cases, relocating their employees, closing operations in certain regions as well as creating special fast-track programs to hire professionals of Ukraine nationality. For instance, Iberdrola contributed to the relocation of Ukrainian citizens, offering jobs to

those highly skilled individuals that could contribute to the organization. In doing so, the firm contributed to help displaced professionals, and was able to attract talent. This increased their corporate reputation and market trust.



Fig. 3. E.ON’s vs. REE’s ESG Risk Rating [29, 33]

Similarly, E.ON offered licenses to Ukraine students relocating to Romania and Hungary so they could continue their education through a metaverse. In this case, the usage of the latest available technology can provide a way to contribute to the advancement of new product portfolios and enlarge testing new products while providing an adequate solution to relocating individuals. Because of this, the firm can improve their reputation and knowledge-acquisition process, enlarge the application of digitalization to new areas and increase the attractiveness of the firms [26].

4.2 ESG Risk Exposure and Management in Renewable-Energy Based Firms

Energy firms listed in the Spanish major stock exchange, IBEX-35 include a renewable-energy based company, Solaria. This firm, which focuses on the development of photovoltaic technology, including large solar farms in Spain and Latin America, does not have the same context as the previously described companies. In this case, the degree of exposure is low, as on the one hand its portfolio does not include highly polluting products such as oil or gas, and on the other hand the regulatory and integrative frameworks are less hostile and uncertain.

In this context, the firm operates in a relatively low-risk environment in terms of ESG exposures. However, the results show that according to data retrieved from their ESG management approach, the firm itself is considered to have a medium ESG risk [28]. Considering the overall industry group ranking of 673 firms worldwide, it ranks number 99, with higher risk compared to other Spanish firms such as REE or Iberdrola (see Fig. 4). The results, considering both REE and Iberdrola operate in high-exposure environments instead of low ones, show that Solaria may not have as consolidated ESG policies, practices, and approaches as other firms with a greater trajectory and who may have initiated a CSR approach earlier in time [28].

Considering the performance of the firms in the energy sector in comparison with other sectors within the flagship indexes IBEX-35 (Spain) and DAX (Germany) results show that in the case of Spain the Energy corporations outperformed the rest of the companies included in the index. Figure 5 shows the comparison between both parameters. In the case of Germany, the DAX index without the energy organizations performs slightly worse than the energy ones. However, the difference is not as large as in the case of the IBEX-35.

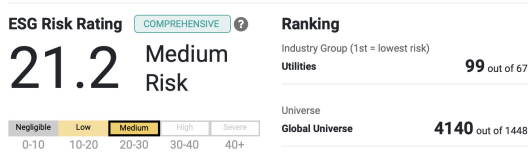


Fig. 4. Solaria’s ESG Risk Rating [34]

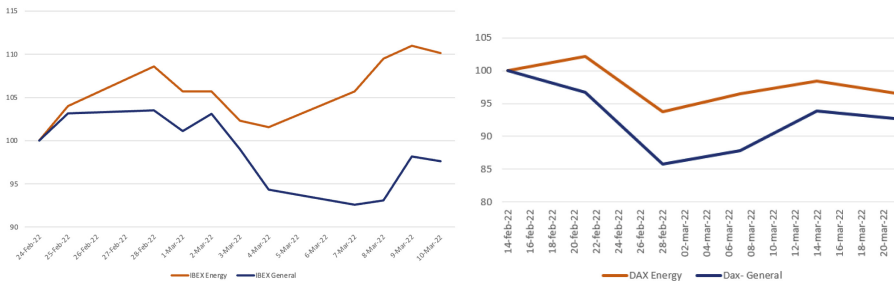


Fig. 5. IBEX energy vs. IBEX no energy – DAX energy vs. DAX no energy (own elaboration) [23]

5 Conclusions, Future Lines of Research and Limitations

The degree of uncertainty in which firms have been operating has significantly increased in the past few years. Starting with the pandemic in 2020, followed by the Ukraine invasion in February 2022, companies across the globe but particularly in Europe continue to encounter limitations and volatility. Because of this, the re-evaluation of business strategies has been an increasing concern both for academics and practitioners.

The present paper contributes to the understanding of the importance of long-term ESG strategies in order to ensure competitive advantages can be consolidated. Additionally, it supports conclusions evidenced by previous literature, by showing that businesses are able to improve their resiliency in contexts of hardship. As portrayed in Fig. 5, the results for Spanish and German firms confirm hypothesis 1.

This contributes to the findings obtained by [3] determining ESG considerations are a key element in investment decision-making. In addition, it enhances the results portrayed [35], as ESG commitment is a driver of market profitability for investors. Therefore, investors can use CSR reports and evaluate corporations’ long-term ESG strategies when conducting their future investments. Furthermore, practitioners can develop business models that incorporate ESG as a core element to ensure the competitive advantage is built upon a resilient and solid base.

While strong ESG strategies can help firms positively impact their financial performance as well as contribute to socio-environmental wellbeing, evidence showed lower ESG strategies and worse CSR policies make companies more at risk, their ability to manage crises being worse. Adequate ESG management in high-exposure environments positively impacts a firm’s ability to manage multiple crises. Hence, hypothesis two can be confirmed. These results contribute to the findings shared by [5] and [7], further

expanding TBL theory into constantly changing, uncertain and ambiguous contexts. Findings show managers ESG and CSR can significantly help in designing strategies that address highly volatile operating contexts.

Additionally, in the case of crises provoked by armed conflict, the relevance of ESG is greater. As [7] identified, the links between companies and conflict areas are a two-way street. With the cases analyzed, firms were able to have positive impacts in the alleviation of negative effects derived from the war while contributing to improvements in their own business structure. As evidenced in the case of E.ON, through a donation of virtual reality tools, the firm can test and evaluate the applicability of their technological developments to new areas, while improving the access to education and continuity of studies in the case of refugee students.

These initiatives can contribute to each company's reputation however in the long-run it will also improve the brand awareness or talent attraction of future professionals. In addition, ESG strategies and proper management have helped firms in this context to continue their operations, reduce their risks and exposure, as well as be considered with a strong managerial approach, creating greater trust in investors. Policy makers can take advantage of these findings and create collaborations with firms in order to design policies and strategies that can benefit individuals affected by those armed conflicts as well as corporations.

The findings from this study can contribute to practitioner's approaches, especially those managing organizations that face political, military or other unexpected turmoil. Managers and corporate directors can adapt their business models by including ESG variables within the strategic design, increase the number of key performance indicators linked to these areas, and use environmental and social impact assessments in their decision-making process.

It was herein evidenced that firms who have been investing in adequate ESG management through longer periods of time obtained better results. Spanish firms herein studied began around 2000 to modify their product offering into "greener" portfolios, improve approaches towards people as well as increase their governance. In addition, these organizations created strong investments in renewables and expanded internationally, changing the balance between nonrenewable and renewable resources. Meanwhile, German firms did not follow that pathway at the same rate, hence creating greater instability and dependency on foreign institutions that could provide oil and gas products. The difference between the results in one case and the other contributed to Spanish firms being able to be exposed to a lower risk in spite of operating in a high-risk industry. Because of this, long-term adequate ESG management can positively impact the ESG risk rating. In this context, hypothesis 3 can be confirmed.

Findings provide managers with a new vision on the effectiveness of ESG policies and CSR strategies, contributing to build competitive advantages and lowering their exposure to risk. This can make these firms more attractive to investors, while policy makers can continue to include ESG requirements and disclosure of ESG investment prerequisites to foster funding flowing into those areas.

These findings contribute to re-evaluate the post-modern world economy as defined by [8] and [9], together with filling the research gaps identified by [5] and [6]. However, it is limited to the specific context of Europe and the two nations mostly impacted

by COVID-19 and Ukraine armed conflict crises. It would be of high interest for both academia and practitioners to study the impact in energy sectors in other markets, such as the United States or Asia. The findings also show a different performance of German and Spanish energy companies. As a future line of research, other industries also significantly impacted by COVID-19 and Ukraine armed conflict can be analyzed to evaluate whether the results here hold true. These could contribute significantly to the advancement of TBL theory while providing valuable insights to practitioners and investors.

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The Impact of Cash Liquidity on Sustainable Financial Growth: A Study on ASE-Listed Industrial Companies

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Abstract. This study examines the impact of cash liquidity on the financial sustainability of industrial public shareholding companies listed on the Amman Stock Exchange (ASE) between 2015 and 2021. A purposeful sample of 28 companies was selected from the population of 53 listed companies based on the availability of complete financial data. Statistical methods using SPSS were employed to analyze the data. The study found that cash flow, as measured by net cash flow from all activities to total assets, net cash flow from all activities to total equity, net cash flow from all activities to total profit, and net operating cash flow to total assets, significantly affects the sustainability of profit growth, sales, and assets of these companies. However, the net cash flow from all activities to total equity does not impact sales growth. The study recommends that companies pay more attention to the cash flow statement and utilize the data therein to make investment and financing decisions. Additionally, companies should focus on improving cash liquidity management and determining the appropriate combination of equity and debt sources to reduce the cost of capital and maximize sustainable financial growth, leading to more profitable investment opportunities.

Keywords: Amman Stock Exchange · Cash liquidity · Financial growth · Industrial companies

1 Introduction

Effective cash flow management is essential for the success and growth of corporations, as an imbalance between cash inflows and outflows can lead to problems in financial management, regardless of whether the difference represents a surplus or a deficit [1]. The availability of liquidity can put pressure on companies to invest in opportunities that may not be beneficial in certain economic conditions, further affecting the sustainability of financial growth [2]. On the other hand, when cash outflows exceed inflows, it can result in a lack of liquidity, hindering a company's ability to meet obligations, move the operating cycle, and cope with emergencies, which affects the sustainability of financial growth [3].

Previous studies have shown that there is a strong relationship between cash liquidity and sustainable financial growth. It was found that a firm's cash position significantly impacts its ability to grow and survive in the long run, with companies having strong cash reserves better able to weather financial crises, take advantage of growth opportunities, and meet their obligations on time [4]. It was also found that effective cash flow management can improve a company's profitability and market value [2]. However, managing cash liquidity can be challenging, as high levels of cash liquidity can result in low rates of resource utilization and missed opportunities for investment, while low levels can hinder a company's ability to meet its obligations, move its operating cycle, and cope with emergencies [5].

This study aims to evaluate the impact of cash liquidity on sustainable financial growth in Jordanian industrial companies by analyzing relevant indicators. The study's contribution is to investigate whether cash liquidity has a positive or negative effect on sustainable financial growth, and explore the relationship between the two. The significance of the study is to provide insights to policy-makers and business leaders for making informed decisions regarding cash management strategies, ultimately leading to sustainable financial growth. Jordan's heavy reliance on the industrial sector and limited research on the topic in the region make this study significant. Sustainable financial growth is defined as a company's ability to maintain profitability and financial stability over time, while considering social and environmental responsibilities.

Lecture Review

Companies hold cash reserves, or liquidity, for various reasons, such as precautionary, transactional, and agency reasons. These factors, coupled with the opportunity cost of holding liquidity assets and the marginal cost of a lack of liquidity, determine a company's cash holdings [6]. Liquidity is a vital indicator of accounting performance that measures a company's ability to pay its short-term debts and obligations. Therefore, efficient liquidity management is critical for the performance of the company and an essential tool used by internal and external users to make informed decisions [7]. From a monetary perspective, liquidity measures the ability of a company to manage cash movements, such as operating, investment, and financing activities, in the short term without stress and in a balanced manner with other business objectives, such as profitability, growth, and continuity [8]. In contrast, financial growth reflects the company's ability to achieve profits during its operations while minimizing risks [9, 10]. The correlation between cash liquidity management and the sustainability of financial growth elements in companies is complex. Liquidity is essential for companies to fulfill their obligations, avoid bankruptcy and liquidation, develop and improve opportunities for financial growth, and prevent borrowing costs if the company incurs losses [11].

However, low liquidity is one of the problems faced by companies due to inaccurate management of current assets, which results in an imbalance between the nature of funding sources and financial uses, and another imbalance between the growth of the company's liabilities and its ability to provide cash from its operational activities [12]. Such issues will hinder the company from seizing available opportunities, leading to bankruptcy and liquidation [13]. Conversely, a high level of cash liquidity in a company indicates inadequate management of liabilities and equity issues, leading to cash flow

disruptions and hindering the company from achieving high operating profits, affecting the sustainability of its asset growth [6].

The impact of liquidity on the sustainability of the elements of financial growth for companies remains a topic of interest, with various studies producing differing results [14]. Some studies, such as Khanqah and Lida (2013), have demonstrated a positive relationship between liquidity and the financial structure and sustainability of corporations [15]. Other studies, like Alshehadeh et al. (2022), have found a positive association between measures of financial leverage and liquidity, with the percentage of company profits positively associated with financial leverage [16]. On the other hand, Bundala (2014) found no association between capital structure and growth opportunities [17], and Awan et al. (2010) found no association between financial leverage and high growth opportunities [18]. However, they found a positive relationship between medium to low growth opportunities and corporate financial leverage. These studies also highlighted that the type of industry can significantly affect the relationship between financial leverage and growth opportunities.

Other studies have explored the influence of investment opportunities and capital structure on company performance [19]. For example, a previous study investigated the impact of investment opportunities on the value of the corporation through the role of corporate governance and the independence of the corporate board of directors [20]. They found that investment opportunities affect the value of the company, and corporate governance and the independence of the board of directors work to mitigate this impact. In contrast, a previous study found that capital structure significantly and negatively affects company performance, with this effect being more significant in state-owned companies [21]. Another study found a negative relationship between investment opportunities and the debt ratio, with companies preferring to finance new investment opportunities through retained earnings rather than debt [19]. This finding indicates that corporations seeking to achieve growth prefer to finance current and future investments through retained earnings, which aligns with the preference for equity financing over debt financing.

Hypotheses Development

The mismanagement of current assets in companies can lead to low liquidity, causing a lack of balance between financing sources and financial uses. This imbalance can result in negative consequences such as the inability to meet growth requirements, loss of investment opportunities, and ultimately bankruptcy [22, 23]. Conversely, high cash liquidity can lead to problems in financing sources and the use of funds, resulting in a similar imbalance. Moreover, the trend of increasing liquidity can disrupt cash flow, leading to low operating profits and delays in payment [24]. In today's competitive business environment, it is essential for companies to invest their available liquidity strategically to achieve sustainable financial growth rates. However, companies may face difficulty selecting investment opportunities that raise financial growth rates and maintain an optimal level of cash flow. Thus, maintaining liquidity can conflict with increasing investment efficiency and expose the company to risk. This research aims to investigate the impact of cash liquidity on the sustainability of financial growth in ASE-listed industrial companies. The research problem is articulated in three questions that will shed light on whether cash liquidity impacts asset, profit, and sales growth

sustainability. Ultimately, this study will contribute to understanding the relationship between liquidity and sustainable financial growth in the context of Jordanian industrial companies.

The following hypotheses are tested to determine the impact of liquidity variables on the sustainability of financial growth.

H01: There is no statistically significant impact at the significance level $\alpha \leq 0.05$) for the cash liquidity indicators on the sustainability of asset growth in the ASE-listed industrial companies.

H02: There is no statistically significant impact at the significance level ($\alpha \leq 0.05$) for the cash liquidity indicators on the sustainability of profit growth in the ASE-listed industrial companies.

H03: There is no statistically significant impact at the significance level ($\alpha \leq 0.05$) for the cash liquidity indicators on the sustainability of sales growth in the ASE-listed industrial companies.

2 Method

To select the sample of 28 companies, the authors employed a purposeful sampling technique, which is a non-random sampling method. The criteria for selecting the sample included the availability of complete financial statements data and meeting the research variables during the research years (2015–2021). The financial statements data for the selected companies were obtained from the Amman Stock Exchange's financial website.

The specific variables that were extracted from the financial statements data include the independent variable of cash liquidity, which was measured using the current ratio, quick ratio, and cash ratio. The dependent variable of sustainable financial growth was measured using return on assets, return on equity, and earnings per share. Other financial ratios, such as debt-to-equity ratio, were also extracted to control for any potential confounding variables.

To ensure the accuracy and reliability of the data, the authors checked for any inconsistencies in the financial statements and cross-checked the data with other sources, such as the annual reports of the companies. The statistical program SPSS was used to analyze the data and apply appropriate statistical methods to test the research hypotheses. Table 1 illustrates the research's independent and dependent variables and their measurement methods. Regression models are used to test the research hypotheses as follows:

$$CL_{it} = \beta_0 + \beta_1 AG_{it} + \beta_2 \varepsilon PG_{it} + \beta_3 SG_{it} + \varepsilon_{it}$$

3 Results and Discussion

The findings of hypothesis (1), which states “there is no statistically significant impact at the level of significance ($\alpha \leq 0.05$) for cash liquidity indicators on the sustainability of asset growth in industrial companies listed on the Amman Stock Exchange,” were analyzed using the multiple linear regression analysis method, employing the stepwise entry of independent variables. The multiple linear regression analysis was utilized to explore the impact of cash liquidity indicators on the sustainability of asset growth in ASE-listed industrial companies, as shown in Table 2.

Table 1. The Research Independent and Dependent Variables and their Measurement Methods

Variable	Measurement Abb.	Measurement Method
Cash Liquidity CL	NCF/TA	Net cash flow from all activities to total assets
	NCF/TE	Net cash flow from all activities to total equity
	NCF/IN	Net cash flow from all activities to income net
	NOCF/TA	Net operating cash flow to total assets
Financial Growth FG	AG	Assets growth rate: (total assets at the end of the period - total assets at the beginning of the period)/total assets at the beginning of the period
	PG	Profit growth rate: (total profit at the end of the period - total profit at the beginning of the period)/total profit at the beginning of the period
	SG	Sales growth rate: (total sales at the end of the period - total sales at the beginning of the period)/total sales at the beginning of the period

Table 2. Multiple Linear Regression Analysis Test between the Indicators of Cash Liquidity and the Sustainability of Asset Growth in the ASE-listed Industrial Companies.

Dependent Variable	R	R ²	F-Value	Statistical Sig	Independent Variables	(B)	(Beta)	T-Value	P-value
AG	0.171	0.151	1145.4	**0.000	Constant	1.883	–	1.634	0.157
					NCF/TA	0.387	0.759-	42.375	0.000**
					NCF/TE	0.741	0.287	3.206	0.001**
					NCF/IN	0.953	0.374	24.158	0.002**
					NOCF/TA	1.883	0.481	27.242	0.031**

** Statistically significant $p < 0.01$

The results reveal that the cash liquidity indicators have a statistically significant impact on the sustainability of asset growth in the ASE-listed industrial companies, contradicting the null hypothesis (H1) that suggests otherwise. This was determined through multiple linear regression analysis, which utilized the stepwise entry method for the independent variables. As presented in Table 2, the absolute value of the multiple correlation coefficient between the cash liquidity indicators and the sustainability of asset growth in the companies is 0.171, with an R2 value of 0.151. This implies that the liquidity indicators can explain 15.1% of the variation in the sustainability of asset growth index. Moreover, the F-value of 1145.410 is statistically significant at the significance level of $\alpha \leq 0.05$, supporting the alternative hypothesis. The results also demonstrate the importance of specific liquidity indicators, including net cash flow from all activities to total assets, net cash flow from all activities to total equity, net cash flow from all

activities to total profit, and net operating cash flow to total assets, in impacting the sustainability of asset growth in the ASE-listed industrial companies.

The results suggest that cash liquidity indicators have a statistically significant impact on the sustainability of asset growth in the ASE-listed industrial companies, supporting the alternative hypothesis. The finding is determined through multiple linear regression analysis and the stepwise entry method for independent variables. The significance of specific liquidity indicators, including net cash flow from all activities to total assets, net cash flow from all activities to total equity, net cash flow from all activities to total profit, and net operating cash flow to total assets, further supports the importance of managing cash liquidity in these companies. It is important to note that the explanatory power of the liquidity indicators on asset growth sustainability is relatively low, as they only explain 15.1% of the variation in the index. Thus, there may be other factors beyond cash liquidity that influence the sustainability of asset growth in these companies. The findings of this study have practical implications for the surveyed companies as they highlight the importance of monitoring and managing cash liquidity effectively to ensure sustainable asset growth. Companies can use the specific liquidity indicators identified in the study to assess their financial health and make informed decisions about their capital structure and financing methods.

The hypothesis (2) states that “there is no statistically significant impact at the level of significance ($\alpha \leq 0.05$) for the cash liquidity indicators on the sustainability of profit growth in the ASE-listed industrial companies”. To test this hypothesis, a multiple linear regression analysis is conducted using the stepwise entry of independent variables. The aim is to investigate whether the cash liquidity indicators have an effect on the sustainability of profit growth in the ASE-listed industrial companies. Table 3 presents the results of the multiple linear regression analysis.

Table 3. Multiple Linear Regression Analysis Test between the Indicators of Cash Liquidity and the Sustainability of Profit Growth in the ASE-listed Industrial Companies.

Dependent Variable	R	R ²	F-Value	Statistical Sig	Independent Variables	(B)	(Beta)	T-Value	P-value
PG	0.431	0.412	116.98	**0.000	Constant	0.361	–	1.932	0.057
					NCF/TA	0.931	0.531	5.216	0.000**
					NCF/TE	0.621	0.389	3.716	0.001**
					NCF/IN	0.728	0.285	4.124	0.003**
					NOCF/TA	0.551	0.438	5.151	0.000**

** Statistically significant $p < 0.01$

The findings reveal that the absolute value of the multiple correlation coefficients between the indicators of cash liquidity and the sustainability of profit growth in the ASE-listed industrial companies is (0.431), with a square value of the correlation coefficient of ($R^2 = 0.412$). This suggests that the liquidity indicators account for (41.2%) of the variation in the profit growth sustainability index. Additionally, the F-value of (116.976) is statistically significant at the significance level of ($\alpha \leq 0.05$), indicating the

acceptance of the alternative hypothesis that “there is a statistically significant impact at the significance level of ($\alpha \leq 0.05$) for cash liquidity indicators on the sustainability of profit growth in the ASE-listed industrial companies.” Moreover, the multiple linear regression analysis highlights the significance of net cash flow from all activities to total assets, net cash flow from all activities to total equity, net cash flow from all activities to total profit, and net operating cash flow to total assets in impacting the sustainability of profit growth in the ASE-listed industrial companies. Furthermore, the analysis highlights the importance of specific liquidity indicators, including net cash flow from all activities to total assets, net cash flow from all activities to total equity, net cash flow from all activities to total profit, and net operating cash flow to total assets, in impacting the sustainability of profit growth. This information can be beneficial to companies as they develop and implement financial strategies that focus on managing cash liquidity effectively. By prioritizing the cash flow statement and utilizing the appropriate mixture of debt and equity sources, companies can increase their efficiency in managing cash liquidity and achieve sustainable financial growth, thereby paving the way for profitable investment opportunities.

The findings related to the second hypothesis, which states that “there is no statistically significant impact at the significance level ($\alpha \leq 0.05$) for the cash liquidity indicators on the sustainability of sales growth in the ASE-listed industrial companies,” were tested using multiple linear regression analysis with the stepwise entry method of independent variables. The analysis aimed to determine the effect of cash liquidity indicators on the sustainability of sales growth in ASE-listed industrial companies, as presented in Table 4.

Table 4. Multiple Linear Regression Analysis Test between the Indicators of Cash Liquidity and the Sustainability of Sales Growth in the ASE-listed Industrial Companies.

Dependent Variable	R	R ²	F-Value	Statistical Sig	Independent Variables	(B)	(Beta)	T-Value	P-value
SG	0.316	0.297	171.11	**0.000	Constant	0.454	–	12.261	0.000**
					NCF/TA	0.491	0.836	8.894	0.000**
					NCF/TE	2.085	0.626	46.233	0.089**
					NCF/IN	0.513	0.255	4.273	0.002**
					NOCF/TA	0.697	0.462	7.281	*.000**

* Statistically significant $p < 0.05$, ** Statistically significant $p < 0.01$, *** Statistically significant $p < 0.001$

The findings reveal that the absolute value of the multiple correlation coefficients between the indicators of cash liquidity and the sustainability of sales growth in the ASE-listed industrial companies is (0.316), while the square of the correlation coefficient is ($R^2 = 0.297$). This indicates that liquidity indicators explain (29.7%) of the variation in the sales growth sustainability index. The F-value is (171.109), which is statistically significant at the significance level of ($\alpha \leq 0.05$), confirming the acceptance of the alternative hypothesis, stipulating “there is a statistically significant impact at the

significance level of ($\alpha \leq 0.05$) for cash liquidity indicators on the sustainability of sales growth in the ASE-listed industrial companies. The multiple linear regression analysis also shows that net cash flow from all activities to total assets, net cash flow from all activities to total profit, and net operating cash flow to total assets have a significant impact on the sustainability of sales growth in the ASE-listed industrial companies. However, the impact of the net cash flow index from all activities to total equity is not found to have a significant effect on the sustainability of sales growth. Furthermore, the study found that net cash flow from all activities to total assets, net cash flow from all activities to total profit, and net operating cash flow to total assets have a significant impact on the sustainability of sales growth in the ASE-listed industrial companies. However, the impact of the net cash flow index from all activities to total equity is not statistically significant.

The results of this study are important for companies in the ASE-listed industrial sector, as they provide insights into the importance of managing cash liquidity to sustain sales growth. The study's findings highlight the significance of certain liquidity indicators in achieving this objective. By paying attention to these liquidity indicators, companies can make better-informed decisions regarding their capital structure, liquidity sources, and management methods. Such decisions can lead to an optimal use of the debt-equity combination and reduce the cost of capital, thereby increasing the elements of sustainable financial growth and paving the way for achieving more profitable investment opportunities available.

4 Conclusion

This study explored the relationship between cash liquidity and the sustainability of financial growth in ASE-listed industrial public shareholding companies from 2015 to 2021. The results indicated that all cash liquidity indicators, except for net cash flow from all activities to total equity, had a statistically significant impact on the sustainability of asset, sales, and profit growth. These findings can contribute to the development of accounting and financial theories that affect sustainable financial growth. The surveyed companies can benefit from these results by efficiently managing their cash liquidity, determining the appropriate mixture of debt and equity sources, and using the data contained in their cash flow statements for investment and financing decisions. By doing so, they can reduce the cost of capital, increase sustainable financial growth, and identify more profitable investment opportunities. Overall, the findings emphasize the importance of paying attention to specific liquidity indicators in achieving sustainable sales growth.

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Adopting Smart Systems and Its Impact on Reducing Work Exhaustion: An Exploratory Study of the Opinions of a Sample of Workers in the General Firm for Northern Cement

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Abstract. The research seeks to demonstrate the impact of adopting smart systems in reducing work exhaustion, and in order to achieve this goal, a hypothetical research model has been designed, starting from the factors affecting the process of adoption and ending with adoption and then reducing work exhaustion by depending on the theories that support the adoption of technology, represented by (TAM, UTAUT). Thus, the influencing factors were extracted according to those theories represented by (TAM) theory variables (technological readiness, and attitude towards smart systems), while the variables (government support, administrative support) are representing the external variables that were added to the model, while the variables represented (UTAUT) theory with the variable of social relations, while the variable of intention to adopt smart systems that was a common variable between the theories (TAM, UTAUT). As for the work exhaustion variable which includes dimensions (workload, role conflict, and role ambiguity), it represents a result that is reached. The research relied on the analytical descriptive approach, where the questionnaire was designed based on previous studies as a tool for data collection, and then distributed electronically. The number of respondents was (411) respondents from the total study population of (7812) individuals. The data were analyzed using (SPSS) & (AMOS) programs, and using the structural equations modeling method. The statistical results showed that there is a significant effect of smart systems in reducing work exhaustion, and one of the most important conclusions reached by the study is that there is a clear indication that the reducing work exhaustion is depending mainly on smart systems in the researched firm. The researchers suggested the need to pay attention to the adoption of smart systems through the implementation of more studies, to identify smart systems and demonstrate the importance of these systems and the features and benefits they provide, in order to motivate individuals and firms to adopt smart systems in their firms.

Keywords: Smart Systems · TAM · UTAUT · Work Exhaustion · General Company for Northern Cement

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1 Introduction

When we talk about work exhaustion, we mean by that an issue that has accompanied the individual since his/her existence on this earth, and the work that s/he does is still a source of fatigue and exhaustion with a great deal of social, economic and other challenges. Work exhaustion was and still continues to receive attention in various fields with the aim of knowing the indicators, causes, and how to overcome them, identifying its results and effects, and how to reduce its repercussions on the working individual and the organization in which s/he works [6]. And since technology has become an essential element in our lives and helps us in most of our work and tasks, whether easy or difficult, it is hardly a day that goes by which we do not hear about the emergence of a new innovation from here, and a scientific discovery from there. The reason for this is the rapid progress that our modern era is going through and the developments and changes brought about by the new industrial revolution known as the Fourth Industrial Revolution 4.0 at all levels, which has led to encouraging organizations and governments to adopt smart systems that contribute to improving and developing the performance of organizations by developing the capabilities of working personnel, developing new products, shortening development periods, achieving resource efficiency and preserving the human resource (Lahlah, 9, 2020). This change, in turn, affected the labor market and the organizations, forcing them to adapt to these developments through the introduction of technologies in their organizations. As a result, the organizations around the world have begun to take advantage of the power of technology and keep pace with rapid developments. So the organizations are focusing on being smarter in their efforts to use and adopt smart systems. This happens in order to ensure their survival and continuity and to preserve their human resource in light of the increasing developments in information and communication technology [41]. Hence, the researchers sought to research the adoption of smart systems as one of the topics of great importance that the world is witnessing today, i.e. the research seeks to study the adoption of smart systems according to the model (TAM, UTAUT) and its impact on reducing work fatigue. The idea of research has been applied in the General Company for Northern Cement through a pilot study that included a sample of individuals working in the researched company. The research included the following topics. The first topic included the research methodology. As for the second one, it included the theoretical aspect of the research. On the other hand, the third topic included the practical side whereas the fourth topic is containing the research conclusions and suggestions.

Hence, this study includes the following sections: Introduction of the study is in Sect. 1; while the theoretical background is in Sect. 2; the research model and hypotheses have been demonstrated in Sect. 3. The measurement method has been proposed in Sect. 4, while Sect. 5 presents the data analysis and discussion. Lastly, Sect. 6 presents the study conclusions including implications and limitations.

2 Theoretical Background

2.1 Smart Systems

2.1.1 The Concept of Smart Systems

There are many opinions of researchers about the concept of smart systems, as [43] who defined them as “devices that can sense environmental changes and respond optimally by changing their properties related to materials, engineering, and mechanical frameworks and responding to these changes”. [49] defined them as “systems that have the ability to learn, adapt dynamically, and make decisions based on the data received, transmitted, or processed to improve its response to the future situation”. On the other hand, [37] defined them as “It is a tool that operates in a complex world with limited resources and has basic cognitive functions such as: perception, behavioral control, inference, and language use, and displays complex intelligent behavior supported by abilities such as: rationality, adaptation through learning, or the ability to explain the use of its knowledge through reflection.

Accordingly, the research is concluded by defining smart systems as “systems that operate independently, have the ability to work in a dynamic environment, sense changes and adapt to them, implement tasks and make decisions in a way that leads to the achievement of goals.”

2.1.2 The Importance of Smart Systems

- Smart systems enable business organizations to provide a positive work environment, to improve the efficiency and productivity of individuals, and to increase and enhance the quality and diversity of work [18].
- The use of smart systems helps to reduce operating costs and complete tasks in a timely manner and with greater energy [2].
- Smart systems help organizations to attract loyal customers, and these results help improve organizational reputation by providing good, reliable and effective goods and services [18].

2.1.3 Advantages of Smart Systems

- Smart systems provide many functions compared to their traditional counterparts. Thus, individual productivity is enhanced and, on the one hand, safety is enhanced [30].
- Increasing the level of production through the tasks performed by smart systems on behalf of individuals [31].
- Using intelligent systems to enhance personal safety on the assumption that intelligent systems make fewer mistakes than individuals [39].

2.1.4 Theories and Models that Support the Adoption of Smart Systems

2.1.4.1 Technology Acceptance Model (TAM)

(Davis, 1989) developed this model that specifically studies the possibility of predicting technology acceptance, as the Technology Acceptance Model (TAM) which is considered as one of the models that are valid and reliable for describing and interpreting technology acceptance [38]. The TAM model is also characterized by the ability to add variables that the researcher deems as important in the research. TAM suggests that the acceptance of any technology is determined by two factors: a- perceived benefit: where perceived benefit is defined as the extent to which an individual believes that the use of a technology will improve his/her performance; B _ perceived ease of use: Where the perceived ease of use refers to the extent of effort that the individual believes will be required to use the technology. Perceived ease of use can improve an individual's performance in a beneficial way [38]. Figure 1 shows the TAM model:

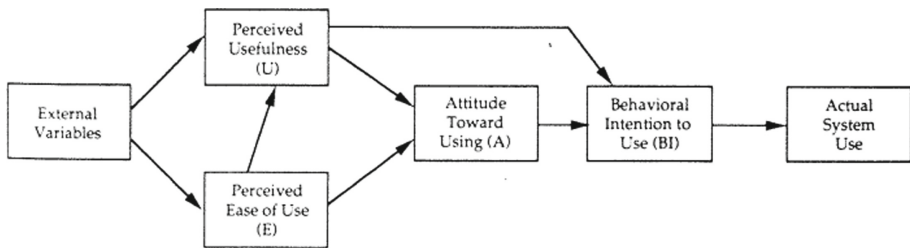


Fig. 1. Technology Acceptance Model (TAM ([38])

2.1.4.2. The Unified Theory of Acceptance and Use of Technology

This theory was developed by [45], as it is one of the most important theories in explaining and understanding the performance of the individual in the use of new technology. The researchers conducted studies on theories related to technology acceptance, then these models and theories were developed and unified into one theory, which is the Unified Theory of Technology Acceptance and Use (UTAUT), which focused on eight models and theories related to technology acceptance, as it helps explain the variables that affect individuals' adoption of technology in the field of work. This theory aims to explain the intentions of individuals and their behavior towards the use of new technology. The factors behind this theory can be explained as follows:

- Performance expectancy: It refers to the degree to which individuals believe that their use of technology will achieve gains in their job performance and the achievement of goals [20].
- Effort expectancy: It refers to the degree to which the individual believes that the use of technology is free of any effort [5].
- Social influences: An individual's behavior is affected by the view of the important individuals for her/him in the use of technology, as the literature indicates that social influence has a direct and indirect effect on the actual use of technology [20].

- Facilitating conditions: The available facilities directly affect the behavior of the actual use of technology by individuals. The more the individual realizes that there is infrastructure and technology, this in turn leads to an effect on the behavior of the actual use of technology [21].
- Behavioral Intentions: The term Behavioral Intent refers to the intention of individuals to make use of a specific tool in the future, which precedes the behavior [45]. Figure 2 illustrates the UTAUT theory:

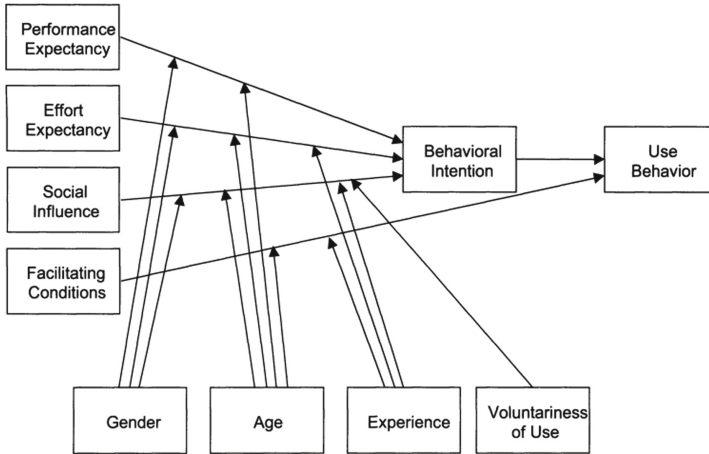


Fig. 2. UTAUT [45]

2.2 Work Exhaustion

2.2.1 The Concept of Work Exhaustion

The concept of work burnout was addressed for the first time by the American psychologist [22] and since then multiple concepts and opinions have emerged about work burnout.

Based on the foregoing, there are many opinions about the concept of work fatigue, so this research presents a set of concepts. [24] defined work burnout as “situations that occur when an individual realizes that s/he may not be able to deal with the situation or pressure s/he is facing”. While it was defined (WHO, 2019) as “a syndrome resulting from chronic stress in the workplace that has not been dealt with successfully, as this condition is characterized by three symptoms: a feeling of energy depletion or exhaustion, increased feelings of negativity or apprehension related to the job, and a decrease in. As for [27], he defined it as “a series of factors that directly affect the psychological and physical health of the individual, which are likely to cause anxiety, frustration, and tension, and then there is an uncomfortable emotional state for him, which leads him to imbalance between his abilities and his needs in life”. As for [13] he defined it as “the loss of a state of balance and compatibility between the employee’s competencies,

abilities, skills, and the needs of the job for which he is responsible, which is reflected in the psychological, physical, intellectual, and functional state per person.”

And based on the concepts and opinions of researchers reviewed about the concept of work exhaustion, the research concluded that work fatigue is defined as a condition that affects the individual as a result of incompatibility with the work environment and exposure to a variety of self and environmental stimuli that exceed his adaptive ability, which leads to a group of the psychological, physiological and behavioral effects that affect his work performance.

2.2.2 The Importance of Studying Work Exhaustion

Organizations, regardless of their work, are currently facing the problem of overwork, and the importance of studying overwork in organizations is as follows: [7, 10].

- Organizations have a social responsibility because they must treat individuals humanely, take care of them, and preserve them as human assets that only individuals can do.
- The realization of modern management that its interest requires taking care of the working individual and his health, because the productivity of the working individual is the outcome of the individual's physical and psychological health.
- Providing organizations with the ability to improve the performance of individual workers by adopting a variety of effective means of follow-up, supervision and guidance to identify their strengths and weaknesses.

2.2.3 Causes of Work Exhaustion

[9] Indicated that the causes that lead to work exhaustion are multiple, and the reasons were classified into functional, personal and social reasons, as follows:

- Functional: The job aspect plays a vital role in work fatigue. There are jobs in which fatigue is very high, and others in which fatigue is not high, and the reason for this is due to: A- Nature of work B- Nature of job role C- Increased responsibility H- Lack of social support.
- Personality: The nature of the individual and his/her ability to adapt to the variables of the work environment is a major cause of work fatigue [11].
- Social: The increasing dependence of community members on social organizations has led to a large number of burdens and tasks, which leads to a decrease in the services provided to an unexpected level, and thus leads to the frustration of the individual whose duties have been increased and he has become vulnerable to work exhaustion.

2.2.4 Sources of Work Exhaustion

Given the importance of the topic, the researchers sought to know the sources of work exhaustion, as there are factors that could be a source of work fatigue. [15] identified three important factors that s/he considered general sources of fatigue and distinguished them accordingly, namely:

- Exhaustion resulting from the environment in which the individual worker works.

- Fatigue resulting from the social environment among individuals within the organization or the environment in which the individual interacts with his colleagues in the fields of work.
- Exhaustion due to the physiological characteristics of the individual, such as: anxiety and management methods.

2.2.5 Dimensions of Work Exhaustion

Work exhaustion differs in some of its indicators from one organization to another, and the reason for this is due to the difference in the nature of work and the duties of the organization. As the result, the researchers were able to identify some indicators of work exhaustion, by reviewing the relevant literature on this subject. They reached the adoption of three variables agreed upon by most researchers, namely (work environment, role ambiguity, and workload), as follows:

- **Workload:** Previous literature indicates that workload is the main cause of work exhaustion. Overburdening of the workload usually occurs as a result of too much work and overloading the individual worker with burdens beyond his capabilities, and overloading the individual with burdens beyond his capacity leads to exhaustion [28].
- **Role ambiguity:** The lack of clarity in the functional elements, the uncertainty in the tasks of the individual, and his lack of understanding of what he must do, in addition to the lack of information necessary to perform his duties in the organization, such as information about his authority and the scope of his responsibility. All these data indicate the ambiguity of the role [23].
- **Role conflict:** The concept of role conflict refers to the extent to which workers perform the tasks required of them without conflicting roles among individuals, such as the boss doing the work of a subordinate that leads to creating a kind of psychological conflict while performing the work [1].

3 Research Model and Hypotheses

The research methodology includes defining the direction of the study, the aspects related to the research problem, its importance and objectives, the study model and the formulation of its hypotheses, as well as the research methodology, as shown below:

3.1 Research Problem

By conducting a field visit to the researched firm, it was found that there is a weakness in the use of smart systems in its operations, which reflects negatively on the working individuals by increasing work fatigue. In addition to the existence of many studies that dealt with the factors influencing the adoption of smart systems in developed countries, however, there is a lack of studies on these factors in developing countries [8]. Studies indicate that there is a knowledge gap in the current literature, indicating a lack of sufficient knowledge of the factors influencing the adoption of smart systems in developing

countries [14]. In a study conducted by [25], it indicates the importance of understanding the factors that affect the adoption process, and then its reflection on reducing work exhaustion and Iraq's need for it, so the research came to fill this gap. Accordingly, a set of research questions can be formulated, which constitute the main problem of the study as a whole, as follows:

- Is there an effect of the factors of adopting smart systems on the attitude towards smart systems?
- Is there an effect of the attitude towards smart systems on the intention to adopt smart systems?
- Is there an effect of the intention to adopt smart systems in reducing work exhaustion through its dimensions?

3.2 The Importance of Research

The importance of the research appears as follows:

- The research provides a justification for the firm in general and the researched firm in particular to adopt smart systems by highlighting the benefits that can be achieved.
- Research gaining great importance in the Iraqi environment due to its urgent need to highlight the role of smart systems to solve bottlenecks in work resulting from the slow pace of development.
- Addressing the importance of the issue of work exhaustion because of its great impact on the survival, continuity, growth and development of firm in the business world.

3.3 Research Objectives

The research seeks to achieve a number of objectives, the most important of which are:

- Building an updated hypothetical model with multiple points of view that depicts the main factors affecting the adoption of smart systems in the researched firm.
- Testing the relationships between the factors affecting the intention to adopt smart systems, to judge the morale and strength of those relationships.
- Standing on the level of the impact of smart systems in reducing work exhaustion for individuals working in the researched firm.

3.4 The Research Model and Its Hypotheses

According to the research problem and its variables, the research model was built based on the theories that support the adoption of smart systems represented by (TAM & UTAUT), which shows the effect relationship between the factors affecting the intention to adopt smart systems and work exhaustion, as shown in Fig. 3:

In this way, the research variables were represented by the following: The variable (government support and administrative support) that was included as external variables for the individual who thinks about adopting smart systems. The study of [3] stated that external variables may affect the attitudes of individuals towards intention to adopt smart systems. As for the variable of social relations in the theory of (UTAUT), where the study of [4] indicates the impact of social relations on the attitudes of individuals towards the

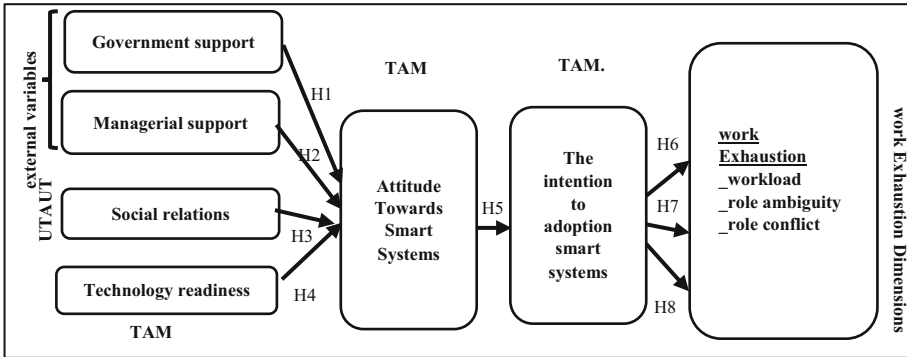


Fig. 3. Research Model

intention to adopt smart systems. As for the variable (technological readiness, and the attitude towards smart systems) that was added according to the TAM model, which is characterized by the possibility of adding variables that researchers consider important, as indicated by the study of (Al-Sabaawi, 349, 2018). Thus, the study of [29] showed that attitude has a strong influence on the intention to adopt intelligent systems, as well as the studies of [35, 42] which indicated the effect of the intention to adopt smart systems in reducing work exhaustion.

3.5 Research Hypotheses

Through the factors that were used in the research model, the research hypotheses will be formulated as follows:

- H1:** Government support has a significant effect on the attitude towards smart systems in the researched firm.
- H2:** Managerial support has a significant effect on the attitude towards smart systems in the researched firm.
- H3:** Social relations have a significant effect on the attitude towards smart systems in the researched firm.
- H4:** Technological readiness has a significant effect on the attitude towards smart systems in the researched firm.
- H5:** The attitude towards smart systems has a significant effect on the intention to adopt smart systems in the researched firm.
- H6:** The intention to adopt smart systems has a significant effect on the workload of the researched firm.
- H7:** The intention to adopt smart systems has a significant effect on the role conflict in the researched firm.
- H8:** The intention to adopt smart systems has a significant impact on the ambiguity of the role in the researched firm.

4 Methods

4.1 Study Approach and Model

This study has adopted a casual approach to identify influences between constructs of the study. Consequently, the literature review and the results of studies in this field have developed the study model as illustrated in Fig. 1 mentioned above.

4.2 Questionnaire Design and Source of Data

This study aims to explore the effects of the factors influencing the adoption of smart systems and their impact on reducing work exhaustion. The survey was conducted from 19/4/2022 to 2/1/2023. 411 questionnaires were received for the analysis. As for the questionnaire, it was designed on the basis of the literature on the subject and according to a five-point Likert scale. Table 1 shows the contents of the questionnaire.

Table 1. Measurement items

Variables	Symbols	References
Government support	SU1_SU4	[36]
Managerial support	MS34_MS36	[36]
Social relations	SN18_SN21	[33]
Technological readiness	TR26_TR29	[17]
Attitude towards Smart Systems	ATSS58_ATSS61	[34]
The intention to adopt smart systems	ASS62_ASS66	[50]
Role conflict	RC72_RC78	[7, 13]
Role ambiguity	AR79_AR82	[7, 13]
Workload	WL83_WL87	

4.3 Pilot Test

In order to ensure the validity of the questionnaire and the metrics, the researchers conducted a pilot study on 35 randomly selected respondents, who were removed from the final survey. The suggestions resulting from the survey were taken into consideration in the final questionnaire of the study.

4.4 Statistical Methods

In order to perform the statistical analysis, structural equation modeling was used to test the causal relationship between the measurement variables in the research model. The main reason for using structural equation modeling is because it takes into consideration several equations simultaneously [44]. The software Amos was used for the analysis.

5 Data Analysis and Discussion

5.1 Testing the Quality of the Measurement Tool Data

To test the quality of the tool data, the researchers used statistical tests of validity and reliability.

- **Validity Test:** for the purpose of verifying the effectiveness of the questionnaire in measuring the research variables, it was subjected to an apparent validity test, by presenting it to academic experts, in order to seek their opinions on the questionnaire's ability to measure the variables to ensure the accuracy of the results.
- **Reliability test:** it means that the questionnaire gives the same results if it is redistributed more than once, under the same terms and conditions. One of the most widely used methods for estimating reliability is Cronbach's alpha which has a minimum acceptance level value for Cronbach's coefficient of 0.70. The results of the reliability test using Cronbach's Alpha are shown in Table 2:

Table 2. Cronbach Alpha Test Results

Variables	Symbols	Cronbach alpha
Government support	SU1_SU4	0.945
Managerial support	MS34_MS36	0.945
Social relations	SN18_SN21	0.944
Technological readiness	TR26_TR29	0.945
Attitude towards Smart Systems	ATSS58_ATSS61	0.944
The intention to adopt smart systems	ASS62_ASS66	0.944
Role conflict	RC72_RC78	0.945
Role ambiguity	AR79_AR82	0.945
Workload	WL83_WL87	0.945

It is clear from Table 3 that the variables achieved the acceptable reliability ratio, as all Cronbach alpha values were greater than (0.70), and this indicates the reliability and stability of the measurement of the underlying factors of the research model.

5.2 Results of Hypothesis Testing and Discussion

For the purpose of testing and ensuring the validity of the research hypotheses, the structural equation model was used, as in Fig. 4. In addition, the values of the tests in this model that indicate acceptance or rejection of the hypothesis were clarified through Table 3 and as shown below:

It is clear from the above Table that:

- H1:** Government support has a significant effect on the attitude towards smart systems in the researched firm.

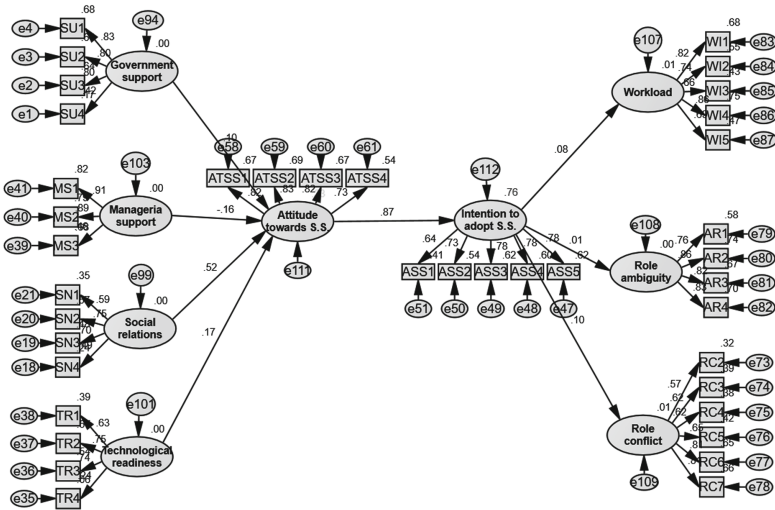


Fig. 4. Results of SEM Tests of Study Model

The data of Table 3 indicate that there is a direct and significant effect of government support on the attitude towards smart systems, through the value of the non-standard regression coefficient (Estimate) of (0.296), and this effect is significant in terms of the P-value of (0.015). It is less than (0.05), and the same result confirms the confidence limits (95% Confidence Interval) for the value of the non-standard regression coefficient in its lower and upper limits (0.079–0.657). From observing this period, we find that it does not include the value (zero) between its limits, and this evidence of a significant effect of the independent variable on the dependent variable, and thus the hypothesis is accepted, and this was confirmed by a study conducted by [38, 48] which showed that government support strongly affects the attitude of adoption of smart systems as well as the positive relationship between them. As a result, government support is necessary to encourage individuals to adopt smart systems by strengthening the attitude towards these systems, and individuals may delay their acceptance of smart systems until the government provides sufficient support, motivation and funds for that.

H2: Managerial support has a significant effect on the attitude towards smart systems in the researched firm.

The data of Table 3 indicate that there is no significant effect of managerial support on the attitude towards smart systems, through the value of the non-standard regression coefficient ((Estimate) of (0.030), and this effect is not significant in terms of the P-value of (0.330), which is greater than (0.05), and the same result confirms the confidence limits (95% Confidence Interval) for the value of the non-standard regression coefficient in its lower and upper limits (0.045-0.108), and it is noted that this period includes the value (zero) between its limits This is evidence of the insignificance of the effect of the independent variable on the dependent variable, and thus the hypothesis is rejected. This is confirmed by previous studies, including the study of [12] which indicated that little or no support from the administration discourages individuals from their use of intelligent

Table 3. Overall Summary of the Hypotheses

Independent variable		Dependent variable	Estimate	95% Confidence Interval		P-value	Results
Government support	→	Attitude towards Smart Systems	0.296	0.079	Lower	0.015	Acceptance
				0.657	Upper		
Managerial support	→	Attitude towards Smart Systems	0.030	0.045-	Lower	0.330	Reject
				0.108	Upper		
Social relations	→	Attitude towards Smart Systems	0.772	0.486	Lower	0.009	Acceptance
				1.289	Upper		
Technological readiness	→	Attitude towards Smart Systems	0.629	0.285	Lower	0.010	Acceptance
				1.061	Upper		
Attitude towards Smart Systems	→	The intention to adopt smart systems	0.863	0.736	Lower	0.006	Acceptance
				1.035	Upper		
The intention to adopt smart systems	→	Workload	0.924	0.887	Lower	0.018	Acceptance
				0.957	Upper		
The intention to adopt smart systems	→	Role conflict	0.915	0.862	Lower	0.023	Acceptance
				0.955	Upper		
The intention to adopt smart systems	→	Role ambiguity	0.845	0.780	Lower	0.026	Acceptance
				0.881	Upper		

systems, which in turn influences the attitude of individuals towards the intention to adopt intelligent systems. As a result, administrative support is essential for the successful implementation of technological innovation as managerial support is part of the enablers that enable individuals to successfully use and implement systems in their workplace [46].

H3: Social relations have a significant effect on the attitude towards smart systems in the researched firm.

The data of Table 3 indicate that there is a direct and significant effect of social relations on the attitude towards smart systems, through the value of the non-standard regression coefficient (Estimate) of (0.772), and this effect is significant in terms of the P-value of (0.009). It is less than (0.05), and the same result confirms the confidence limits (95% Confidence Interval) for the value of the non-standard regression coefficient in its lower and upper limits (0.486_1.289). From observing this period, it is clear that it does not include the value (zero) between its limits, and this Evidence of the significance of the effect of the independent variable on the dependent variable, and thus

the hypothesis is accepted, and this is confirmed by previous studies, including the study [16], which indicated that social relations in various fields contribute to strengthening the individual's attitude towards systems. Smart systems and thus help individuals to adopt smart systems, a study [40, 42] indicated that social relations can enhance the speed of adopting smart systems, as individuals work to disseminate information about smart systems, which Positively affects the attitude to systems smart.

H4: Technological readiness has a significant effect on the attitude towards smart systems in the researched firm.

The data of Table 3 indicate that there is a direct and significant effect of technological readiness on the attitude towards smart systems, through the value of the standard regression coefficient (SRW) amounting to (0.216), as well as the value of the non-standard regression coefficient (Estimate) amounting to (0.629), and this effect is significant in terms of the probability value (P-value) of (0.010), which is less than (0.05), and the same result confirms the confidence limits (95% Confidence Interval) for the value of the non-standard regression coefficient, which is in its lower and upper limits (0.285_1.061). It turns out that the period does not include the value (zero) between its limits, and this is an evidence of the significance of the effect of the independent variable on the dependent variable, and thus the hypothesis is accepted. This is confirmed by previous studies, including a study conducted by [32]. It showed the impact of technological readiness on the attitude of individuals towards smart systems, and that technological readiness develops a positive attitude and indicates the importance of adopting such systems among individuals. On the other hand, the study of [35] indicated the role of technological readiness and how this affected the positive attitude towards the adoption of systems by individuals. So they will see smart systems as something that will benefit them.

H5: The attitude towards smart systems has a significant effect on the intention to adopt smart systems in the researched firm.

The data of Table 3 indicate that there is a direct and significant effect of the attitude towards smart systems on the intention to adopt smart systems, through the value of the non-standard regression coefficient (Estimate) of (0.863), and this effect is significant in terms of the probability value (P-value) of (0.006), which is less than (0.05), and the same result confirms the confidence limits (95% Confidence Interval) for the value of the non-standard regression coefficient at its lower and upper limits (0.736_1.035). From observing this period, it is clear that it does not include the value (zero) between this is evidence of the significance of the influence of the independent variable on the dependent variable, and thus the hypothesis is accepted, and this is confirmed by previous studies, including the study [26], which showed the effect of the intention to adopt smart systems on the individual's attitude towards those systems. The positive attitude towards smart systems is one of the reasons that encourage individuals to adopt smart systems. On the other hand, [47] indicated that the attitude towards smart systems is a precondition for the adoption of those systems.

H6: The intention to adopt smart systems has a significant effect on the workload of the researched firm.

The data of Table 3 indicate that there is a direct and significant effect of the intention to adopt smart systems on the workload, through the value of the non-standard regression coefficient (Estimate) of (0.924), and this effect is significant in terms of the P-value of (0.018). It is less than (0.05), and the same result confirms the confidence limits (95% Confidence Interval) for the value of the non-standard regression coefficient in its lower and upper limits (0.887_0.941), and from observing this period it is clear that it does not include the value (zero) between its limits. This is an evidence of the significance of the effect of the independent variable on the dependent variable, and thus the hypothesis is accepted, and this was confirmed by previous studies, including the study of [39] when it indicated that the use of smart systems leads to an increase in the feeling of comfort and thus leads to Reducing the workload on the individual worker and he can focus on carrying out other tasks, and this indicates the role that smart systems play in alleviating work exhaustion on individual workers.

H7: The intention to adopt smart systems has a significant effect on the role conflict in the researched firm.

The data of Table 3 indicate that there is a direct and significant effect of the intention to adopt smart systems in the role conflict, through the value of the non-standard regression coefficient ((Estimate) of (0.915), and this effect is significant in terms of the P-value of (0.023). It is less than (0.05), and the same result confirms the limits of confidence (95% Confidence Interval) for the value of the non-standard regression coefficient in its lower and upper limits (0.862_0.955), and from observing this period it is clear that it does not include the value (zero) between its limit. This is an evidence of the significance of the influence of the independent variable on the dependent variable, and thus the hypothesis is accepted. This is confirmed by the previous studies, including the study (Ko, 2021,1) when it indicated that the use of smart systems allows individuals to perform their duties at anytime and anywhere without conflict. In the role by organizing work and duties and defining tasks and responsibilities among individuals, and thus they are more flexible and efficient in doing the work.

H8: The intention to adopt smart systems has a significant impact on the ambiguity of the role in the researched firm.

The data of Table 3 indicate that there is a direct and significant effect of the intention to adopt smart systems in the ambiguity of the role, through the value of the non-standard regression coefficient (Estimate) of (0.845), and this effect is significant in terms of the P-value of (0.026.) which is less than (0.05), and the same result also confirms the confidence limits (95% Confidence Interval) for the value of the non-standard regression coefficient in its lower and upper limits (0.780_0.881), and from observing this period it is clear that it does not include the value (zero) between its limits. This is evidence of the significance of the effect of the independent variable on the dependent variable, and thus the hypothesis is accepted. This is confirmed by previous studies, including the study [19], which indicated that the adoption of smart systems helps individuals to carry out tasks and duties efficiently and provides New and varied ways to complete tasks, demonstrating the positive impact of intelligent systems intent on role ambiguity.

6 Conclusion and Suggestions

6.1 Conclusions

- There is a positive effect of influencing factors (government support, social relations, technological readiness, the position of smart systems) in the intention to adopt smart systems according to the theories of TAM & UTAUT in the authorized organization.
- The results indicate that the lack of administrative support praises individuals working on the adoption of smart systems.
- The results showed that the intention to adopt smart systems is high among individuals working in the authorized organization.
- The results also showed that the dimensions of work exhaustion are positively affected by the adoption of smart systems in the authorized organization.

6.2 Suggestions

In light of the conclusions, the researchers suggest the following:

- Working to spread awareness of the importance of adopting and using smart systems in the field of work, and continuing to explain their importance, in order to increase the position of individuals towards the intention to adopt smart systems in the authorized organization.
- Adopting a mechanism to motivate individuals working on the use of smart systems, as it corresponds to their knowledge and experience and is compatible with the nature of their work.
- Working to address everything that contributes to exhausting work and increasing the enthusiasm of individuals by creating a comfortable work environment and providing them with organizational support.

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The Potential Role of Blockchain Technology in Addressing Development Challenges in Developing Countries

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Abstract. Lack of transparency and accountability pose long-term challenges to the economic development of developing countries. This study argues that blockchain technology is a revolutionary innovation with the potential to address development challenges. However, it leaves behind a trail of challenges. Blockchain technology can help overcome various challenges by providing a secure digital infrastructure, facilitating faster and more cost-effective international payments, verifying identities, and securing property and property rights. The decentralized nature of blockchain technology creates new regulations by enhancing information security and transparency through the sharing of encrypted data between peer-to-peer (P2P) networks. To maximize the multifaceted contributions of blockchain technology in addressing development challenges, developing countries must act quickly to establish the necessary environment. This includes developing an organizational framework and appropriate digital infrastructure to support the economic potential and risks of blockchain technology and the digital economy. Further investigation into privacy-preserving mechanisms for blockchain is strongly recommended.

Keywords: Blockchain · Cryptocurrency · Bitcoin · Big Data · Technology · Development · Developing Countries

JEL Classification: G32 · E51 · F30

1 Introduction

Recent technological developments are radically changing work environments by increasing automation through digitalization. It is widely accepted in economics that technology is the primary catalyst for economic growth and development. Technology advancements enable the more efficient production of higher quality goods and services, which serve as the foundation for prosperity. Blockchain technology has gained attention in non-financial sectors such as healthcare, retail, manufacturing, and government services. The use of digital technologies can assist individuals living in poverty to lead better, healthier lives. Due to technology's ability to eliminate the need for intermediaries

in transactions, innovation can also help reduce poverty at a low cost. The economies of developing countries are becoming more marginalized in the global economy, where economic development models that are plagued with political, financial, and institutional challenges dominate.

Satoshi Nakamoto [1] introduced a Crypto mailing list for Bitcoin, a peer-to-peer (P2P) electronic cash system “based on cryptography rather than trust, making it more secure and decentralized,” in October 2008, just a few weeks after the emergency economic stability act saved the US financial system from collapse. It eliminates the requirement for a reliable third party by allowing any two willing parties to transact directly with one another. As a result, for the first time in history, value can be reliably transferred between two dispersed and unreliable parties without the use of a middleman. By cleverly combining game theory and cryptography. To verify and settle cryptocurrency transactions at a low cost, any participant can use the “blockchain” - a distributed public transaction ledger - in the network.

Blockchain is a unique type of database with a key distinction from existing technologies: the decentralization of data storage, where the storage is distributed in many locations throughout the network known as (Nodes), as opposed to the current systems which store their data on specialized central devices known as (Servers). Blockchain’s working mechanism involves storing data in a sequential archive that is encrypted to prevent tampering with the original input. The data is also shared and accessible by anyone with the access code, and the transactions are gathered and updated roughly every ten minutes, making it something new every time it is renewed [2]. Without the need for centralized authority, all network users validate new transactions when they are added, and most users then decide whether or not the transaction is valid [3].

Bitcoin was the first large-scale platform to rely on a decentralized “consensus” on the internet for its operations, as opposed to a central clearinghouse or market maker. By combining a shared ledger with an incentive system designed to keep it secure, the platform was able to settle the transfer of ownership rights in the underlying digital token (Bitcoin). Cryptographic and distributed ledger record-keeping technologies have enabled secure (P2P) interactions and the creation of so-called crypto assets. Initially, these assets were created as private digital money (such as Bitcoin). They have recently been used to raise funds, for example, through initial coin offerings (ICOs).

When blockchain first caught the attention of the business community in late 2015, it offered a new way to create, share, and track ownership of financial assets on a (P2P) basis during transactions. These benefits of that technology have encouraged owners of capital and players operating in the financial services industry to invest in this new technology field [4]. In addition to the use of blockchain technology for applications other than finance, such as machine-to-machine exchanges on the Internet of Things (IoT), supply chains, digital identity management, and healthcare record management, blockchains have also impacted a wide range of economic and governmental activities. This was particularly true when the so-called “smart contracts” emerged, specifically in the sectors of health, banking, smart governments, and taxes. Big data has a significant impact on raising the quality of financial reporting because it enhances accounting reporting and professional judgment. Analytics based on big data have a positive effect on environmental performance. Additionally, the nexus between big data analytics and

environmental process integration in accounting reports is positively moderated by a digital learning orientation. Businesses may possibly benefit from a number of things when analytical big data methods are used effectively, including customized products, streamlined processes, improved risk assessment, and increased risk management [5, 6].

The significance of this study lies in its handling of one of the modern topics that the financial community is currently preoccupied with. This topic will lead to a massive technological revolution, arousing the interest of researchers to study and deal with it. Additionally, it has a practical importance in its multiple applications in many business sectors, which serves as an incentive to exploit its multiple advantages in advancing various sectors in development.

Hence, the objective of this study is to better understand the technological and socio-economic concerns and barriers to blockchain solutions in developing countries, as well as to assess the potential role of blockchain technology in addressing economic development challenges in those countries. The study attempts to examine potential blockchain solutions to developing country development patterns and challenges, including social and economic considerations. On a technical level, the study discusses the barriers to the growth of this technology, as well as its potential for rejection attacks. The study, on the other hand, seeks to answer fundamental questions about blockchain technology and explain its design by clarifying what the blockchain revolution is, how realistic it is, and whether we should work to redesign our institutions to accommodate it. The study's methods included a review of scientific publications and research papers on blockchain and its technological and socioeconomic implications in developing countries.

This study seeks to address the following question: How can blockchain technology assist developing countries to address development challenges? Another question is, "What challenges do developing countries face when implementing blockchain technology?" So far, however, there has been little discussion about the numerous advantages of blockchain's multifaceted role in improving social welfare in developing nations. This study, therefore, sets out to assess the effect of blockchain technology in addressing development challenges in developing countries.

2 Overview of Blockchain Technology

Recently, investigators have examined the effects and advantages of blockchain adoption, impacting factors, and blockchain in the supply chain or the financial sector [7–11]. Surveys, such as the one conducted by Saif et al. [11] showed that blockchain is causing concern among researchers in a variety of fields from 2016 to 2021. The most influential subject areas were engineering, computer science, and business management, from which more than 44 pieces of research were published. There are very few publications in some other academic disciplines, including decision science, economics, medicine, and mathematics.

The advancement of technology has never been faster. A growing number of development experts are focusing on exploring modern technologies to adopt digital technologies for use in poverty reduction and improving the lives of the poor. The evolution of mobile financial services demonstrates how rapidly a new system can improve economic outcomes for the world's poorest people. The first project using mobile phones as a platform

for financial services was launched in the Philippines in 2001, but it wasn't until the success of M-Pesa in Kenya, introduced by the development community six years later, that the technology's potential for poverty alleviation was fully realized. Since then, the number of experts, donors, and policymakers working on digitally-enabled financial inclusion, as well as the number of initiatives, has grown rapidly. By 2017, mobile money services were available in 92 countries with over 174 million active accounts, and there is mounting evidence that these services can help alleviate poverty [12].

We no longer require an intermediary to complete transactions due to technology. In the conventional financial system, for instance, at least one "trusted moderator" is required for any type of cashless transaction. Verification and record-keeping are carried out by all system participants in a decentralized, open, and transparent manner using distributed ledger technology (DLT). At the same time, technology offers a dependable remedy for the double-spending issue, i.e., money handled digitally is not spent twice [13]. The foundation of the new technology is decentralized record-keeping, enabling decentralized trust. Information is kept in a distributed ledger rather than a central ledger that is kept by a reputable institution. In other words, the same information is kept concurrently on a large number of computers. As a result, trust can become decentralized. Figure 1 shows the typical transaction flow in a blockchain network.

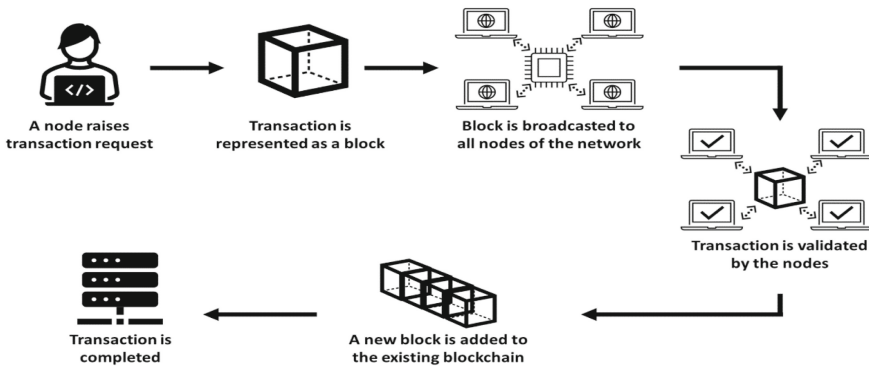


Fig. 1. Transaction flow in a blockchain network. Source: <https://doi.org/10.3390/logistics6010015>

2.1 Blockchain Technology: Conceptual Framework

Because of the variety of its technological, operational, legal, and regulatory dimensions, definitions of blockchain technology have varied. According to David Rose, blockchains are “decentralized protocols for recording transactions in which each participant owns their copy of the ledger, and there is no central authority responsible for maintaining the ledger”. Guadamuz and Chris [14] state that blockchain technology is an open, decentralized ledger that can be used to execute any type of financial or non-financial transaction based on the Bitcoin currency.

The different definitions of the blockchain demonstrate the distinction between electronic money and the traditional form of money. For example, traditional money can be kept as a stock with the same unit of account, whereas in virtual money, the unit of account is converted into a virtual currency. Electronic money also differs from the traditional form of money in terms of its legal status. For example, virtual money is subject to legal regulation and is issued by non-financial private companies, as trading in the stock market. The user can convert it to traditional currencies or use it to make purchases online, just like any other currency [15].

It has many drawbacks, just like any other technology. Among the benefits is a higher level of safety due to risk distribution. It is extremely difficult to lose, hack, or alter this data. In addition to the advantages of transparency. Among the drawbacks, in some instances, there is a loss of control due to security risks, particularly for governments. Because it is difficult to delete data for any reason,

2.2 Blockchain Technology and Its Cutting-Edge Applications

Blockchain is now being used in a variety of research and business fields, providing limitless opportunities for exploration. Through several methods, including the following, the blockchain is suitable for applications in the military, medical, educational, media, finance, transportation, and many other sectors. Figure 2 shows the technology of blockchain and some of its cutting-edge applications.

Blockchain applications are divided into financial and non-financial ones [16], as cryptocurrencies make up a considerable portion of the current blockchain networks. Blockchain technology is currently used in a wide range of financial fields, including business services, financial asset settlement, prediction markets, and economic transactions [17]. Blockchain is expected to play a critical role in the long-term development of the global economy, benefiting consumers, the current banking system, and society in general [18].

The blockchain can be used for a variety of financial and non-financial applications via a variety of methods, including smart contracts, digital registries, and cryptocurrencies. Smart contracts refer to the automation of the contracting process. They allow for the automatic implementation, performance, and monitoring of contractual promises, which contributes to lower trade management costs, fewer human mistakes, faster contract completion, and secure contract documentation. These contracts are created on a variety of platforms, including the open-source Ethereum platform. One of the drawbacks of these smart contracts is the difficulty in changing them when needed, resulting in losses, an inability to accommodate anomalies, and the difficulty of immediate modification.

Regarding contracts and documentation (Digital Registry), blockchain technology is currently used in a variety of fields, including transfer of ownership, voting, IoT, supply chain management, and intellectual property. Cryptocurrencies are digital assets that use encryption to secure their transactions, control the creation of additional units, and verify the non-copy transfer of assets and values, and are based on blockchain technology [19].



Fig. 2. Mind-map abstraction of numerous types of blockchain applications. Source: <https://doi.org/10.1016/j.tele.2018.11.006>

Blockchain benefits developing countries and lower-income countries with less developed and sophisticated economies by addressing operational inefficiencies, establishing legal property rights, reducing corruption, and detecting fraud using big data analysis. Big data benefits include the detection of suspicious activities in accounts or transactions, as well as internal and external processes. Furthermore, using big data analytics during brainstorming sessions significantly improves the efficiency and effectiveness of fraud risk evaluations [20, 21].

Sustainable development goals can be achieved by developing nations that are on a successful path of development with the help of disruptive technology like blockchain [22]. After considering the benefits and drawbacks of blockchain technology, many developing countries must begin taking steps to implement blockchain technology in their organizations.

3 Blockchain Technology: Potentials and Risks

The blockchain is significantly different from conventional databases in numerous key features, including decentralization, transparency, consensus mechanism, traceability, autonomy, immutability, and high trust [23]. The following is a description of the potential and risks of blockchain technology.

3.1 Blockchain Technology: Potentials

The primary distinction between blockchain and traditional databases is decentralization. Blockchain does not rely on a central authority for data storage, auditing, processing, or transfer. A higher level of safety, as a result of the distribution of risks, is one of the benefits. Where it would be extremely difficult to lose or modify the data. Transparency is one of its key characteristics, although sometimes it can be viewed negatively if it is something we do not want. The loss of control, particularly with governments, and security risks are other drawbacks. While every technological advancement carries some risk, the difficulty of erasing data is seen as a drawback. The immutability of blockchain is due to its decentralization. This technology protects rights if one does not want to change what was registered. This is advantageous in voting procedures, registration, and ownership transfers, for instance. The inability to delete or change information in the event of a desire to do so, such as a transmission or documentation error, is one of the drawbacks.

A further considerable distinction between blockchain and traditional databases is transparency. Among the benefits is the ability for everyone to view information that is meant to be transparent, such as voting. Among the drawbacks is the inability to keep information private if it is intended to be kept private. In private networks, this feature might be necessary, but it can occasionally present an ethical dilemma in public networks.

The efficiency of blockchain technology is demonstrated by the speed with which data can be transferred when compared to existing systems, as well as by the cost savings that come from automating processes, and the security that comes from the fact that a hacking process has not yet been established, despite numerous instances of hacking on banks and their operational systems. One more feature of blockchain technology is autonomy. Autonomy implies that each (Node) in the network is distinct from, unaffected by, and equal. Parity and justice are two benefits of this, while the challenge of reining in a centralized authority, if necessary, is one drawback.

3.2 Blockchain Technology: Risks

Blockchain technology is being implemented in a variety of sectors. However, as with any innovative technology, problems and challenges arise. What follows are socio-economic limitations and barriers to blockchain solutions in developing countries.

Issues with security and privacy present significant obstacles for blockchain. Both adoption and execution. Ateniese and colleagues [24] claim that the absence of certification can be accountable for the growing privacy concerns. Hacking and system attacks in the cryptocurrency system raise concerns about blockchain security [25]. Most developing countries suffer from a lack of standardization, as well as a lack of data integrity and trust, conflict resolution, tax evasion, limitation of knowledge, and integration issues with different regulations and laws [26–29]. Numerous countries are sluggish in developing effective regulations, new rules, and laws for blockchain implementation [8, 26]. The use of certified Bitcoin can help accelerate blockchain adoption in e-commerce [24].

Poor access to IT infrastructure in developing countries impedes effective and stable blockchain implementation [30]. Several governance issues have been identified by researchers as impediments to blockchain adoption and implementation. Governance mechanisms govern responsibility delegation, communication, and decision-making processes within an organization [31]. The key governance challenges that directly affect blockchain adoption and implementation are management scalability, insufficient government regulations, insufficient trust among stakeholders, and a lack of an active regulatory board. According to findings [32], social influence has a less significant impact on blockchain intention than performance and effort expectations. Furthermore, the expectation of effort and performance, as well as the intention to use blockchain, are directly and favorably impacted by trust.

There have been several high-profile cases of blockchain-based cryptocurrencies being used for money laundering, human trafficking, and criminal financing. As a result, before implementing blockchain-enabled solutions, one should assess the suitability of blockchain technology to the use case requirements [33].

4 Results

The results of this study indicate that blockchain-based solutions can still be beneficial to a significant number of people in developing countries. Blockchain technology has the potential to make a significant contribution towards achieving sustainable development goals and promoting economic growth in developing nations. In this era of cutting-edge technology, blockchain can be a game-changer for these countries. Developing countries can benefit from blockchain technology not only to facilitate payments, but also to ensure their security and authorization. This may explain the observed result. These findings have significant implications for development. An implication of this is that blockchain technology has the potential to reduce fraud and corruption in developing countries. By utilizing data already available on transactions, it is possible to reduce execution costs and measure the effectiveness and efficiency of spending.

One unanticipated finding was that the primary obstacles to adopting and implementing blockchain technology are technological in nature. The technical capability, difficulty, complexity, and emergence of innovations for adoption are all influenced by the technological context. This is evident. The most apparent finding from the analysis is that most developing countries are slow in establishing effective regulatory frameworks for implementing blockchain technology. Due to various factors, the adoption of blockchain technology remains significantly low in developing countries. Several obstacles hinder the adoption and implementation of blockchain technology.

This collection of findings provides some support for the conceptual premise that waves of rejection and prohibition for religious reasons resulted from the difficulty in understanding the operation of certain technologies. Additionally, the inability to face the risks associated with these technologies, due to limited capabilities and the challenge of keeping up with technological development, has proven ineffective. Over the past few decades, the harm caused by these waves of rejection and prohibition has outweighed their benefits.

5 Implications and Future Research

The findings of this study have significant implications for future practice. This study supports the notion that successful implementation of blockchain technology in developing countries can be improved through efficient coordination, collaboration, and communication among top management, professionals, entrepreneurs, IT experts, regulators, and policymakers. This finding has important implications for understanding how a lack of comprehension can lead to distrust among relevant parties, including IT experts, technicians, business owners, managers, security experts, policymakers, and workers.

A key policy priority should therefore be to plan for the long-term maintenance of digital infrastructure. To successfully implement blockchain systems on a larger scale for developing economies, a set of regulatory guidelines must be established and enforced. Taken together, these results suggest that prioritizing the establishment of appropriate systems, services, and support for blockchain technology should be a government priority. There is a definite need to ensure appropriate orientation and training to develop workforces with the necessary skills for blockchain technology.

Further research is necessary to accurately assess the potential risks associated with blockchain technology. An appropriate regulatory framework must be established to address the economic potential and risks associated with blockchain technology and crypto assets. Blockchain technology needs to be adopted cautiously. It is necessary to approach emerging technologies with prudence, rather than expecting them to act as fully functional solutions instantly. Prior to adoption, a more comprehensive discussion about blockchain technology is necessary.

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Intellectual Capital and Sustainable Competitive Advantage: The Mediating Role of Marketing Knowledge Management

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Abstract. The objective of this research is to investigate how intellectual capital affects sustainable competitive advantage in the Jordanian telecommunication industry, with a focus on the mediating effect of marketing knowledge management. An online questionnaire was randomly distributed to 300 participants from various managerial levels. The proposed conceptual model and associated hypothesis were tested using SEM-PLS. The findings indicated that only Human Capital exerted a direct significant impact on sustainable competitive advantage. Marketing knowledge management fully mediated the relationship between relational capital, structural capital, and sustainable competitive advantage. The research highlights the importance of how the telecommunication sector management uses intellectual capital and marketing knowledge management in determining the sustainable competitive advantage of their business. Furthermore, it fills the gap and aids telecommunication sector management in focusing on the critical role of marketing knowledge management in achieving sustainable competitive advantage.

Keywords: Intellectual Capital · Sustainable Competitive Advantage · Marketing knowledge Management · Human Capital · Relational Capital · Structural Capital

1 Introduction

Organizations can attain a sustainable competitive advantage (SCA) by leveraging intellectual capital (IC) and marketing knowledge management (MKM) [1–3]. Intellectual capital can be used to develop innovative products and services, create new markets, and improve customer service. It also provides a competitive edge by allowing an organization to better understand customer needs, develop better strategies, and create more efficient and sustainable processes [4, 5]. Given the present economic circumstances, researchers and stakeholders consider intellectual capital as one of the most crucial areas of interest due to its vital core to improving organizational performance [6, 7].

IC included three main types of capital: human capital (HC), relational capital (RC), and structural capital (SC) [8]. In addition, [9] confirmed that by leveraging intellectual capital, organizations can gain a competitive advantage that is difficult for competitors to replicate. This can lead to increased market share, higher profits, and improved customer loyalty. Ultimately, IC can be a powerful tool for achieving SCA.

Conversely, scholars in management and marketing emphasize the significance of utilizing marketing knowledge as a critical resource to improve organizational performance and gain a competitive edge [10]. Marketing knowledge encompasses tactics such as strategies against competitors, forming alliances, and managing customer relationships. MKM includes built-in marketing assets (BMA), invested-in marketing assets (IMA), external marketing capabilities (EMC), and internal marketing capabilities (IMC) [11]. Thus, this knowledge affects the sustainable competitive advantage of organizations and needs to be managed efficiently and effectively.

In today's rapidly evolving market, having effective marketing knowledge management is crucial for businesses to maintain their competitiveness. With knowledge management, organizations can capture, store, and share valuable information that can be used to drive innovation and increase efficiency [12]. This leads to making better decisions, improving customer service, and increasing profitability. Knowledge management can also help you build a culture of learning and collaboration, which can lead to greater employee satisfaction and retention [13]. Therefore, investing in knowledge management can achieve a sustainable advantage that will benefit organizations for years to come.

During the Industrial Revolution period, companies aimed to gain a competitive advantage by improving their production efficiency, increasing output, and reducing costs through the adoption of new technologies and manufacturing processes. However, SCA can be reached when the organizational resources are valuable, rare, and difficult to imitate [14]. Kising'u et al. [15] added that sustainable competitive advantage can be achieved by attaining superior product quality, acquiring the right resources, and responding promptly to the changing business environment.

According to the above, it is apparent that both intellectual capital and marketing knowledge management is essentially valuable for business organizations. According to the Telecommunication Regulatory Commission (TRC) reports in 2019, the telecommunication sector is one of the keystones of the economy, as it offers several job opportunities and contributes greatly to the gross domestic product (GDP). The primary business and competencies of the telecommunication sector depend on managing knowledge and improving human, structural, and relational capital, in addition to building marketing assets and capabilities [4]. As a result, this study is anticipated to aid telecommunication firms in formulating new strategies and giving significant emphasis to IC and MKM to improve their SCA.

Although there is a growing body of literature that investigates the correlation between IC, MKM, and competitive advantage [16], there is still a lack of research that addresses the impact of both IC and MKM on SCA. The mediating role of MKM is very scarce in the literature. Obaidat [17] considered Arab IC is still in its nascent stages, and additional research in this domain is recommended. Furthermore, Al-Dmour et al. [16] recommended examining the impact of MKM on an organization's performance

in the service industry specifically in Jordan. Also, added that there was an insufficient number of studies in this field.

The absence of a comprehensive theoretical framework in the Arab region, and especially in Jordan is one of the reasons behind conducting this research. The research aims to clarify and examine how both IC and MKM can achieve SCA.

2 Literature Review

2.1 Intellectual Capital

IC is the intangible worth of a company that originates from its workers, procedures, and innovations. It is the combination of knowledge, skills, experience, and creativity that a company has developed over time [18–21]. IC plays a critical role in the achievement of success in any business, as it provides a sustainable competitive advantage and helps to drive innovation [22]. It is also a source of long-term value, as it can be leveraged to develop novel products and services and to increase efficiency and productivity [23].

The intangibility of the IC makes it challenging to measure and quantify, yet it is essential to an organization's success and sustainability. Most definitions in the field of IC have indicated that intangible assets as the basic elements of IC [24, 25]. Intangibles were defined as non-monetary sources that can generate profits in the future. Also, it lacked the financial substance that could be sold independently from other assets owned by a corporation [26]. This intangibility aspect requires deep and rigorous conceptualization in theory and practice [27, 28]. IC is the source of SCA, as it is the foundation of an organization's capacity to innovate and adapt to changing markets [29].

Thomas Stewart [30] introduced the IC based on three elements: HC, SC, and customer capital (CC). While Bontis [27] stated that IC encompasses four dimensions a) HC which relates to the level of knowledge employees own; b) SC which are nonhuman assets or capabilities possessed by an organization that are suitable for fulfilling market demands; c) intellectual property (IP) that relates to protected asset and has a legal definition; d) relational capital (RC) that entails organizational relationships with various stakeholders.

HC denotes the intangible expertise and knowledge of an organization's employees [31]. HC encompasses various aspects of human resources, such as attitudes, competencies, experiences, skills, tacit knowledge, and individuals' innovation and capabilities [3, 32]. HC is essential to enterprises as an origin of strategic creativity, innovation, and reinvention [32, 33]. Subramaniam and Youndt [34] stated that HC is one of the fundamental strategic assets because employees' knowledge and skill are crucial, uncommon, and valuable in today's shifting competitive climates and challenges.

HC is exemplified by distinguished capabilities that exist among some employees. With such capabilities, skills, experiences, and distinguished knowledge, they can deliver novel ideas or develop valuable insights. Such valuable outcomes can generate an extra competitive advantage for an organization [35].

SC is composed of the firm's infrastructure, procedures, cycles, and databases that allow human capital to work. SC is owned by the firm, unlike HC. It includes the organization's capabilities, routines, methods, procedures, and approaches [36]. According

to Shanthi [37], SC can be described as the collection of assets and capabilities within a company, which includes copyrights, brands, computer hardware, programs, databanks, and overall organizational capacity.

SC is defined by Shanthi [37] as patents, trademarks, hardware, software, databases, organizational culture, and capacity inside the company. Furthermore, competitive intelligence, information systems, rules, and other items resulting from the firm's products or systems throughout time are also included [21, 38].

Whereas, RC is the intrinsic value of a firm's relationships and connections with its customers, vendors, and other key stakeholders. Knowledge, capabilities, processes, and systems generated through interactions with external agents are also included [36, 39]. RC is an intangible asset as it describes the quality and depth of the relationships with various stakeholders that have an impact on business performance [40]. Customer Capital, also known as RC, refers to the degree of influence and commitment that a company's customers have toward the business [41].

2.2 Marketing Knowledge Management

MKM involves identifying and analyzing available and necessary marketing-related resources and capabilities, as well as the subsequent skills, and then planning and managing activities to create both marketing resources and skills to achieve business goals [10, 42]. MKM is part of the intangible knowledge that an organization possesses that supports organizational strategies and operations [2]. It helps in the process of depicting, disseminating, and effectively using knowledge [43]. MKM involves the use of technology to capture, store, and analyze data related to marketing activities, such as customer segmentation, product positioning, pricing, and promotional campaigns [44]. MKM helps organizations to better understand their customers, develop more effective marketing strategies, and improve overall performance [45].

MKM includes BMA, IMA, IMC, and EMC. The built-in marketing assets are the assets that the organizations gain over time. For example, an organization's name, brand, and image may affect the consumers' buying decisions, level of satisfaction, and loyalty [46]. Meanwhile, the IMC are assets that are predicted to be upgraded or invented by organizations [42, 44].

IMC refers to a set of intricate skills and knowledge that a company possesses and utilizes through its organizational processes. Internal market capabilities refer to the capability of a company to market its goods and services to its employees. This includes the ability to create and implement effective internal marketing campaigns, develop and maintain relationships with employees, and use internal communication channels to promote products and services. It also involves the ability to measure the effectiveness of internal marketing efforts and use the data to inform future campaigns [47]. Finally, external marketing capabilities refer to the capacity of a company to market its products and services to external customers. This includes the ability to create and implement effective external marketing campaigns, develop and maintain relationships with customers, and use external communication channels to promote products and services. It also involves the ability to measure the effectiveness of external marketing efforts and use the data to inform future campaigns [16, 44]. This research focuses on BMA and EMC to measure MKM.

2.3 Sustainable Competitive Advantage

SCA is a business tactic that permits an organization to maintain its competitive edge over its competitors [48]. It is achieved by developing unique merchandise that is difficult for competitors to replicate or imitate. This can be done through innovation, superior customer service, or a strong brand identity. Sustainable competitive advantage is important for businesses to remain competitive in the long term, as it allows them to differentiate themselves from their competitors and create a lasting impression on customers [14]. To assess whether the organization has achieved SCA, this research utilized the measurement of [15] SCA which depends on organizational effectiveness and organizational responsiveness. Organizational effectiveness depends on how organizations achieve their objectives by obtaining and absorbing resources [49]. Meanwhile, organizational responsiveness measures the speed of organizations in responding to customers' demands and changes in the business environment.

3 Research Model and Hypotheses

Even though a small number of researchers have attempted to investigate the influence of IC components on SCA, their contributions to the field of IC are quite limited [50, 51]. Further, the investigation of the mediating effect of MKM between IC and SCA is scarcely studied in this field. Drawing from the literature review, as well as the theory of knowledge management [52] and the resource-based theory [53], the research model is presented in Fig. 1. The model proposes that IC components, namely HC, SC, and RC, have a favorable impact on SCA. Moreover, the model illustrates that marketing knowledge management acts as a positive mediator in the relationship between IC and SCA.

HC, as a crucial element of IC, refers to the combined knowledge, expertise, and skills possessed by a company's employees, which can be leveraged to generate value. HC is a valuable resource for any organization, as it can be utilized to innovate new products, services, and processes, as well as to enhance existing ones. Empirical studies have demonstrated a favorable correlation between HC and SCA, such as the research conducted by [18, 35], and Yaseen et al. [3]. Accordingly, the following hypothesis is suggested:

H1. HC positively affects SCA

SC is a form of IC that pertains to the resources and processes that are ingrained within an organization.

It contains the organizational structure, systems, processes, and policies that enable the firm to perform and it is a key component to leveraging intellectual assets. Research findings, such as [4, 54] indicate a positive impact of SC on SCA. Hence, the following hypothesis is proposed:

H2. SC positively affects SCA

Relational capital is a type of intellectual capital that refers to the connections between an organization and its customers, suppliers, affiliates, and employees. Relational capital is important for an organization because it can help to create a SCA,

increase customer loyalty, and advance the overall operation of the organization [55–57]. Therefore, the following hypothesis is suggested:

H3: RC positively affects SCA

Marketing knowledge management can be used to create SCA by providing organizations with the ability to quickly identify and respond to customer needs. By leveraging marketing knowledge management, organizations can develop an understanding of customer preferences and behaviors, allowing them to create more targeted and effective marketing campaigns [58, 59]. This can lead to increased sales and improved customer loyalty, ultimately resulting in a sustainable competitive advantage.

Although there has been a significant amount of research on IC and SCA, the majority of it has not taken into consideration the mediating effect of MKM between IC and SCA. Previous research has demonstrated a favorable impact of MKM on organizational performance [16, 42]. Hersh and Aladwan [60] also found that MKM has a positive influence on the competitive advantage of hotels. Consequently, observing that the concept of MKM has not been sufficiently addressed in IC literature, this research argues that:

H4: MKM positively mediates the relationship between IC and SCA.

4 Methodology

4.1 Sampling

The entire population of this study was the Jordanian Telecommunication Companies (Zain, Orange, and Umniah). The total number of employees in this sector was 4045 according to the Telecommunication Regulatory Commission (TRC) in 2022. The unit of analysis consisted of directors, managers, and team leaders in various departments. For this study, a simple random sampling method was utilized, and a total of 300 participants at various managerial positions were selected to complete online questionnaires.

4.2 Measurement

The data was collected from telecommunication management employees through the use of a questionnaire. The questionnaire utilized a 5-point Likert scale, with responses ranging from 1 (strongly disagree) to 5 (strongly agree). The questions were adapted from previous literature. In specific, the questions of IC were adapted from the studies of [18, 61], and [62]. The questions of MKM were adapted from [63–65]. Finally, SCA measurements were adapted from [15]. The face validity of the measurements was evaluated by a panel of experts in the telecommunication field and language professionals to ensure clarity of language.

5 Data Analysis and Outcomes

The demographic of the participants showed that 70.7% of the respondents were males and 29.3% were females. The majority of the participants were young between the age of 30–39, representing 44% of the sample. While 43.3% were between the age of 40–49,

while 9.3% were less than 30 years. Finally, 3.3% of the participants were over 50 years old. Most of the participants were educated and held a bachelor's degree representing 79.7% of the sample. Concerning occupation, 59% of the participants were team leaders. While 37.7% were managers, and 3.3% were Directors of marketing departments. Table 1 illustrates the participants' profile.

The study employs smart PLS version 4 to analyze the collected data and to provide analysis for the measurement and structural models [66]. The measurement model provides statistics related to the validity and reliability of the constructs and the structured model illustrates the associations between the constructs and tests the hypotheses.

Table 1. Participants' Profile

		Frequency	Percentage
Gender	Male	212	70.7%
	female	88	29.3%
Age	Less than 30 years	28	9.3%
	30–39 years	132	44%
	40–49 years	130	43.3%
	50 years and above	10	3.3%
Education Level	Diploma	7	2.3%
	Bachelor	239	79.7%
	Master	48	16%
	Higher Diploma	5	1.7%
	Ph.D	1	0.3%
Occupation	Team Leader	177	59%
	Manager	113	37.7%
	Director	10	3.3%

5.1 Measurement Model

The analysis of reliability and validity were examined for the research reflective model. The individual item reliability was evaluated in terms of the loading of each item on its variable. Loadings lower than 0.7 should be excluded and square loading (R2) should be equal to or higher than 0.5 according to [66]. A filtration process was made and items (HC6, HC5, SC5, SC6, RC5, BMA1, BMA3 and CA1) were removed. All loadings were greater than 0.7 and extremely significant at ($\alpha = 0.05$).

Analysis of composite reliability and Cronbach's alpha coefficients were undergone to assess the construct reliability. Cronbach's alpha values were higher than 0.70 for all constructs and the composite reliability values were higher than 0.8.

The convergent validity was measured by testing composite reliability (CR) and average variance extracted (AVE). The thresholds for CR should range between 0.70–0.90 and the $AVE \geq 0.5$ according to Fornell and Larcker [67], and [66]. Table 2 illustrates that all values exceeded the recommended thresholds.

Finally, Discriminant validity was tested by examining the square roots of the AVE and the correlation between constructs. Table 3 illustrates that the square roots of the AVE are more than the correlation between the constructs in the model. Thus, achieving discriminant validity as the recommendation of [68].

Table 2. Reliability and Convergent Validity

Constructs	Cronbach's alpha	Composite reliability (rho_a)	AVE	R ²
Human Capital	0.779	0.783	0.603	
Marketing Knowledge Management	0.885	0.887	0.592	
Relational Capital	0.835	0.842	0.668	
Structural Capital	0.805	0.806	0.63	
Sustainable Competitive Advantage	0.834	0.849	0.601	0.527

Table 3. Discriminant Validity (Fornell and Larcker criterion)

Constructs	Human Capital	Marketing Knowledge Management	Relational Capital	Structural Capital	Sustainable Competitive Advantage
Human Capital	0.777				
Marketing Knowledge Management	0.654	0.77			
Relational Capital	0.574	0.696	0.817		
Structural Capital	0.542	0.647	0.67	0.794	
Sustainable Competitive Advantage	0.555	0.704	0.589	0.541	0.775

5.2 Structural Model

The research model accounts for 0.527 of the variance in SCA. The path analysis is illustrated in figure one. Table four illustrates the results of the proposed hypothesis. The construct of HC has statistical significant effect on SCA with path coefficients at 0.123. Furthermore, the table indicates the significant mediating effect of MKM between IC components and SCA.

The strongest direct effect on the SCA was HC ($B = 0.123$, $t\text{-value} = 1.967$), indicating the important effect of human capital on SCA. The direct effect of Structural Capital is insignificant on the sustainable competitive advantage ($\beta = 0.071$, $t = 1.015$), meanwhile relational capital has an insignificant direct effect on SCA ($\beta = 0.134$, $t\text{-value} = 1.92$).

The mediation analysis was carried out using the methodology suggested by Preacher and Hayes (2008). The criterion for rejecting or accepting the hypothesis was based on $t\text{-values} \geq 1.96$ and the absence of zeros in the confidence interval. MKM partially mediates the relationship between HC and SCA ($B = 0.324$, $t = 4.368$) since HC directly affects SCA. Also, MKM exerts a complete mediating significant effect on the relationship between relational capital and SCA ($\beta = 0.235$, $t = 4.238$) since the relationship between RC and SCA. Finally, MKM has a completely significant mediation effect on the relationship between structural capital and SCA ($\beta = 0.325$, $t = 3.859$) since the SC effect on SCA was insignificant. The results indicate the importance of the mediating effect of marketing knowledge management on the relationship between intellectual capital and sustainable competitive advantage (Table 4).

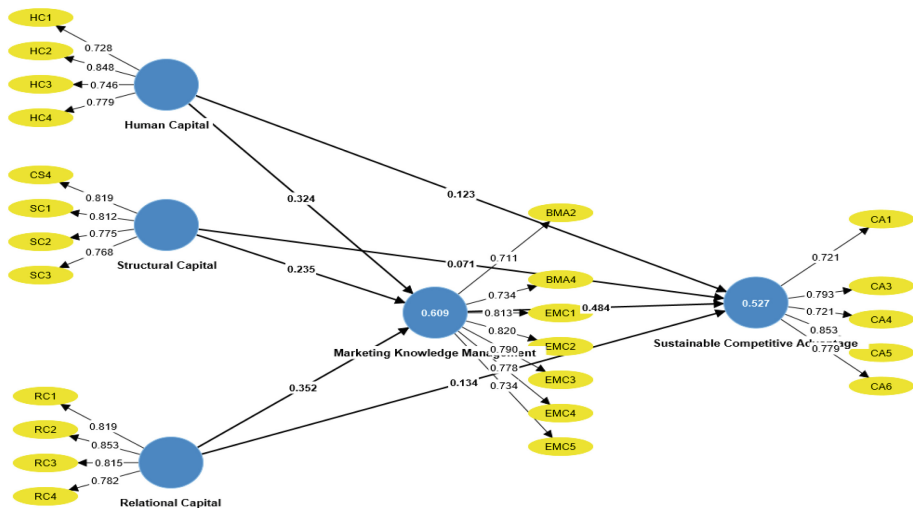


Fig. 1. Research Model and Path Coefficients

Table 4. Hypothesis Assessment Summary

Path	Path coefficient	T statistics	P values	Result
Human Capital -> Sustainable Competitive Advantage	0.123	1.967	0.049	<i>Support</i>
Relational Capital -> Sustainable Competitive Advantage	0.134	1.923	0.055	<i>Not support</i>
Structural Capital -> Sustainable Competitive Advantage	0.071	1.015	0.31	<i>Not support</i>
Human Capital -> Marketing Knowledge Management -> Sustainable Competitive Advantage	0.324	4.368	0.000	<i>support</i>
Relational Capital -> Marketing Knowledge Management -> Sustainable Competitive Advantage	0.352	4.238	0.000	<i>support</i>
Structural Capital -> Marketing Knowledge Management -> Sustainable Competitive Advantage	0.235	3.859	0.000	<i>Support</i>

6 Discussion and Implication

The study found that there is a strong and significant relationship between human capital (HC) and sustainable competitive advantage (SCA) in the telecommunications sector in Jordan. This is because human capital plays a vital role in promoting innovation, knowledge sharing, and overall growth within companies. Specifically, 0.527 of SCA is attributed to HC. These findings support previous research studies such as [50, 69, 70], and [4], which also emphasize the importance of human capital in achieving sustainable competitive advantage. However, these results contradict the findings of [3], which focused on companies' reliance on external technological advancements during that time period.

In contrast, RC and SC had an insignificant direct effect on SCA. This result contradicts with the work of prior studies, including [3, 4, 50, 69–71]. The importance of these two variables appeared when they were fully and significantly mediated by marketing knowledge management. Through the mediation effect, all the components of IC exerted a significant indirect effect on SCA. The highest impact was for relational capital, human capital, and structural capital. The mediation effect is not surprising since external marketing capabilities play a role in acquiring new knowledge and experiences that make the company more capable of attracting customers and generating new marketing ideas and thus improving the market share of these companies to increase sustainable competitive advantages. While built-in marketing assets assist telecommunication companies to adopt unique and new marketing systems to improve relations with customers and better responses to customers, as well as assisting these companies to build technological capabilities to help them in their activities. Marketing knowledge management systems improve organizational capacity and increase organizational performance, thus creating

a SCA. The result is consistent with the direct effect of MKM on competitive advantage in previous studies, such as [42, 65, 72, 73] and [16].

The study has a significant contribution to practice and theory. Managers should intensify their contribution to HC by hiring qualified and experienced employees in different departments, especially in Training and Development, to ensure that all employees have the required and essential knowledge to access the required data and benefit from it. Management and decision-makers should focus on investing in technological infrastructure such as data centers and data warehouses to support the transfer and storage of knowledge within departments. Management should encourage generating new ideas and improving services provided via performing data mining. They should focus on marketing programs that analyze customer behavior and perform a product market match for their future customers to attain sustainable competitive advantage. The existence of a marketing intelligence team is also vital for their sustainable development. Theoretically, this study is one of the limited studies that examine the mediating role of MKM between the components of the IC and SCA in the telecommunication sector in Jordan.

7 Conclusion

The study analyzed the impact of IC components on the SCA in telecommunication companies in Jordan. The outcomes indicated the significant and meaningful effect of HC on SCA. The RC and SC had no direct significant effect. However, MKM had a completely significant mediating effect on the relationship between these two variables (RC, SC), and SCA. In addition, MKM partially mediates the relationship between HC and SCA. The results indicated the importance of MKM in attaining SCA in telecommunication companies. However, this study holds some limitations. First, it is cross-sectional in nature. Future studies could employ longitudinal methodology. Second, future studies should include other variables to measure MKM, such as internal marketing capabilities and investment in marketing assets. Finally, future research should consider contexts other than the Jordanian telecommunications companies, such as the industrial and financial sectors.

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Evaluation of the Water Retention Capacity of a Pioneering Sustainable Liquid Natural Clay

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Abstract. This study is conducted to evaluate the effectiveness of a unique product named Liquid Natural Clay (LNC), produced by Desert Control Middle East LLC, with the intent to revolutionize the war against desertification. The LNC is an innovative solution to a problem that today is more relevant than ever, enabling sandy soil to retain water, improving fertility, and strengthening resilience to drought. The process utilizes clay and natural minerals known for thousands of years to enhance soil quality and drought resilience. The LNC creates sustainable soil to support quality food production and with substantial reductions in water usage by enriching fertility capability in the desert sand. Onsite soil infiltration tests were conducted at different controlled and treated soils. The tests were performed in two different sites located in Al Rawdah in Al Ain and Khalifa Public Park in Abu Dhabi. Each site had different natural conditions and was divided into smaller zones (sub-sites) to be tested individually. The overall purpose of the investigation is to determine the infiltration rates of treated soils with the LNC and compare them with untreated soils (control without LNC) using the single-ring infiltrometer method. The trial areas were prepared, partially treated with LNC, and monitored for 11 months prior to the soil infiltration tests. The tests were conducted according to special protocol and logistics provided by the Desert Control Middle East LLC team.

Keywords: Soil Infiltration Test · LNC · Desertification · Sustainability

1 Introduction

Desertification can be defined as the process by which fertile land is transformed into desert due to multiple natural and/or man-made activities such as climate change and pollution. The process involves the degradation of soil quality, loss of vegetation, and a decline in biodiversity, leading to an increase in aridity and the formation of desert-like conditions [1]. Examples of human activities that may lead to desertification are overgrazing, deforestation, agricultural practices that deplete soil nutrients, and excessive

water use. Climate change can also contribute to desertification by altering rainfall patterns and increasing temperatures, which further exacerbate the loss of soil moisture and vegetation. The consequences of desertification can be severe, including food and water shortages [2] as well as increased vulnerability to erosion [3]. Vegetation helps to stabilize soil and prevent erosion, but as it declines, the risk of soil erosion and landslides increases. This can further worsen the loss of plant cover and lead to further soil degradation, displacement of communities, and increased poverty [4]. Efforts to combat desertification often involve sustainable land management practices, such as conservation agriculture, afforestation, and soil treatment, as well as policies to reduce greenhouse gas emissions and address the causes of environmental degradation [5].

Liquid Natural Clay (LNC), refers to a suspension of very small clay particles in water or another liquid. The small size of the clay particles gives the LNC unique properties, such as a very high surface area, high cation exchange capacity, and the ability to form strong bonds with other materials thanks to the negative charge on the surface of the clay platelets [6–8]. The LNC produced by Desert Control is designed to combat desertification by improving soil quality and increasing soil's water retention in arid regions. LNC is produced using a patented process (Ref to patent: WO 2007/081219 A1 "Inorganic, Static Electric Binder Composition, Use Thereof and Method for the Preparation of Said Binder Composition") to exfoliate or delaminate (separate) the clay into a massive number of tiny individual platelets and air mixed into a liquid state with unique properties to avoid the risk of creating concrete-like impermeable layers [9]. Splitting the clay into tiny platelets further reduces the amount needed per m² from 100 kg to less than 1 kg. In short, LNC is a homogeneous suspension of clay, natural minerals, water, and air; processed into a liquid state without using chemicals, making it a 100% nature-based solution. LNC applied to the land surface will percolate into the ground and form a soil structure that retains water and nutrients, just like a sponge. A one-time LNC application is a soil upgrade proven effective over five years of validation and field trials.

When applied to dry or barren soils, the LNC is absorbed into the soil, (1) increasing soil surface area, (2) increasing soil surface charge, and (3) creating clay bridges that form soil aggregates by binding sand particles together and creating micropores and macropores for air and water storage. The soil geology is upgraded by changing these properties, creating a more stable soil ecosystem that retains water and nutrients in the root zone. This structure helps to prevent erosion and dust mitigation and increases water retention, allowing plants to grow in areas where they previously could not [9]. Desert Control LNC was used successfully in a number of arid regions around the world, including the UAE, USA, Egypt, Pakistan, and China. It has been shown to reduce water usage by 35% to 50%, increase crop yields and quality, and help mitigate soil erosion and dust.

Overall, Desert Control LNC is a promising solution for combating desertification and improving water management in arid regions, potentially enabling agriculture, green landscapes, reforestation, afforestation, and regeneration of desert plant growth in previously considered unsuitable areas for such activities. In the company's mission of continuous research and development of the LNC product, this study is conducted in collaboration with Al Ain University to compare the water-retention capabilities of treated

and untreated areas at various locations in the UAE using onsite standard soil-infiltration tests.

2 Soil-Infiltration Test Protocol

The single-ring infiltrometer method was performed using a 6 in. (150 mm) long PVC pipe with an inner diameter of 4 in. (100 mm). Figure 1 shows the components of the soil infiltration test setup. Four inches (100 mm) of pipe was carefully inserted inside the soil to minimize the soil disturbance and inner stresses. After driving the pipe into the soil, a bubble level was used to ensure a leveled surface of the pipe. A 200 ml measured volume of distilled water was added inside the pipe to infiltrate the soil. A stopwatch was used to measure the duration for the water to fully infiltrated inside the soil. The time was taken after excessive water was no longer visible on the surface of the soil inside the pipe. This process was fixed and repeated several times in each location. After the infiltration was complete, the pipe was removed, and the site was cleared.



Fig. 1. Onsite soil infiltration test.

3 Test Locations and Sites Description

3.1 Al Rawdah Site

The first investigated site was in Al Rawdah area, which is part of Abu Dhabi region and specifically to the west of Al Ain city. The rural area is approximately 120 km away from Abu Dhabi coastline toward inland. After visually inspecting the site, the soil was found to be sandy soil with a nonuniform distribution of small to medium size gravel and stones (1–3 cm). Some dry vegetation roots and organic matter were also visually detected on the site. Parts of the soil surface were not leveled compared to other parts of the study area, as shown in Fig. 2; however, the surface of the soil was completely dry throughout the site.



Fig. 2. Site-view at Al Rawdah area of treated and untreated sand.

3.2 Khalifa Park Site

The second testing location was in Khalifa Public Park, Abu Dhabi city. The park is about 500 m away from the sea (Khor Al Baghal). The infiltration test was performed on two vegetated strips approximately 5–7 m wide, located within the middle area of the park. The two vegetation strips were separated by curbs and white decorative stones, as shown in Fig. 3. From visual inspection of the site; it can be clearly noticed that the two vegetation strips were different in color, the density of the grass, and the soil moisture observed by feel and appearance method. The area called LF2_{control} presented dry patches. Several environmental sensor devices were installed at specific locations along each vegetation strip by Desert Control for monitoring purposes. The area was regularly irrigated on daily bases by the automatic sprinkler system.



Fig. 3. View at Khalifa Park site of treated and untreated regions.

4 Results and Discussion

After measuring the duration in which the distilled water completely infiltrated the soil inside the pipe in each test, the infiltration rates were calculated. Soil infiltration refers to the ability of the soil to allow water to move into and through the soil profile. Infiltration allows the soil to temporarily store water, making it available for use by plants and soil organisms. The infiltration rate is a measure of how fast water enters the soil. In sandy texture soil, the infiltration rate is high because the soil cannot slow down water movement toward gravitational force. Tables 1 and 2 show the results obtained for both Al Rawdah and Khalifa Park areas, respectively. All the durations were converted from seconds to hours by dividing them by 3600 s. The amount of distilled water used each time was 200 ml, and the inner pipe diameter was 4'' (~100 mm). The depth of the water to be infiltrated equals the volume of water (200,000 mm³) over the cross-section area of the pipe (8,203 mm²), equals to 0.96'' (24.4 mm).

Table 1. Infiltration test results at Al Rawdah site, dry soil.

Zone	Test No.	Duration (s)	Infiltration Rate (in/hr)	Average Infiltration Rate (in/hr)	Enhancement of infiltration rates
<i>PF1treated</i>	1	49.1	70.4	69.4	32% 1.5 times
	2	50.5	68.4		
<i>PF2control</i>	1	33.1	104.4	102.2	
	2	34.6	99.9		
<i>AF3treated</i>	1	64.7	53.4	55.9	Minimal difference
	2	59.3	58.3		
<i>AF4control</i>	1	70.0	49.4	57.9	
	2	52.0	66.5		

Table 2. Infiltration test results at Khalifa Park site, soil covered with vegetation.

Zone	Test No.	Duration (s)	Infiltration Rate (in/hour)	Average Infiltration Rate (in/hr)	Enhancement of infiltration rates
<i>LF1treated</i>	1	2114.9	1.6	1.8	88% 8.5 times
	2	1702.0	2.0		
<i>LF2control</i>	1	210.2	16.4	15.3	
	2	244.4	14.1		

4.1 Al Rawdah Site Results

The trial at Al Rawdah was divided into Panicum and Alfalfa production areas between September 2021 and February 2022. The production area was separated by the fence as shown in Fig. 4 and the sections were further divided into PF1_{treated}, PF2_{control} in the Panicum production area, and AF3_{treated} and AF4_{control} for the Alfalfa production area. Two tests were performed in each subsection, and the approximate location of the tests was identified by a star symbol in Fig. 5. The infiltration rates presented in Table 1 range between 68.4 to 104.4 in/hr for the previously produced Panicum area. In contrast, in the area that previously produced Alfalfa, the range was relatively lower, scoring between 53.4 to 66.5 in/hr. The average infiltration rates were calculated to estimate the overall performance of each subsection. Figure 6 shows the difference in percentage between these averages, pointing out that the average infiltration of PF2_{control} was 1.5 times higher than PF1_{treated}. However, the difference observed in rates between AF3_{treated} and AF4_{control} was much lower and almost negligible. This is probably due to the water not being fully drained; thus, the soil below the study depth might be saturated, which causes lower overall infiltration rates. Furthermore, vegetation roots and organic materials bond the soil particles and densify the soil. It led to a reduction of the water movement and therefore impacted the infiltration test result.

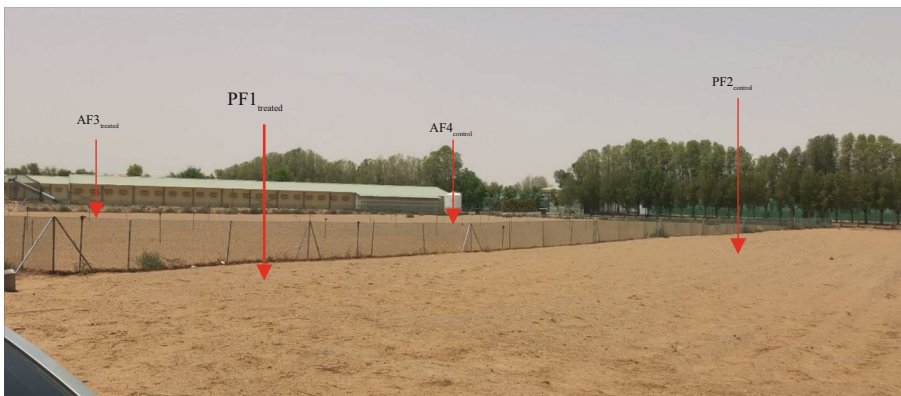


Fig. 4. Locations of the subsections at Al Rawdah site.

4.2 Khalifa Park Site Results

The two separated vegetation strips located in the Khalifa Public Park site were tested for infiltration rates. The strips were named LF1_{treated} and LF2_{control} as shown in Fig. 7 and the location of these tests is shown in Fig. 8. The table shows the durations and the infiltration rates of each test as well as the average rates per strip. The infiltration rate ranges between 1.6 to 16.4 in/hr in both strips. However, LF1_{treated} rates were found to be significantly slower than those of LF2_{control}. Figure 9 shows that the average infiltration rate 1.8 in/hr for LF1_{treated} is 8.5 times better in slowing down the irrigation water movement than the 15.3 in/hr average rate of LF2_{control}. It allows the plant to uptake water as needed and provides the capability to retain water at the target root zone.

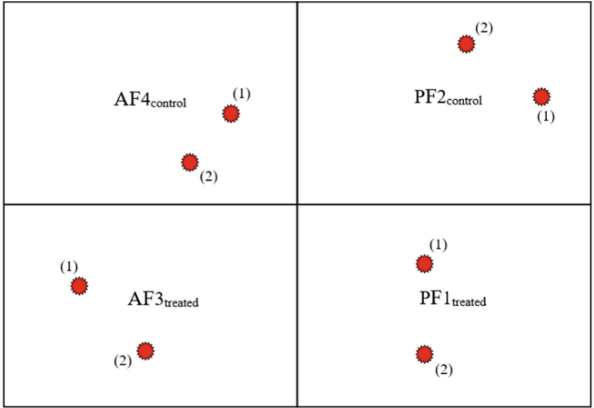


Fig. 5. Diagram showing the subsections location of each test at Al Rawdah.

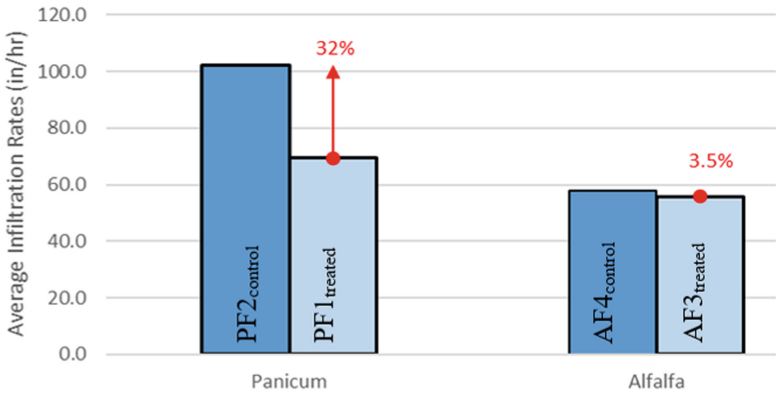


Fig. 6. The difference in infiltration rates among each subsection of Al Rawdah site.

4.3 Comparison Between Al Rawdah and Khalifa Park Sites

According to the calculated infiltration rates for both sites summarized in Tables 1 and 2, the overall infiltration rates for Al Rawdah site were significantly lower than Khalifa site. This can be explained by site condition between dry soil and irrigated soil with vegetation covered. Because of the frequent irrigation of the soil in Khalifa Park site compared to the dry soil of Al Rawdah, the moisture content is higher as confirmed by feel and appearance method during the infiltration test. This was also confirmed by the fact that the force needed to insert 4'' of the pipe in the soil was noticeably higher at Khalifa compared to Al Rawdah site.



Fig. 7. Locations of LF1 and LF2 sections in the Khalifa Public Park site.

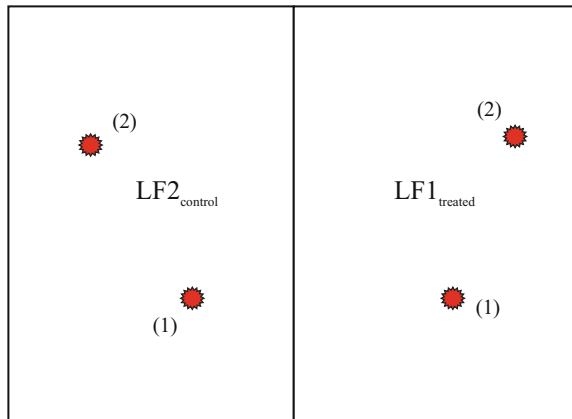


Fig. 8. Diagram showing the subsection's location of each test at Khalifa Park.

In contact with soil moisture, the clay platelets are swelling, improving the infiltration rate and lateral movement of water. However, when the soil is dry, like in Al Rahdah, the clay platelets lose their absorbed water content, reducing the LNC effect on infiltration rate as confirmed by our results. Figure 10 shows the difference in the calculated average infiltration rates for all the treated soils among both locations; the infiltration rate of Khalifa's treated soil (LF1_{treated}) is approximately 97% better than both of the treated soils in the Panicum (PF1_{treated}) and Alfalfa (AF3_{treated}) sites in Al Rawdah.

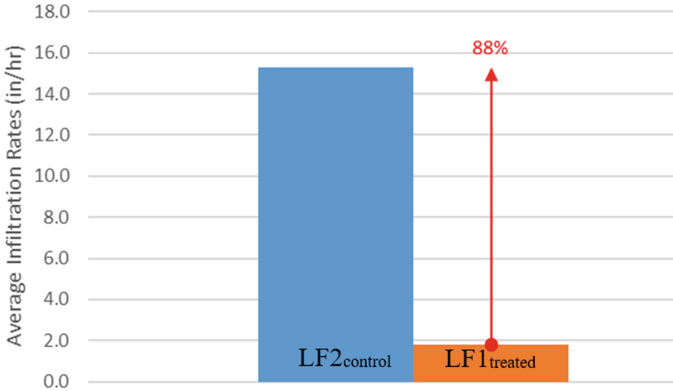


Fig. 9. The difference in infiltration rates among each section of the Khalifa Park site.

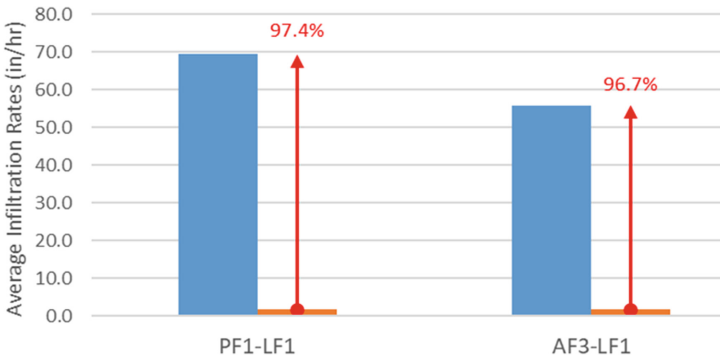


Fig. 10. Comparisons between all treated soils with LNC in Al Rawdah site (PF1_{treated} and AF3_{treated}) with Khalifa site (LF1_{treated}).

5 Conclusion

A total of 6 different soil sites were tested for the determination of the infiltration rate using the single-ring infiltration method. The LNC was applied to improve water retention and slow down the water movement in the soil profile. The results indicate a significant improvement in soil infiltration rates within each site, reflecting the ability of LNC. The 1.5 and 8.5 times slow-down of water movement in the soil as shown from the respective result of the infiltration rates within Al Rawdah and Khalifa Park, confirm the effectiveness of the LNC product and its efficacy as soil conditioner. The effect of the LNC treatment in the soil improves when water is sufficiently present in the soil.

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Orthodontic Treatment and Periodontal Health in the Big Data Era

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Abstract. The aim of this research is to conduct a critical analysis review of recent orthodontics literature regarding the interrelationship between orthodontic treatment and periodontal health underlying need for Artificial Intelligence (AI) based algorithms for optimized prediction models and reliable results. After an intensive review of previous publications, 122 research papers were identified and 40 papers were selected according to the inclusion and exclusion criteria. Analysis of the literature revealed that there are discrepancies between results in the published papers. These variations were due to a mermaid of causes such as small sample sizes and inconsistencies in the experimental protocol. The majority of researchers conceptualized and performed orthodontic as well as periodontal treatments differently making it difficult to compare prior findings using standard statistics. This heterogeneity in results leads to difficulties in using the statistical findings in a clinical setting. Furthermore, the majority of studies suffers from low relevance of their statistical findings.

Therefore, it is essential to synthesis findings from recent research seeking knowledge gaps and research limitations by critically identifying, highlighting and discussing the gaps and discrepancies that exist in published literature. In the era of AI, big data pooling and optimizing algorithms it is possible to obtain reliable results from multicenter large-scale studies making it possible to generalize findings.

Keywords: Orthodontics · Periodontal Health · Artificial Intelligence · Deep Learning

1 Introduction

Orthodontics is a dental specialty concerned with facial growth, development of the dentition and occlusion, and the diagnosis, and correction of malocclusion. The main assertion for orthodontic treatment is to prolong the longevity of the dental apparatus through the correction of occlusal anomalies. The positive effect of orthodontic treatment on appearance and psychological health is easy to envision. However, it is still unclear what is the role of orthodontic treatment regarding periodontal health.

There is an ongoing discussion on the effect of orthodontic treatment on the periodontal health. The main stream in orthodontics literature suggests an enhancement of periodontal health after proper orthodontic treatment underlying the importance of

proper oral hygiene and plaque control [1, 2]. There is evidence that plaque accumulation is one of the main causes of periodontal disease and that malocclusion is associated with plaque accumulation [3, 4]. In this regard, orthodontic treatment should benefit oral hygiene since correcting dental irregularities helps maintain proper oral hygiene reducing the probability of incidence of gingivitis and periodontitis. In addition, an ideal functional occlusion eliminates traumatic occlusion forces which also destroy the PDL [5].

On the contrary, clinical investigations show that orthodontic treatment may affect the equilibrium of oral microflora causing an inflammatory response of periodontal tissues which is detected by periodontal indices measurements [6, 7]. In addition, during orthodontic treatment hygiene can be disturbed due to the fact that it's much harder to control biofilm accumulation with an orthodontic appliance in the patient's mouth [8].

Although the mentioned arguments were studied throughout the years, there is still an increased demand for research regarding the orthodontic-periodontal knowledge domain. This is due to the fact that in recent years the orthodontic patient profile has changed with more adults seeking orthodontic treatment [9]. Adults as orthodontic patients bring new challenges to the orthodontic office, the major one being periodontal health as it is well known that adults in contrast to children have a higher predilection to periodontal problems. Hence, the increased demand for research focused on this topic.

Therefore, this research attempts to answer the following significant questions:

- Does treating malocclusion benefit periodontal health?
- Are the research papers regarding this topic consistent in their results providing us with statistically relevant findings in clinical settings?
- Can AI aid in acquiring results that are less biased, form prediction models for orthodontic treatment outcomes with regards to periodontal health?

Moreover, the current research provides evidence on the orthodontic treatment and highlights research gaps in the existing literature.

2 Literature Review

The main aim of orthodontic treatment is to preserve the health and longevity of the masticatory apparatus through the correction of malocclusion [4, 10].

During orthodontic treatment teeth move in the direction of applied forces. Orthodontic forces cause two main changes in the periodontal ligament. In the pressure side osteoclasts are activated causing bone resorption while in the apposition side osteoblasts are activated causing bone apposition in the periodontal ligament thus rear-ranging the periodontal fibers. The net effect of this remodeling process is tooth movement [11]. This area of bone turnover might increase the risk of short-term clinical attachment loss in the periodontium affected by external forces exerted by the orthodontic appliance on the maligned teeth. Clinical attachment loss is considered the golden standard in evaluating the destruction of periodontal support thus periodontitis [8].

This review concentrates on Adult as an orthodontic patient, and although there is a plethora of research papers on the orthodontic-periodontal interrelationship in this paper those with the biggest impact factor on the discussion were identified.

According to literature, bacterial plaque is considered the primary etiological factor of gingival inflammation and periodontitis [5]. Gastel et al. (2008), [12], postulated that wire insertion in banded sites of fixed appliances is directly linked to plaque accumulation and site-specific inflammation (As shown in Table 1). These results coincide with Papa-georgiou et al. (2017), whose results show that the insertion of fixed orthodontic appliance induces a qualitative and quantitative alteration of the intraoral microbiota which also has a negative effect on the periodontium [13]. Researchers aim to find solutions to these problems. In contrast to the negative effect of orthodontic problems on periodontal health, there's a reverse relationship as well. Researchers argue that advanced periodontal disease cause orthodontic problems such as proclination, diastema, and extrusion that often leads to pathological tooth migration [14, 15]. These findings, in a simplified manner, explain the orthodontic-periodontal interrelationship underlining the importance of multidisciplinary approach to dental problems and the need of further research in this area.

The review of recent literature asserts that even with appropriate plaque control, subjects undergoing fixed orthodontic treatment suffer from short-term worsening of their periodontal conditions [16–19]. However, Elkordy et al. (2019), [20], questions the validity of these results stating that the majority of publications showing a temporary worsening of periodontal parameters during orthodontic treatment are of low quality and further research is needed to verify findings. Following this clinical problem, in his analysis, Sallum et al. (2014), [21], claims that gingival inflammation during orthodontic treatment can be reversed after appliance removal with proper oral hygiene protocol.

In contrast, Kaygisiz et al. (2014), [22], compared two treatment methods; using steel-ligated conventional brackets and self-ligating brackets and their effect on the periodontal status of subjects. The author's results showed no statistically significant worsening of periodontal measurements (As shown in Table 1). His results were later on confirmed by Papa-georgiou et al. (2017), [13], who also contended the negative effect of orthodontic treatment using fixed appliances on the PDL. The author's results suggest that orthodontic treatment has little to no clinically important effect on the clinical attachment levels. A similar investigation was carried out by Yan et al. (2019), [2], who studied the effect of self-ligating appliances on periodontal health as they facilitate proper oral hygiene maintenance achieving similar results (As shown in Table 1). A different approach was carried out by Gastel et al. (2008), [12], who compared banded sites to bonded sites in the same patient. His results purport higher predilection of gingival inflammation in the banded sites and revealed that wire insertion causes difficulties in plaque control of inter-proximal spaces resulting in increased PD. However, the author admits that the formation of pseudopockets and weakened connective tissues might have hindered the reliability of results. During probing higher PD measurements might have been recorded causing an overestimation of real values.

In addition, an important drawback of this research is lack of CAL measurements.

Meanwhile, measurement of CAL remains the gold standard in evaluating the destruction of periodontal ligament associated with orthodontic treatment [23].

According to Sallum et al. 2014, [21], gingival inflammation during orthodontic treatment can be reversed after appliance removal with proper oral hygiene protocol.

However, the research was conducted on a small group of patients with no information on the periodontal status of subjects before treatment which might contribute to bias in results. In the line of plaque control problems during orthodontic treatment, Yan et al., (2019), [2], investigated the effect of orthodontic treatment using self-ligating appliances on the periodontal status of patients with Aggressive periodontitis. The research focused on the fact that self-ligating appliances help maintain proper oral hygiene which is crucial as plaque accumulation is probably the main factor contributing to periodontal problems. Although the research findings suggested a positive effect of treatment on periodontal measurements some limitations are inherent in this research.

First, this is a non-randomized short-term investigation. Second, the last measurements were taken 3 months after appliance placement while post-treatment measurements would have provided more accurate results.

Kaygisiz et al. (2014), [22], compared two treatment methods; using steel-ligated conventional brackets and self-ligating brackets. The author's results showed no significant worsening of periodontal measurements. As per the author, this might have been due to Hawthorne effect (patient's improved hygiene regimen as they are aware that they will be evaluated). Although the author states randomization of subjects included, they were selected according to certain criteria; such as inclusion of only Angle class I malocclusions, which is considered convenience sampling.

Agrawal et al. (2016), [8], identified other factors contributing to gingival inflammation such as extraction sites, tooth movement and occlusal trauma. Documenting that they also contribute to the loss of periodontal support. However, the research limitations, such as lack of recordings before appliance placement and after appliance removal. Also, the investigation was carried out solely on adolescent patients leading to bias due to small pool of subjects.

Contrarily, Carvalho et al. (2018), [1], has recordings before, during and 4 months after the end of orthodontic treatment. The research revealed the importance of combined orthodontic-periodontics treatment in subjects with compromised periodontium. The results although promising are based on a small sample group thus should be used with caution.

Sampling was also a weakness of the investigation carried out by Gomes et al. (2007), [25], who conducted a study on dental students. This sample group might lead to bias results as dental students are known to have a better overall oral hygiene than the general population.

Agrawal results weren't confirmed by Rosa et al. (2016), [26], who studied the association between space closure (intrusion and extrusion) and periodontal status. The research states lack of destructive effect of orthodontic treatment on the periodontal status of subjects, which again proves the discrepancies between papers.

Meanwhile, Zhang et al. (2017), [27], study has a plethora of strengths. Primarily, the research was conducted on a larger scale of 117 subjects in comparison to the majority of other studies. The research was based on the comparison between three different treatment approaches (subjects receiving only periodontal treatment, combined orthodontic-periodontal treatment and healthy subjects) thus providing a broader perspective. In addition, apart from standard periodontal parameters, inflammatory cytokines were measured

consequently providing more data. However, although the results confirmed the beneficial effect of combined orthodontic-periodontics treatment they were influenced by a number of factors that might have hindered the precision of data collected. These factors included the following problems: GCF acquisition method influenced inflammatory cytokines detection as well as imprecise bone evaluation from panoramic x-rays.

This brief review of recent research shows how large the discrepancies between findings are (As shown in Table 1). The interconnection between orthodontic treatment and periodontal status is considered a challenge clinically, particularly periodontal health during and after orthodontic treatment. This has pushed researchers to study the interconnection between orthodontic treatment and periodontal health. However, due to the complexity of the problem, and lack of high quality longitudinal large-scale research the heterogeneity between published papers is vast, making it hard to retrieve clinically

Table 1. Research methods and statistical analysis of result.

Authors	Hygiene control; Periodontal treatment; Orthodontic treatment	Control group	Measurements	Statistical analysis	Timing	Novel results
Yan et al. 2019	OHI; _____; orthodontic treatment using self ligating appliance	Healthy periodontum	PPD, CAL, BoP, PI, GCF, bone mineral density	T-test	Before appliance placement, 1 month and 3 months after appliance placement	Positive effect of orthodontic treatment with self-ligating appliance on periodontal measurements in patients with AP
Carvalho et al. 2018	OHI; scaling, root planning, antibiotics, surgical complementation (open full-thickness flap); edgewise appliance	Healthy periodontum	PI, BoP, PPD, CAL, CEJ-GM	Chi-square test	Before, during, 4 months after end of orthodontic treatment	Joint perio-ortho treatment is beneficial for patients with AP when oral hygiene is maintained
Zhang et al. 2017	OHI; scaling, root planning ; Functional and fixed appliances	Healthy periodontum	Serum level of inflammatory cytokines, PD, PI, CAL, GCF, tooth mobility	T-test	Before, after 6 months and after 18 months of treatment	Combined orthodontic-periodontal treatment helps control levels of inflammatory cytokines in patients with periodontitis

(continued)

Table 1. (continued)

Authors	Hygiene control; Periodontal treatment; Orthodontic treatment	Control group	Measurements	Statistical analysis	Timing	Novel results
Agrawal et al. 2016	OHI; _____; extraction of first premolars, canines retracted to the post-extraction sites	_____	PI, GI, PPD, CAL Records were taken in canines (bonded next to extraction site) in comparison to first molars (banded)	Anova	1 month after the beginning of orthodontic treatment. Every 3 months till end of orthodontic treatment	Cal loss in canines was 0.17, in molars 0.2. Banding and bonding are not the only causes of worsening of periodontal status in orthodontic patients. Extraction sites, occlusal trauma and other factors should be taken into consideration as well
Rosa et al. 2016	_____; _____; orthodontic space closure 1st premolar intrusion, canine extrusion	Orthodontic treatment without space closure	PD, BoP, recession, Teeth mobility	T-test	10 years after treatment	Orthodontic treatment of patients with missing lateral incisor doesn't have a negative effect on their periodontal status
Kaygisiz et al. 2014	OHI; healthy; self-ligating rackets and conventional rackets	Without orthodontic needs, without periodontitis	Halitosis, PI, GI, PD, BOP, TCI	Anova	1 week before orthodontic treatment up to 8 weeks after bonding	Orthodontic treatment has a mild positive effect on periodontal parameters

(continued)

Table 1. (continued)

Authors	Hygiene control; Periodontal treatment; Orthodontic treatment	Control group	Measurements	Statistical analysis	Timing	Novel results
Gastel et al. 2008	OHI, plaque control during treatment with erythrosine solution; _____ band placement and headgear then at week 18 bracket bonding	None, comparison to teeth not treated orthodontically; neither banded nor bonded sites in the same patients	Microbial sampling, PD, BoP, GCF		Before treatment, after 18,20,24 and 36 weeks	In fixed orthodontic appliances bonded sites have a worse effect on the periodontum than banded sites. Wire insertion causes difficulties in approximal cleaning
Gomes et al. 2007	_____	Without orthodontic treatment	VPI, GI, PPD, CAL	Mann-Whitney test T-test	After orthodontic treatment	No relationship found between orthodontic treatment and periodontal conditions
Sallum et al. 2004	OHI; _____; _____	_____	PI, GI, PPD, microbiology	T-test	Baseling - gingival inflammation before orthodontic appliance removal; 1 month after appliance removal	Removal of orthodontic appliance coupled with good oral hygiene has a positive effect of restoring periodontal health

relevant results. Also, literature shortcoming caused by research limitations and a number of unknown variables lead to an increased risk of bias resulting in statistical findings with no clinical implications. The main shortcomings in the literature underpinning the relationship between orthodontic treatment and periodontal health are the following:

First, the majority of studies are limited to a small sample group with no randomization.

Second, studies lack longer periods of follow-ups essential in validating the accuracy of results. Third, most reviews are contradictory in their findings with their validity highly influenced by the methodology used. The heterogeneity is high among studies (study type, cohort or cross sectional; follow-up duration; design and size of brackets; types of

ligation; bonding procedures; sample size and level of oral hygiene of subjects), causing conflicting findings.

Control group - with healthy periodontum, AP; Aggressive periodontitis, VPI - Visible plaque index, GBI - gingival bleeding index, CAL - clinical attachment loss, BOP - bleeding on probing, GCF; gingival cervical fluid, TCI; tongue coating index, GCF - gingival cervicular fluid.

3 Methodology

The Current research is based on three methodological steps:

First, selection of literature related sources

Second, definition of a time horizon work

Third, selection of the papers to be reviewed.

For this research we used a key word search in PubMed, Clarivate Analytics (Web of Science) and Scopus databases. A rigorous set of criteria were developed to review these articles.

Inclusion criteria: The time frame was set from year 2000 and onward; including only recent up-to-date research. Studies whose target population is humans with a minimum sample size of 20 patients; decreasing result bias.

No restriction regarding patient's age, gender, ethnicity or occlusion characteristics were applied. Studies where orthodontic treatment was carried out using fixed dental appliances. Studies with at least two periodontal measurements recorded.

Exclusion criteria:

Publications published before the year 2000, studies on animals, orthodontic treatment using removable appliances only, orthognathic surgery and distraction osteogenesis as their results could differ significantly from nonsurgical orthodontic therapy. Technique-sensitive periodontally compromising treatments do not correspond to an average orthodontic treatment using fixed appliances. Studies that lacked periodontal measurements during or after orthodontic treatment, non-clinical studies.

Craniofacial anomalies as they could hinder comparativeness of results with other publications.

Also, to ensure capturing all relevant published research we also used Google Scholar search engine to cover all publications I systematically searched sources in the area and 114 research papers were identified.

4 Conclusion, Implications and Future Research

The review of literature shows that the during orthodontic treatment there is a site-specific worsening of the periodontal status. However, the changes seem to be temporary and reversible after the removal of the orthodontic appliance.

The is no sufficient evidence whether this worsening of periodontal status is only due to the difficulties in maintaining proper oral hygiene during orthodontic treatment.

Worsening of the periodontal status is multifactorial and other causes should be taken into consideration as well.

The majority of studies in literature suffer from limitations in their design and methodology. In addition, the heterogeneity of results in available literature decreases the validity and power of generated evidence. Studies with more rigorous methodological criteria would provide more precise evidence to the orthodontic and periodontal inter-relationship. Future researchers should perform large scale longitudinal randomized clinical trials with standardized diagnostic criteria for periodontitis. It is essential to perform a full assessment of the periodontal status of patients by checking pocket depths, clinical attachment loss and bleeding on probing before, during and after the completion of orthodontic treatment.

Using AI it's possible to combine all variables that we want to assess, such as PD, CAL, BOP as well as different types of malocclusions and form a prediction model of the treatment outcomes in relation to orthodontics as well as periodontal health status. AI aids in finding interrelationships from nonlinear patterns that are far too complex for the human brains to decipher, it can derive results from unlimited amount of input data, decreasing risk of bias and making it possible to generalize findings. AI based prediction model performed for using Python coding language could aid in identifying interrelationships between an individual's periodontal health and type of orthodontic treatment carried out. Deep learning can be utilized to form prediction models for an individual's periodontal health and malocclusion to assess possible risk of worsening or enhancement of the periodontal health after orthodontic treatment. Most probably, the future of orthodontics as a discipline lays in individualized treatment plans with the possibility of predicting final treatment results using AI based neural networks [28, 29].

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A Systematic Review of Green Economy and Energy Efficiency Nexus

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Abstract. The notion of green economy and green growth has become center of attention for many policy makers. However, green economy has diverse aspects that link with energy efficiency and sustainability. In this article, we focus on the green economy and related energy efficiency mechanism by anticipating green growth. The objective of this paper is to check systematically published literature to compile the main driving aspects of green economy. For this purpose, a systematic literature review was conducted by searching full text, peer reviewed English articles from Scopus, Science direct and PubMed databases. The Preferred Reporting Items for Systematic Review was used to select relevant articles. Accompanying the full screening, 34 articles met the selection criteria and discussed in the current study. Three main aspects that lead to green economy as; green total factor productivity, human capital and green finance were identified based on the traditional approach of, “green economy”. Therefore, this study proposes policies and practices to scale up the energy efficiency by financial support from government. It is concluded that future research can carry on identifying the various challenges in successful adoption of green economy practices and attaining energy transition.

Keywords: Green economy · systematic review · green total factor productivity · human capital · green finance · sustainability

1 Introduction

With rapid pace of industrialization and technical innovation has resulted in high economic growth. However, along with this, energy consumption and environmental pollution posed serious challenges worldwide. There is urgent need to transform energy sector by having entire changes in the way we produce and consume energy. This fundamental enhancement of energy utilization will result in economic transition to attain sustainable growth. Overall, the entire world is ambitious about sustainability, which is a common feature of green economy. [1] has highlighted that green economics require a design of economic systems with effective government policies to secure sustainable development. This requires government’s swift action towards focusing on investment and spending towards a range of green sectors. The entire cost and benefit analysis in all economic activities will lead to change a total factor productivity that will comprehend towards,

“green economy”. [2] justified that energy efficiency; renewable energy and technology are the positive predictors of green economic growth. Furthermore, government plays a vital role in implementing efficient production processes.

Most of emerging economies are striving to achieve zero-carbon agenda by using sustainable production techniques. If the key inputs in production process are efficient for example, renewable energy that can result in sustainable level of output. This mean that businesses should focus on green production resources to develop circular economy. [3] identified that green financing and logistics played have a significant and positive effect on sustainable production in green economy. [4] also examined the role of financial inclusion for controlling pollution and environmental sustainability. They suggested that to promote sustainable economic growth it is vital to foster financial institutions and energy sector collaboration.

Therefore, the aim of this systematic review is to identify the driving forces in generating green economy. Overall, this paper is mainly comprises of five main sections. Firstly, following the brief introduction Sect. 2 is a systematic review analysis conducted to identify the potential studies regarding factor input, human capital and financial inclusion in context of green economy and energy efficiency. In Sect. 3, these selected studies described and characterized with respect to green economy. Furthermore, lastly in Sect. 4 some conclusion and policy implications have discussed based on three main perspectives to support transition towards green economy and sustainability.

2 Methodology

Current study review the literature review as outlined by Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA). The main aim is to answer the question that how green economy achieve sustainability with energy efficiency.

2.1 Literature Search

In the initial stage the scoping was done by using the main search terms (“green economy” OR “circular economy” OR “green growth” OR “sustainable growth”) AND (“energy efficiency OR “renewable energy”) to identify the relevant journals to be use in literature search. Managing the initial search, the main two electronic databases specifically Econ-Papers, Scopus and Science Direct were selected for relevant literature search. Mainly these databases were used due to their citations and extensive research, which help to review the relevant research area.

The key words used to search for all three databases were related to subject matter mainly reflecting green economy and energy efficiency: (“Green economy” OR “circular economy” OR “sustainable economy” OR “green growth” OR “industrial ecology” OR “bio-economy) AND (“renewable energy” OR “green energy” OR “environmental friendly” OR “eco-friendly” OR “energy saving”).

While extracting the articles, the advanced search has used to limit the search and filter the articles to mainly identify the peer reviewed and full texts, all English language articles that published during last 5 years (between January 2019 and January 2023). There is intensive evolving research work going on with rapid innovation and technical

advancement especially in energy efficiency to attain sustainable growth. Therefore, it is important to consider the latest research work to avail current recommendations and policies. Furthermore, conference proceedings, blogs, review and book chapters are excluded (see Table 1) as below:

Table 1. Criteria for topic inclusion.

Other Sources	PubMed	Scopus	Science Direct
MDPI EconPapers	All topics related to energy efficiency	Energy Business Management and Accounting Economics, Econometrics and Finance Environment Science	Environmental Technology & Innovation Resources, Conservation and Recycling Energy Policy Renewable Energy Journal of Innovation & Knowledge

2.2 Article Screening and Selection

As the study has used different databases for search, there was a high possibility of duplication of some articles. In this context, a comprehensive screening process has done by screening all identified articles to remove the duplicates. After discarding the duplicates, all the titles and abstracts were checked gain for eligibility criteria. Lastly, the full text review has taken all the remaining research papers to meet the inclusion/exclusion criteria as in Table 2.

As shown in the PRISMA diagram in Fig. 1, the search retrieved 9652 articles and 36 resources identified from other sources. All 9,688 articles were screened and it was found that 2020 studies were duplicated. In the next stage, 7668 selected articles were in title and abstract screening stage and finally came up with 295 potential studies for next stage. The full text review has done for 295 studies by using inclusion and exclusion criteria as described earlier section and total 34 articles fulfil the eligibility criteria and analyzed for systematic review.

2.3 Limitations

Mainly by using the systematic review in the search category, some of the valuable published studies might be excluded as out of the scope. For example, only the full text articles were reviewed for writing the literature review. However, the conference papers were excluded so there might be some resourceful published material that was missed to include in the current study.

Table 2. Article Inclusion and exclusion criteria.

	Inclusion	Exclusion
Location	China, U.S., UK	All other countries
Research Methodology	Qualitative, Quantitative and Mixed methods	
Type of Study	Research articles from the perspective of economists, policy makers, production managers in sectoral performance related entities	Studies that focused purely on thermal, chemical and mechanical manufacturing process
Timeframe	Collected data lies between January 2019 to January 2023	Research articles before 2019
Main Setting	Economic efficiency e.g. public policies. Financing and inputs efficiency	Non-economists settings

3 Findings

Green economy concept revolves around improving human wellbeing by reducing environmental risk and ecological constraints. [6] highlighted that green economy implies the rethinking of designing economic system to meet unconstrained desires. Their discussion towards green economy and sustainability mainly leads towards three aspects as firstly the scale and magnitude of economic output where factor input is vital so giving the value to efficiency and productivity. Secondly, the human preferences where people will value the environmental and ready to change by feeling of wellbeing. This can be further reflect in market-based decision with changes in consumer behavior. Lastly, the value based decision-making that is command and control based that means the investment to avoid social cost and generate social benefits, These all perspectives have themed in three categories as total factor productivity, human capital and green finance as summarized in Table 3.

3.1 Green Total Factor Productivity (GTFP)

Various studies identify that green total factor productivity is the essence to allocate the resource efficiently. [8] evaluated the Chinese pilot project of cities with low carbon control target. They used OP and LP methods to calculate the total factor productivity (TFP) in Shanghai and Shenzhen from 2005 to 2015 in 285 prefecture-level cities. The study provided a strong support for expansion of low carbon cities by scientific implementation of urban emission reduction control. Beside this, [26] shed light on another interesting point that China is generating GTFP in high-speed rail operation. They demonstrated that high-speed rail opening has significantly increased the GTFP. They found that such policies reduce emissions and improve the climate conditions. [15] mentioned that China shown international responsibility by having Belt and Road

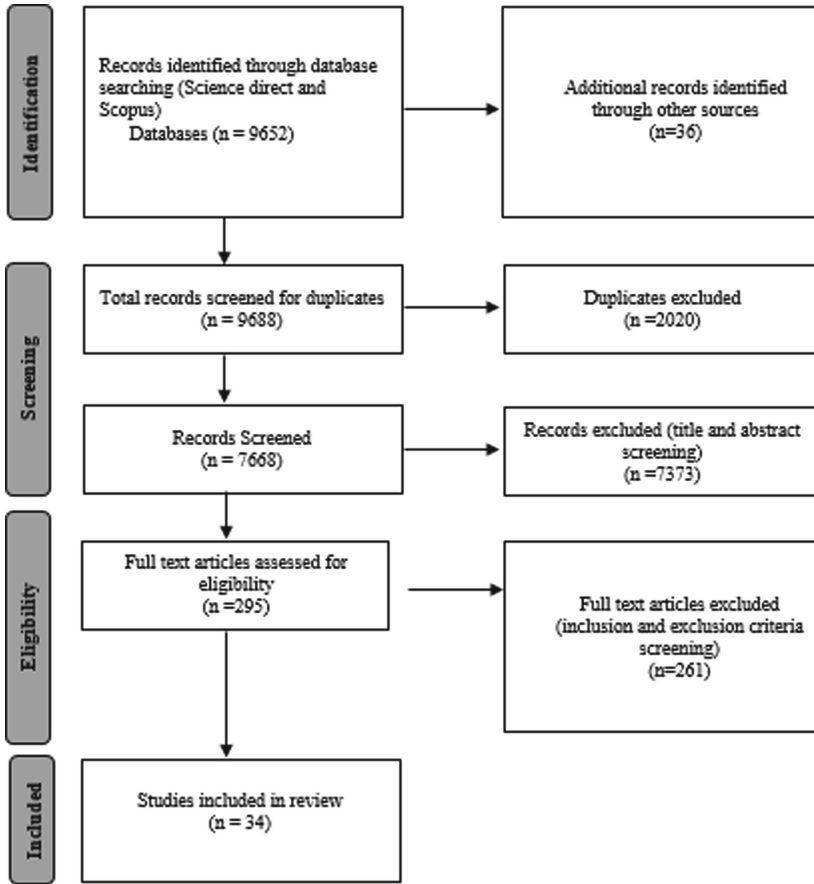


Fig. 1. PRISMA article screening process. Source: [5]

Initiative (BRI) project. They explored the effect of BRI on the GTFP by using annual panel data of Chinese cities from 2004 to 2018. With the series of robustness test, they came up with the policy implication that there is strong link between BRI and Free Trade Zone to promote GTFP. This would not only generate the benefits for the cities along the route but will also radiate the GTFP in neighboring cities along the route.

Moreover, [12] mentioned that sustainability and green growth is a strategic choice in China. They justified that factor productivity leads to dual benefits of energy saving and economic growth. At the same time, technical innovation can indirectly influence the GTFP by structure and growth path. [11] decompose the GTFP into internal growth and factor allocation in 23 Chinese sectors from 2005 to 2017. They came up with the multiple result findings regarding factor productivity such as sectoral technology, reallocation effect of capital, reallocation effect of labor and energy allocation efficiency. They proposed interesting facts that allocation efficiency is necessary to accelerate the green development. [7] calculated the GTFP by using Moran's index and the GTWR model in 30 manufacturing industries in China. They proposed that clean energy leads to

Table 3. Key aspects in attaining green growth.

	Related Aspects	Sources
Green total factor productivity	Clean energy in manufacturing	[7]
	Low carbon city project and optimization of resource efficiency	[8]
	Environmental regulations	[9]
	Productivity index in service sectors	[10]
	Factor allocation	[11]
	Environmental regulations	[12]
	Green sustainable development and factor productivity	[13]
	Digital economy and factor productivity	[14]
	Green development and domestic route	[15]
	High speed rail and factor productivity	[16]
Human capital and sharing economy	Investment in human capital and green economy	[17]
	Human capital development and green growth	[18]
	Human capital and sustainable energy transition	[19]
	Human capital impact on energy consumption	[20]
	Human capital and green development	[21]
	Human capital and use of natural resources	[22]
	Sharing ideas and energy efficiency	[23]
	User adoption and energy efficiency	[24]
	Sharing governance structure and energy efficiency	[25]
	Sharing economy and cleaner production	[26]
	Resource sharing green economy	[27]
	Spatial spillover and energy efficiency	[28]
Green Finance	Technical finance corporation and energy efficiency	[29]
	Technical investment on factor productivity	[30]
	Green credit and factor productivity	[31]
	Green finance and energy consumption	[32]

(continued)

Table 3. (continued)

	Related Aspects	Sources
	Green finance and energy transition	[33]
	Green financial development and energy efficiency	[34]
	Green finance and renewable energy	[35]
	Green finance and structural effect	[36]
	Financial inclusion and green system	[37]
	Financial inclusion and energy efficiency	[38]
	Financial reforms	[39]
	Green bonds and renewable energy	[40]
	Green finance and renewable energy	[41]

green development, and accelerate sustainable industrial transformation. Due to increasing trend of sustainability, the total factor productivity not only confined to production techniques but also expand in service sectors. Additionally, [10] outlined the dynamic changes and convergence of GTFP in 14 sub-sectors of service industry in China. The paper decomposed the GTFP by employing cutting-edge epsilon-based measure (EBM) generalizing slacks-based measure (SBM) as well as Global Malmquist-Luenberger (GML) productivity index. The study recommended that optimizing energy structure and technical innovation in service industry could boost the sectoral performance. Some relevant studies also justified the same findings about factor productivity [9, 13, 14].

3.2 Sharing Economy and Human Capital

Due to advancement of cleaner production, sharing economy and internal mechanism, practices are resulting in energy transition. Various resource sharing models and green industry development models of factor input are playing an evolutionary game between enterprises and consumers [26–28]. Energy efficiency and sharing economy became significant factors in attainment of sustainable green growth, which require the attention from entire community. [24] documented the energy efficiency through user adoption of sharing economy as central element of sustainable development. [23] investigated the impact of energy efficiency and sharing economy in China by using secondary data from 1991 to 2020. By using augmented Dickey-Fuller (ADF) test and quantile autoregressive distributed lag (QARDL) model it was concluded a positive linkage amongst study variables such as; energy use, sharing economy users, sharing economy values, urbanization, population growth and sustainable growth. This further verified by [25] by investigating the impact of sharing economy including sharing economy users and values on energy use in China. Research applies nonlinear autoregressive distributed lagged (NARDL) model using data from 1986 to 2020. It was found a strong association between sharing economy users, sharing economy values, population, FDI, energy use and sustainable economic development.

Due to rapid industrialization process, it is emphasized to develop a green low carbon economy by raising the slogan of, “ecological civilization”. Superficially, this also means a lot for China to embrace environmental sustainability with immediate understanding of nature. [17] explored the relationship between human capital and green economy to capture the changes in transformation process. The study performed in-depth analysis to assess the greenness of its economy by using spatial error model (SEM) model for 30 Chinese provinces from 2000 to 2017. It was concluded that China’s green development relies heavily on human capital stock as compare to human capital structure. Furthermore, [21] mentioned that human capital plays a regulatory role in green development path.

In the human capital aspect, [20] disclosed the effect of human capital on energy consumption for a panel of OECD economies over the period 1965–2014. Their findings suggested that human capital generates significant positive externalities for the environment. In the same lines, another study by [19] examined the impact of technical innovation, human capital and energy pricing on aggregated and disaggregated energy sources in OECD nations between 1991 and 2019. The study applied pooled mean group (PMG), mean group (MG) and dynamic fixed effect (DFE) and cross-sectional Auto-Regressive Distributed Lag (CS-ARDL). The findings suggested that human capital are innovation are leading tools in OECD to increase the clean energy consumption.

Human capital may reduce the ecological footprint and stimulate green growth with various policy initiatives. [22] captured the effect of human capital, foreign direct investment and amount of natural resources on the ecological footprint in U.S. data from 1970 to 2015. The estimated result found unidirectional causality between human capitals to natural resources. Therefore, it was suggested that U.S. could attract more FDI and human capital from other countries to attain sustainable green growth. [2] highlight this same phenomenon in G7 economies that the member countries can attain green growth by developing human capital. The green growth agenda may exacerbate the region’s resource curse dilemma by having more clean energy.

3.3 Green Finance

The scale up of financing flows from the public and private sectors are key part to manage environmental constraints. It is a vital opportunity to invest and take a decent rate of return in form of environmental benefit. [41] offered an empirical study on renewable energy in China from the perspective of green finance by using provincial data from 2001 to 2019. Their findings strongly recommended that green finance directly promote renewable energy. Furthermore, it has spillover effect in the region by harnessing multiple benefits in the short and long term. Due to increasing importance of green finance, [31] justified that China has improved factor productivity with green credit policy. This initiative is optimizing the mechanism of energy use and stimulation green innovation. In addition to the reaping benefits of green finance, [32] provided a systematic implication of green finance on the comprehension impact of spatial externalities on energy efficiency. The same aspect as revealed by some other researchers such [38] in U.S. economy and [39] in UK. Various researchers have also shed light on the key role of financial support in energy transition and sustainable development [4, 29, 33, 37, 40].

Financing the green economy is at the top priority in China to develop resource efficient economy and achieve green growth. [34] estimated the connections regression analysis approach and the Richardson model to assess China's renewable energy investment efficiency. They proposed interesting policy that financial institutions and renewable energy firms should work with collaboration to enhance green growth. [36] highlighted the importance of green Belt and Road Initiative (BRI) in green transition. They used GMM techniques to measure the association between government expenditure and the green economic performance in BRI countries. It was found that government expenditures have profound impact on energy projects. [35] have the same suggestions as inline that Chinese government should enhance investment in renewable energy projects by giving financial support. This means that financial inclusion generate energy efficiency and results in sustainable growth. It has emerged as a vital component in China's financial reforms and provide signs for possible government and institutional support. [30] suggested that the dual aspects as financial inclusion and human capital generate benefits of factor productivity in Chinese economy.

4 Conclusion and Policy Implications

Based on literature of various aspects of green economy and energy efficiency the current study has revealed mainly three components comprises on; total factor productivity, human capital and green finance. The study proposed that systematic literature review is an effective technique in documenting important studies despite some limitations. It presents a clear picture of green economy and energy efficiency aspects from the Scopus database. It has found that mainly most of the recent studies comprises on Chinese economy. That justified that there is massive research work in China based on sustainability plans and developments [15].

It has been noted that establishing a regulatory framework for green economy is complex process that needs an extensive planning process. Therefore, it is vital to understand the establishment of regulatory framework to remove certain barriers to green investment. It is equally important to resolve the environmental challenges by adopting energy efficiency strategies. Furthermore, the adoption of effectively managed resource allocation from various sectoral planners can also provide roadmaps towards sustainable growth. The command and control regulations can work practically if align them with the public policies. This means that public spending can help to develop sustainable production methods and energy transition that can lead to large-scale economic transformation. The scarcity of energy resources is a challenge in green growth but can be resolve by strengthening international collaboration and developing low carbon energy workforce.

The research presented in this paper is based on the literature review, so presented results are tentative and have limited value. Hence, further research needed to explore the complex key aspects in attaining green growth and energy efficiency. This systematic review may not include many studies that are written in a language other than English. Further studies can include some more aspects in form of opportunities and challenges in these three aspects in various economies.

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Artificial Intelligence Applicability in Orthodontics: Quo Vadis Orthodontics?

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Abstract. Nowadays, crucial orthodontic knowledge is scattered and hidden in raw data. Without the aid of Artificial Intelligence (AI) we are not capable of connecting evidence hidden in complex, high dimension, nonlinear dynamic data in order to derive logical and useful patterns. Artificial Intelligence is a branch of computer science; it involves the development of algorithms in adjunct to computer programs which can learn and improve over time to perform tasks that normally require human level intelligence. Artificial Intelligence followed by Deep Learning might soon revolutionise orthodontics in all aspects of its workflow. Orthodontics with the aid of Artificial Intelligence is going through a paradigm shift towards ‘precision orthodontics’ concentrated on optimized, individualized treatments. Today, if we ask ourselves “Quo Vadis Orthodontic?” What could the answer be?

Keywords: Orthodontics · Artificial Intelligence · Deep Learning · Algorithms

1 Introduction

Nowadays, crucial knowledge is scattered and hidden in raw data, without the aid of Artificial Intelligence (AI) we aren’t capable of connecting evidence hidden in complex, high dimension, nonlinear dynamic data in order to derive logical and useful patterns. Artificial intelligence followed by Deep Learning might soon revolutionise orthodontics in all aspects of its workflow; it is an emerging main stream approach in orthodontics. Artificial Intelligence is a branch of computer science, it involves the development of algorithms in adjunct to computer programs which can learn and improve over time to perform tasks that normally require human level intelligence. AI was first defined in 1950 by the Turin test [1] as computers capable of human intelligence. In 1956, John McCarthy described AI as “the science and engineering of making intelligent machines” [2]. A more elaborate definition describes AI as a system’s capacity to effectively decipher outside information, to gain from such information, and to utilize those learning to accomplish explicit objectives and assignments through adaptable transformation’. The ultimate goal of Artificial Intelligence is to create intelligent machines that can reason, understand, and solve problems in ways that are similar or even surpass human intelligence.

2 Artificial Intelligence and Orthodontics

Currently, we are part of the 4th industrial revolution, it's impacting almost all fields, including medicine, and in an unprecedented rate changes pattern recognition from linear to non-linear. Artificial Intelligence was inspired by the function of our brains; the brain neural networks. Two subsets of AI are Machine Learning (ML) and Deep Learning (DL). ML is based on algorithms that are trained from data without being explicitly programmed, the algorithms parse data, learn from them and use what they've learned to make informed decisions. ML identifies patterns that enable it to learn and apply this to future similar scenarios. ML doesn't use a static algorithm thus its model can be used for individualized patient care. Advances in ML led to the Era of Deep Learning with more powerful and complex mathematical algorithms. Algorithms capable of learning from big unstructured data followed by accurate decision making with minor or no human intervention. Deep learning is a specialized subset of Machine learning, it uses Artificial Neural Networks (ANN) that are layered and entwined mimicking the human brain. ANN consist of multiple neural layers interconnected via nodes that pass information with different weights. The algorithm learns from the weights within the nodes to generate high accuracy models from complex non-linear patterns [3]. Neural Networks can be used to generalize unseen data since it can provide accurate predictions based on unseen new data. This is crucial in medical applicability as the model needs to be robust to various patients. Also, they can handle an enormous number of datasets and can be adjusted to unique prediction tasks by adjusting the number of neuron layers and activation functions. This aids in tailoring the model to perform specific prediction tasks (4). There are several types of ANNs such as Multilayer Perceptron (MLP), Convolution Neural Network (CNN), Probabilistic Neural Network (PNN), and Recurrent Neural Network (RNN) [4]. MLP is a neural network that learns by stochastic gradient descent and backpropagation, it can extract high-level features from raw data that are not easily discernible by human experts. MLP architecture consists of three layers; an input layer, multiple hidden layers, and an output layer that predicts results. Each layer in MLP is made of multiple perceptrons. From perceptrons a model can be built in which "neurons" are used for recognition which is based on the ability of learning profoundly. Perceptrons receive input data which are multiplied by their corresponding weights. Each input can be adjusted by its weight. The input signal is multiplied by its weight and the outcome value is assigned to the particular input. The weights are adjusted during the learning phase. Once the modified output signals are summed up, bias can be added in the learning phase. The hidden layer extracts different features of the input data and produces the final prediction using an activation function which is applied to the weighted sum of the input values. Then, actual output is determined. MLPs are trained by backpropagation where the weights and biases of the NN are adjusted to minimize potential inaccuracy between the predicted outcome and the real outcome. However, often due to the nature of medical data which represents real-life data, balancing data algorithms is required before implementing deep learning algorithms [5].

The applicability of AI-based neural networks in medicine are vast, they have already boosted discoveries in genetics and molecular medicine. It is used in image processing; it analyzes magnetic resonance as well as non-contrast head CT images in mere seconds. It can detect cancerous lesions and create differential diagnosis. It's used to screen for diabetic retinopathy, cardiovascular risk assessment and Alzheimer disease progression prediction as well as accurate prediction of drug therapy response. In addition, it is used by surgeons through the Da Vinci robot to facilitate complex surgical procedures such as valve repair [6–9]. Furthermore, in Juvenile Idiopathic Arthritis (JIA), ML and DL can be used to predict clinical response to immunomodulating drugs such as Methotrexate through Extreme gradient boosting (XGBoost) [10], in distinguishing JIA patients from healthy patients [11–15] and in diagnosing Temporomandibular Joint Dysfunction (TMD) in JIA patients [16]. Ribera et al. developed a NN that stages bony degenerative changes in the TMJ due to osteoarthritis from temporomandibular joint CBCT images. They named their product “Shape Variation Analyzer” [17].

Limited medical resources will continue to be a problem of the future and one of the solutions lies in decreasing specialists' work load with the aid of intelligent processing tools. The discipline of orthodontics faces the same challenges which is why the applicability of Artificial Intelligence in orthodontics has been steadily increasing for the past 25 years [18]. The earliest study published on AI in orthodontics was published in 1986, the author proposed an algorithm for facilitating landmark positioning in cephalometric analysis [19]. Since then multiple researchers worked on the atomization of landmark positioning on lateral cephalograms, CBCT images and frontal cephalograms. According to literature automatized landmark positioning in comparison to traditional methods is characterized by equivalent or higher accuracy with lower time consumption thus decreased human effort [20–22].

Another domain of AI applicability in orthodontics is diagnostics and treatment planning. In orthodontic treatment planning one of the main dilemmas is to decide whether to extract teeth or treat without extractions. This has led researchers to try and develop decisions support systems to aid in tailoring individualised treatment decision unbiased by specialist's experience decreasing subjectivity. To achieve this, Artificial Intelligence based Neural Networks (NN) were developed. The authors were able to build prediction models with accuracy rates as high as 94% [23].

Another major dilemma is whether patients require adjunct orthognathic surgical intervention in conjunct to orthodontic treatment or if orthodontic camouflage is possible. This decision has to be made prior to orthodontic treatment start as usually pre-surgical orthodontics and orthodontic camouflage treatments are done in ways that are opposite to one another [24]. Precise, individualised treatment planning is crucial in orthognathic surgery planning because a minor mistake could deteriorate patient's facial aesthetics [24]. Choi et al. developed a prediction model using two layers NN with one hidden layer to predict surgery/no surgery, surgery type as well as extraction/non-extraction. The model is of 96% success rate for surgery/no surgery decision and of 91% success rate for extraction/no extraction dilemma. Stehrer et al. used random forest algorithm to predict blood loss before orthognathic surgery [25]. These kinds of models could be especially helpful in aiding young unexperienced clinicians in their decision-making. A group from the United States tried to find the best AI-based computational analysis to

achieve not only binary results from prediction models but more detailed results. Most researchers developed models that provide an answer whether to extract or not. However, they don't provide information on which tooth or set of teeth to extract. Also, the models input factors are often limited to only crowding and teeth inclinations while AI provides the means to have a larger set of input factors. Choi et al. broadened the input factors by adding data about sagittal and vertical dentoskeletal discrepancies, transverse discrepancies, information about soft tissues and intra-arch conditions. The group tried different AI approaches for model development however they concluded that Random Forest (RF) model provides best real-life results as it decreases bias related to overfitting in comparison to more complex NN models. Other studies also confirm that RF simpler model outperforms more complex models [26–28]. Choi et al. were able to develop a successful RF prediction model that simulates orthodontic extraction/non-extraction decision [29]. Also, during orthognathic treatment planning cone-beam computed tomography (CBCT) is merged with intraoral scan to improve CBCT occlusal visualisation. Lee et al. found that deep learning-based oral scans integration is as accurate as the manual method with superior efficiency when taking into consideration time consumption.

Cleft lip and palate (CLP) patients are another challenging patient group for orthodontists and surgeons. Zaturrawiah et al. used Random Forest to detect CLP patients' features that determine whether the preoperative orthodontic treatment will be successful or not. Orthodontic treatment success is important to have a successful alveolar bone graft later [30].

Orthodontic treatment outcome in CI II and CI III patients also has an unpredictable component to it. Especially CI III patients since prolonged mandible growth time can be difficult to predict. Auconi et al. showed that fuzzy clustering repartition can be successfully used to predict hyrax-facemask treatment outcome in an individual patient. Kim et al. used feature wrapping model to predict CI III malocclusion treatment effectiveness [31]. This information gives a broader perspective on future treatment needs, especially in patients where interceptive treatment outcomes are not optimal and future orthognathic surgery might be needed.

Random Forest was used to identify determinants for maxillary canine impaction with an accuracy in predicting canine eruption path of 88.3% [32]. Moghimi et al. used a hybrid-NN with genetic algorithms to predict the unerupted canine/premolar size which is important to assess the amount of space needed for the tooth in the dental arch [33]. Skeletal age maturation is a guide for orthodontist to determine optimal time for treatment start. The most common approach to determine skeletal age is through AI-based NN; they were found to be the best AI method of predicting growth and development through cervical vertebrae [34]. Lu et al. build a NN that analyses growth patterns through tensor analysis [35]. AI also found its applicability in Orthodontic biomechanics where a NN effectively mapped the force system of a T-retraction Spring [36].

All in all, although the applicability of AI in orthodontics is steadily increasing its practical use hasn't reached its full potential. The field of orthodontics focuses on treating malocclusions and influencing growth patterns thus precise diagnosis with the aid of AI allows is important to effectively assess and prioritize treatment needs.

In the future with the aid of AI in the medical field we might be able to gain more insight into the cellular basis of the disease which will aid in developing targeted preventive strategies and targeted therapeutics [37]. With access to big genomics data AI will help us simplify our understanding of the systematic disease complexity which in turn will alter the way we understand and affect biology. This will improve drug efficiency through early active agent prediction as well as aid in providing the possibility to anticipate adverse drug effects beforehand. AI based prediction models will give us an insight into the most probably disease progression and possible future problems associated with it, i.e. dentofacial deformities and need for combined orthodontic and surgical intervention in Juvenile Idiopathic Arthritis patients. This can aid in decision making such as commencing orthodontic treatment at an earlier age or altering the treatment strategy. Prediction models could also improve specialist-patient communication.

AI reduces human mistakes, and with time as the data collected increases, the algorithms will become more and more precise and we will have powerful engines that might lead to a new era of perfectionism in orthodontics. Future applicability might include aiding in not only treating frequently occurring cases according to present algorithms but using DL for optimising rare cases prediction models. Also, adjoining AI, DL, CAD/CAM technology and wire bending robotics is a future that might be quite near [38]. However, the aim of AI in the medical field should be to aid clinicians in tailoring individualized treatment plans rather than blindly following a single algorithm.

Nowadays, crucial knowledge is scattered and hidden in raw data, without the aid of AI we won't be capable to connect evidence hidden in complex, high dimension, nonlinear dynamic data in order to derive logical and useful patterns. Also, limited medical resources will continue to be a problem of the future. The solution lies in decreasing specialists' work load by providing them with reliable intelligent processing tools. Today, if we ask ourselves "Quo Vadis Orthodontic?" what could the answer be? The probable answer is Big Data Pooling as it's a prerequisite for Artificial Intelligence. Hopefully the future of orthodontics lies in individualized, patient centered diagnostics with individualized and optimized treatment modalities.

All in all, to answer Quo Vadis is to make a prediction.

As Ophelia stated in Shakespeare's play Hamlet, "we know what we are, but we know not what we may become."

3 Conclusion and Future Research

Orthodontics is currently at the inception of leveraging Artificial Intelligence. Although the applicability of AI in orthodontics is steadily increasing it is still far behind the medical field. Future researchers should concentrate on acquiring high quality data and advances in deep learning with the aim of achieving a positive symbiosis between clinical work and AI.

All in all, to answer Quo Vadis is to make a prediction and it depends on us not to lose our intrinsic specialty skills and clinical sense of reasoning but rather viewing AI as a tool that will enhance our specialty and lead to its next paradigm shift; precision orthodontics.

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Circular Economy Practices in Higher Education Institutions: Towards Sustainable Development

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Abstract. There is a growing global interest in shifting from linear to Circular Economy (CE), which is closely linked to the implementation of sustainable development. Higher Education Institutions (HEIs) can play a major role in the dissemination of CE practices, skills and knowledge. This study provides a review of current practices of CE in HEIs. For this purpose, a number of recent articles have been reviewed and analyzed. This study provides a framework for CE application in HEIs. A case study shows how a university has applied CE practices and how its UI GreenMetric® evaluation can be used to assess the level of universities' engagement in the CE. The results showed that CE practices in HEIs could be categorized into six groups. Furthermore, the case study reflects an example of CE practices in HEIs and a high correlation of UI GreenMetric® with the degree of CE application.

Keywords: Circular Economy · Higher Education Institutions · Sustainable Development

1 Introduction

The concept of CE has first appeared in 1990 by Pearce and Turner [1], but has become more common and gained more attention by scholars and practitioners in the recent years [2]. CE is mainly related to reducing, reusing, recycling and recovering activities, but it is also should be linked to sustainable development [3]. HEIs play a major role in driving the systematic change to CE, especially that the governments and industries alone cannot drive the progress. HEIs can contribute greatly into promoting the application of CE by increasing students' awareness of CE importance to bring its approaches to the reality. Furthermore, HEIs could have contribution by applying CE into their campuses.

The United Nations established 17 Sustainable Development Goals (SDGs) in 2015, which world leaders adopted with the goal of achieving them by 2030. Despite the fact that, each one focuses on a different aspect and, as a result, each objective serves a different purpose, a common idea underpins all of them: the implementation of the CE as a sustainable alternative to the current model of production and resource management,

the effects of which have a negative impact on the economic, social, and environmental dimensions [4].

CE is an innovative approach that has gained significant traction in recent years as a means of promoting sustainability and efficient resource use. It is a model that seeks to move away from the traditional linear approach of take-make-dispose towards a more restorative and regenerative one, where resources are kept in use for as long as possible [3]. It is an economic model that aims to maintain the value of products, materials, and resources in the economy for as long as possible by keeping them in use, regenerating natural systems, and minimizing waste generation. This concept emphasizes the importance of the ‘three R’s’: Reduce, Reuse, and Recycle, and aims to decouple economic growth from resource consumption.

The Ellen MacArthur Foundation, a leading organization promoting CE, defines it as “an economy that is restorative and regenerative by design, and which aims to keep products, components, and materials at their highest utility and value at all times, distinguishing between technical and biological cycles” [5]. This definition emphasizes the importance of keeping resources and materials in use, as opposed to the linear “take-make-dispose” model of traditional economies.

In the context of higher education institutions, there is a growing interest in adopting circular economy principles as a mean of promoting sustainability and environmental stewardship. Universities and colleges have a critical role to play in shaping the next generation of leaders and professionals who will be responsible for driving the transition to CE [6].

According to a report by the Ellen MacArthur Foundation, “Circular Economy in Universities: A Guide to Moving from Theory to Implementation,” universities can play a significant role in driving the circular economy by integrating circular economy principles into their operations, research, and teaching. The report highlights examples of universities around the world that have already begun to adopt circular economy principles, such as the University of Bradford in the UK, which has developed a circular economy strategy that includes reducing waste, promoting reuse and recycling, and integrating circular economy principles into its curriculum [5].

Overall, CE represents a promising approach to promoting sustainability and resource efficiency, and higher education institutions have an important role to play in advancing this agenda. By adopting CE principles in their operations, research, and teaching, universities can help to create a more sustainable and resilient future for all.

Sustainable development and CE are related concepts that share similar goals. While CE is concentrating on maximizing the use of resources and minimizing waste, sustainable development provides a broader concept that consider a balance of economic, social, and environmental factors to meet the need of the present without compromising the opportunities of future generations to meet their needs [7].

More examples of previous literature that investigated factors affecting CE implementation in different types of organizations that may apply to HEIs are summarized in Table 1.

Table 1. Factors affecting CE implementation.

Reference	Organizations	Factors
[8]	Different types	<ol style="list-style-type: none"> 1. Intention-action gap: lack of awareness or not translating awareness into action 2. Risk attitudes: risk averse to making changes 3. Policy actions: law, regulation, procedure, administrative action, incentive, or voluntary practice of governments and other institutions 4. Technology, Knowledge and Infrastructure
[9]	Different types	<ol style="list-style-type: none"> 1. Government Perceptive: Why the government wants industries to implement CE 2. Organizational and suppliers perspective 3. Society perspective 4. Consumer perspective
[10]	In Vietnam	<ol style="list-style-type: none"> 1. Attitude towards the decision to buy CE products 2. Subjective norm: buying the product if others buy it or influenced by others opinions 3. Cognitive-behavioral control: financial ability, knowledge, barriers overcome 4. Benefit of individual economics 5. Attitude toward the environment 6. Integrated readiness to participate

2 Methodology

Several studies have conducted review of articles on CE. However, there is still a lack of studies that review CE applications in HEIs. The aim of this study is to identify CE practices in HEIs. In order to fulfill this aim, CE practices in HEIs have been reviewed and analysed from related articles published in the last 10 years (2013–2023). A systematic review were conducted to capture studies related to CE practices in HEIs by using Google Scholar database. The results of this study will provide a framework for applying CE in HEIs to support the sustainable development in these institutions.

A case study has been conducted to provide an example of the implementation of CE in HEIs and to show how UI GreenMetric® evaluation can be related to the degree of CE application. UI GreenMetric® is a common ranking method to evaluate the practices related to environmental sustainability and green campus in HEIs.

The procedure of this study is illustrated in Fig. 1.

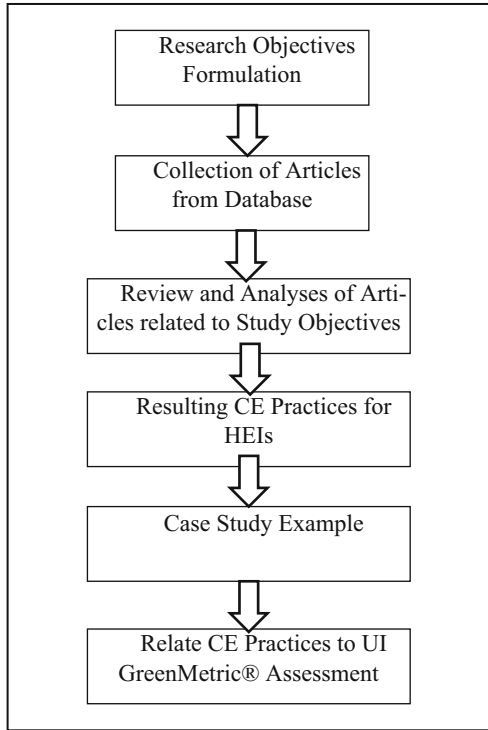


Fig. 1. Illustration of the study procedure.

3 Review of Literature for CE in HEIs

A study by Maruyama et al. [11] presented sustainability experiences in two Latin America HEIs and investigated ways for promoting CE in university campuses. It showed that students' projects could be conducted in HEIs to contribute to CE. The results showed an encouraging connection between Life Cycle Assessment and HEIs in a CE approach.

A methodological framework was developed by Mendoza et al. [12, 13] for the application of CE in HEIs. The framework aimed at enhancing the resource efficiency and environmental sustainability on HEIs' campus operation. The framework involves three main steps: background analysis to evaluate the integration of CE thinking within the corporate sustainability policies; foreground analysis to engage sustainable-related stakeholders and decision-makers by different ways, including interviews, focus groups, workshops and surveys to investigate the criteria, methods, tools and indicators used by stakeholders in supporting sustainability management processes; and finally, CE implementation strategy to identify barriers and opportunities and develop guideline or checklist for CE strategy implementation.

A study by Nunes et al. [14] has examined the interactions between university estate management and the CE to identify six themes related to CE, which are: campus sustainability, the hidden curriculum, environmental governance, local impact, university material flows, and the role of universities as catalysts for business.

Serrano-Bedia and Perez-Perez [15] investigated the contribution of HEIs worldwide to the development, dissemination, and assessment of the CE. Seventy-seven articles were analyzed and grouped into a framework of five categories, following the five roles played by HEIs as proposed by EMF, Ellen MacArthur Foundation [5, 16, 17]. The results showed high opportunities for HEIs to promote CE application in collaboration with industrial practitioners, consumers, and governments.

The Circular Collective [18] presented ten practices that may promote CE in HEIs. The first is by Building a business case on campus focusing on food, energy, water, and recycling of waste. Second is by Promoting remanufactured furniture in the university campus and students' accommodations, and by providing buy-back offers. Third is by applying deposit return system for mugs and food containers. Forth is by providing circular pay-per-use appliances such as washing machines, fridges, and vacuum cleaners. Fifth is by offering lighting as a service rather than ownership. Sixth is by financing circular innovative projects of students and researchers. Seventh is by developing an innovation hub to bring together researchers and practitioners to exchange ideas and expertise. Eighth is by providing teaching and research, which are supported by the necessary knowledge and technologies to promote CE implementation and dissemination. Ninth is by expanding linkage to industry to provide supporting and hosting to businesses. Tenth is by promoting the university-wide thinking through seminars and conferences.

Overall, these literatures suggest that HEIs have the potential to play a significant role in promoting circular economy practices and advancing sustainability. However, there are also challenges to implementing circular economy in HEIs, including financial constraints, regulatory barriers, and cultural factors. Further research is needed to address these challenges and to develop effective strategies for integrating CE principles into higher education curricula and operations.

4 Case Study

A case study approach was adopted in this study to provide example of the implementation of CE practices in HEIs. The quantitative data was collected from the databases of the finance department, while the qualitative data was collected from the archived files and reports mainly from the faculty of scientific research and innovations, and the department of quality assurance. Al-Zaytoonah University of Jordan (ZUJ) was selected to carry out the case study. Regionally, ZUJ is known of its great efforts for sustainable development, and in the good achievement of the UI Green Metrics (181 globally in 2022), which is a university rank related to CE and sustainable development in HEIs.

To ensure maintaining and enhancing its local and global rank and reputation, ZUJ has implemented a continuous improvement policy by applying CE practices in the campus environment, infrastructure, renewable energy, solid and liquid waste management, water and wastewater treatment, water and energy consumption optimization, transportation, and the education and learning processes. The following subsections provide examples of CE practices adopted by ZUJ categorized into six groups.

4.1 Setting and Infrastructure

During the last few years, the university has invested to improve the level of infrastructure to provide better and efficient service for its users. The university has worked on the installation of sustainable materials in its buildings that may help saving energy and reducing the cost and efforts of maintenance. Example of a material that can be easily reused after careful removal from the facades of the buildings is the high quality stones used in all the university buildings. In addition, the university promotes using remanufactured furniture in its offices and classrooms with the help and support of the engineering workshops.

4.2 Renewable Energy

In April 2016, ZUJ has launched a photovoltaic solar system with capacity around 1800 kWh to make the university almost an electricity self-sufficient. The payback period of the system was about 2 years and 2 months. The solar panels are in the form of roof top farms installed on the roofs of almost all the buildings in the university as shown in Fig. 2.



Fig. 2. Satellite google map showing solar panels on top of some buildings in ZUJ

In conjunction with the implementation of the photovoltaic solar system, ZUJ has started to install energy-saving appliances for air conditioning and LED lighting. Figure 3 shows the electricity consumption and production before and after the installation of the photovoltaic solar system and the energy saving appliances. As can be noticed, the energy production during the summer season is higher than the energy consumption, and so the energy is saved to the grid and almost consumed during the winter season where the consumption of energy is higher than the production. Furthermore, it can be noticed that the consumption of energy has decreased since the installation of the energy-saving appliances.

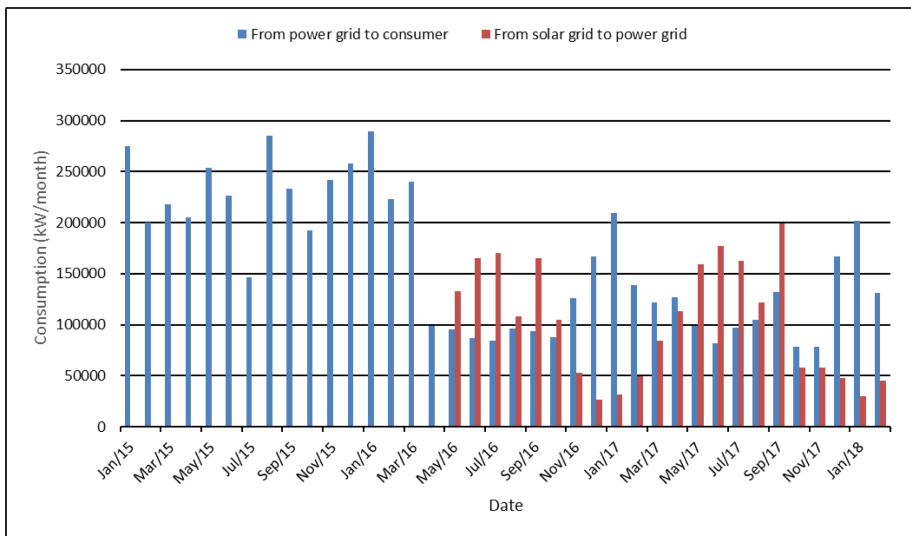


Fig. 3. Electricity Consumption and Production before and after launching the photovoltaic solar system

4.3 Water Resources

The water used in ZUJ comes from two sources: artesian well used after treatment as tap water, and treated wastewater used for irrigating part of the green areas in the university. The university employs its own artesian well, artesian water treatment plant, and wastewater treatment plant. The water is tested on a daily bases to ensure that the water produced is according to the universal drinking and irrigation water standards. Efficient water appliances such as economic water tabs, toilet flushes, and drip irrigation networks were used in the university, in addition to using low water consumption plants and trees throughout the campus. A high percentage of the university trees are productive trees with low water consumption such as olive trees and palm trees. Despite all the water efficient systems and procedures that have been applied, water consumption continues to increase (as shown in Fig. 4) due to the growth of the university in terms of buildings, green areas, and the number of students and employees.

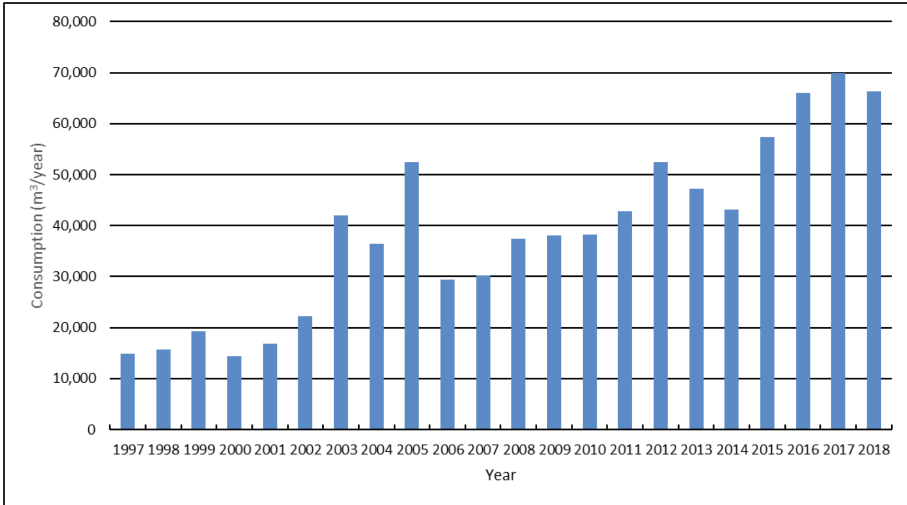


Fig. 4. Annual water consumption in the university campus

4.4 Solid Waste Management

The university is keen to apply waste sorting and recycling programs for aluminum cans, glass bottles, plastics, paper, and residues from tree trimming. Furthermore, electronic document management systems were installed to reduce paper use.

4.5 Transportation

To encourage group transportation, the university runs about 120 shuttle buses (in 2022) to serve students in their travel between the university and their accommodations. Furthermore, the university applied free electric vehicle charging stations to encourage the use of Zero Emission Vehicles (ZEV) by its employees. Figure 5 shows examples of the shuttle buses and electric vehicle charging stations used in the university.



Fig. 5. Examples of the shuttles buses and electric vehicle charging stations used in ZUJ

4.6 Education and Research

Practices of CE and sustainability is very well encouraged in the research projects and courses offered by the university departments. Based on historic records, the university spends about 5% of its operating budget on research activities, and about 12% of these can be considered as dedicated to subjects highly related to sustainable development.

UI GreenMetric®

UI GreenMetric® is a ranking is an external assessment used by the university to evaluate and encourage its efforts toward the CE and sustainable development achievements. This metric depends on six assessment categories including setting and infrastructure, energy and climate change, waste, water, transportation, and education. These categories are consistent with the efforts implemented by the university to promote CE and sustainable development.

5 Conclusion

This research has provided a framework and guidance to help university in their efforts to implement and promote CE inside and outside HEIs. The paper shows examples of practices for CE application in the university campus. Furthermore, it shows how HEIs can play major role in increasing the awareness and the dissemination of CE implementation. The implementation of CE in HEIs still needs more efforts in research and application. Future research can go through more cases and examples of CE application in HEIs and other types of organizations. Future work is needed to provide assessment measures for the effectiveness of CE strategies and efforts.

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The Mediating Role of Green Disclosures on the Relationship Between Sustainability and Financial Performance in an Emerging Market

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Abstract. This study aims to determine whether executive compensation intends to spur managers to pursue Financial Performance (FP) issues as assessed by sustainability Performance (SP) disclosures, in connection to Jordanian banks from 2018 to 2020, influenced by ROA and Tobin-Q, as FP indicators. Based on stakeholder theory, this study also provides discussion of the mediating function of green accounting indicators (GI). Results showed only a relationship in terms of SP on ROA, according to the regression association between SP and FP. The GI findings indicate that there is no correlation between SP and Tobin-Q as a performance measure, but that there is a mediating role for green accounting indicators within the relationship between SP and FP directed by ROA. This suggests that Jordanian banks may be more inclined to pursue sustainability disclosure indicators in the future and emerging-market exporters' adoption of more green techniques as an incentive; ultimately, that influences a firm's financial performance.

Keywords: Sustainability · Financial Performance · Green Accounting

1 Introduction

Non-financial data is now included in the scope of modern reporting together with traditional financial data. Although interest in innovation processes for sustainable development has grown over the past two decades, empirical research methodologies are still in their infancy [1, 2] claim that financial performance (FP) is a significant indicator of an organization's financial health.

[3] added that information disclosure guidelines have an impact on it is implemented. According to some academics, social and environmental goals might cause managers to deviate from their intended goal of generating shareholder value [4]. According to the

stakeholders' theory happiness is not only shareholders satisfaction, as it may negatively impact owners' and managers' capacity to maximize profits and increase its value [5, 6].

This study conducts the perspective disclosures in GI, focuses on the impact of corporate innovation spending on environmental Sustainability in order to create a new perspective on the factors influencing corporate sustainable development goal capabilities [7]. The majority of the research focus on how an organization's ability for sustainable growth influenced environmentally friendly supply chain administration [8], philanthropic contributions [9], and financial volatility [10]. Investigating, analyzing, and elucidating the relationship between FP and SP indicators in the Jordanian banking industry is the driving force for this work. Rules and directives with diverse objectives and explicit or inferred boundary structures may have an impact on a range of annual report sections [11, 12]. Because of this, the aforementioned measures will cover many aspects of financial sustainability using data from the statement of financial position, income statement, and stock market. Data forms the basis for choosing the ROA, Tobin Q, and SP indicators for the endogenous and exogenous variables FP and SP, respectively. This ambiguity emerges because of the nature of existing non-financial reporting standards, which mark an earlier innovation in increasing openness and documenting the impact of a company's operations on concerns regarding sustainability [13].

The subsequent sections contribute up this study as following: literature review; methodology; results; discussions and conclusions. The conceptual framework and comparison of present regulations and suggestions add to the scant body of literature that considers both financial and non-financial limits simultaneously, which is crucial for annual reports. This paper is willing to provide stakeholders with a novel perspective on the factors affecting corporate sustainable performance and its power to affect the FP of Jordanian banks, as the study findings of this paper anticipated to be significant both in theory and in practice.

2 Literature Review and Hypothesis Development

The study's analysis of Jordan's banks sector focuses on the SP, FP, and GIs domains. The goal of this research is to clarify the relationship between the variables while endeavoring to connect them utilizing evidence from prior studies.

2.1 Sustainability Disclosures

To publish structurally consistent SP reports using a pick-and-choose approach and the same reporting methodology would almost surely result in the company failing [14]. It is important to note that since beginning operations in the late 1980s, it has rapidly gained notoriety as one of the key economic hubs with a substantial commercial area [15]. The Integrated Reporting Council made the decision to act as a framework for the alignment of SP reporting standards in order to harmonize requirements for financial disclosure connected to climate change [16]. In addition, a SP report quantifies and articulates a company's activities while being accountable to stakeholders, both internal and external, achieving the objective of sustainable evolution [17]. In contrast to traditional

financial reporting, which primarily gives information on financial performance, sustainability reporting offers a platform for the distribution of information on economic, social, and environmental performance to diverse stakeholders, which goes along with the stakeholders theory [18].

The results of [19] showed that manager' perceptions of the importance of SP reporting, regional contextual challenges, and international norms all have an impact on how much and what kind of SP data organizations report. Public reports on a company's compliance with its corporate regulations, as well as its environmental and social performance, are accessible. Although "S" and "sustainable" are interchangeably, they both refer to separate ideas and people [20]. Requirements for corporate SP reporting provide stakeholders with a means of comparing organizations and motivate them to take steps to advance social and environmental well-being [16]. In a developing country, manufacturing competitiveness is highly impacted by social responsibility and green innovation. When a company behaves responsibly, it has a long-term interest in enhancing the social and economic value it provides in order to satisfy its stakeholders in alignment with the stakeholder's theory [21].

The disclosure of the SP report also includes information on the company's socially responsible and environmentally friendly business practices, as well as information about how society and its products have responded [22]. This reporting defined by the [15] as the process of measuring, disclosing, and holding organizations accountable for their efforts to promote sustainable development. SP concepts must be included into core business operations and corporate SP plans in order to contribute to a global sustainable development [23]. It is a comprehensive overview that the business gives internal and external stakeholders a sense of its position and its environmental, social, and economic actions [24].

Since this increases the impact of SP and helps social and environmental impacts to increase productivity in work and management of natural resources, which remains important to shareholders, employees, and stakeholders, reporting should also be a tool that helps organizations recognize strengths and weaknesses and identify the interconnections that exist in them, not a tool for public relations. As a result, business SP aims to minimize risks and eliminate external influences that contribute to irresponsible behavior toward society [25, 26]. Investors persuaded that a company is less hazardous than others are by SP reports [27].

2.2 Financial Performance Disclosures (FP)

Company resources starts from the control system that begins with planning for increased performance and ends with reporting on the performance to a variety of internal and external stakeholders to serve as the foundation for the plans for the following year [28]. The expansion of commerce and technology pushes businesses to compete, enabling them to make innovations and have sustainability [29, 30]. Financial and non-financial information from annual reports improves strategic management and enhances strategy review [31, 32]. To support the internal advantages of reporting for performance improvement, [33] appended it importance in compliance with the stakeholder's theory, the consistency between sustainability reporting and effectiveness.

Even though it is only statistically significant at low intensities, the FP and GI disclosure index components, show a continuous broadband connection [34]. Managers can identify items that increase their social and environmental costs by accounting for the implementation of innovation, which helps them, assess the performance of their companies and their financial results [35, 36].

As a result, ROA and Tobin-Q are effective FP indicators. By increasing deposits, innovation can also benefit banks' FP [37]. Furthermore, despite the probability that numerous theoretical stances and methodologies will be required to handle the complex task of defining and implementing SP because of ambiguity, this cross-disciplinary research effort still seems to be in its adolescence [38]. In light of the literature review, the study came with the following hypotheses:

H1: *There is a significant relationship between SP and FP of Jordanian Financial Institutions, measured by ROA.*

H2: *There is a significant relationship between SP and FP of Jordanian Financial Institutions, measured by Tobin-Q.*

2.3 Green Disclosure Indicators

Environmental integrity issues are receiving more attention from corporations because of increasing external demand from a variety of stakeholders. Following this pattern, the present increase in environmental costs has forced businesses to consider environmental considerations [39]. Financial entities nevertheless incur indirect expenses from environmental degradation even if there are no direct consequences. Until then, these financial sectors will continue to experience reputational, legal, and credit concerns. The developing economies have not yet embraced the idea.

Climate change is frequently at the forefront of corporate social responsibility (CSR) strategies in the building industry, which has environmental repercussions [40]. Environmental issues, particularly those involving water, have emerged as a significant roadblock to social change in the direction of S. The importance of water resources, especially for larger businesses, has increased in the last ten years, in part because social and climatic change are increasingly strategic considerations [41]. Although it is intended to inform investors about how society and the environment affect the reporting organization, the IFRS Foundation's responsibility to enter the sustainability reporting standard-setting space is an effort to reinforce its position as the go-to standard-setter for all reporting standards [42].

Creating GIs does not guarantee, at least in the near term, a good economic balance between the costs incurred and the advantages gained by the organization; gradually, intangible rewards may become available. Businesses that support GIs and respect the principles of sustainable development are increasingly attracting the interest of banks and investors [43]. This tendency is a legitimate chance for financial enterprise to build a positive reputation as an ethical organization in the broadest sense [44].

GI is essential when creating a sustainable framework, according to this study, which addressed the current research gap. The relationship between GI and SP principles highlighted in this conclusion, indicates that GI advancement must be encouraged in order to support SP goals, which call for regulatory oversight and expertise.

H3: There is a mediating effect of GI on the relationship between SP and FP, measured by ROA.

H4: There is a mediating effect of GI on the relationship between SP and FP, measured by Tobin-Q.

3 Research Methodology

According to [45, 46], ROA calculated by dividing net income after taxes by the average total assets. The Tobin-Q ratio calculated as the market value of equity divided by the total book value of liabilities. The market value of equity is determined, similarly to [47], by dividing the total number of outstanding shares by the closing price at the end of the year.

Due to limited disclosure in the financial industry, this study uses secondary data gathered through public annual reports on the ASE website starting in 2018 and ending in 2020 the final year of data gathering, of 15 Jordanian banks. Despite the modest size of our sample, it is comparable to earlier research as [48, 49] when taking into consideration the particularity of Jordanian companies, and its investment prosperity, as a country in the Middle East, by using SmartPLS 4.

The exogenous and endogenous variables measure information through three dimensions (ROA and Tobin-Q as performance indicators; and SP with seven indicators, by their total averages; as indicated in analysis results). Finally, GI are measured (mediating variable) through twelve items eligible for banks, whereas a mediator explains how two variables are associated. Indicators gathered mainly from [48], as green accounting is still not a widely used indicator in ASE; meanwhile, the SP indicators are as indicated from the Guidance on SP Reporting in Jordan [50].

The study applied regression and mediating analyses to test the relationships and effects between the variables. Regression equations are as follows:

$$PERFORMANCE = \beta_0 + \beta_i SP_{i,t} + \sum YEAR_{i,t} + \varepsilon_{i,t} \quad (1)$$

if significant, the following equations will be directed to find the level of mediation,

$$GI = \beta_0 + \beta_i SP_{i,t} + \sum YEAR_{i,t} + \varepsilon_{i,t} \quad (2)$$

$$PERFORMANCE = \beta_0 + \beta_i SP_{i,t} + \beta_j GI_{i,t} + \sum YEAR_{i,t} + \varepsilon_{i,t} \quad (3)$$

4 Results

Results indicate that once the model regression analysis demonstrates that the correlations are substantial, additional mediation tests is possible. This study imply that the endogenous variables have an impact on ROA with a 0.389 path coefficient and 0.005 significance, representing 0.151 R-square. Meanwhile, it is difficult to conduct any additional GI mediating tests for Tobin-Q because it did not yield any significant results (stating 0.145 as a path coefficient, with a 0.304 significance level and 0.021 R-square);

as identified in Fig. 1. At the same time the study tested the interim variables related to SOS and their effect on the exogenous variables, and results also indicated that they effect ROA, in a positive significant way (0.038), noticing an increase in the level of the path coefficient (0.616), and an increase in R-square (0.38), as in Fig. 2. Which results in accepting the first hypothesis (in relation to ROA) and rejecting the second (in relation to Tobin-Q).

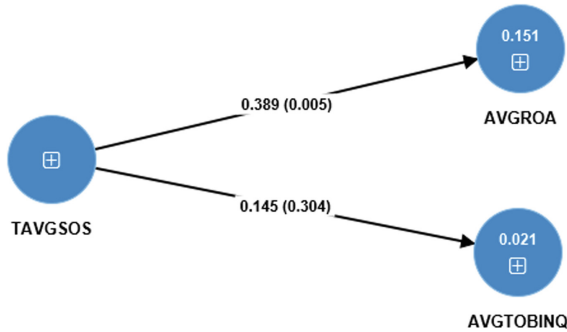


Fig. 1. (Simple regression results)

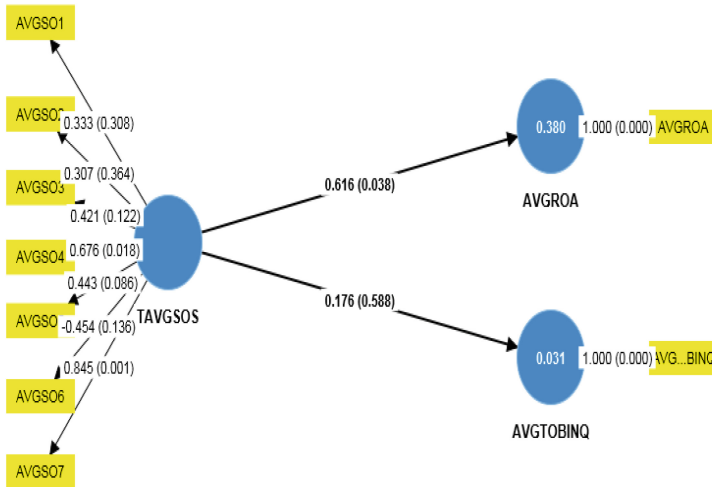


Fig. 2. (SOS interim variables regression results)

Constructed on bootstrapping confidence interval of 5000 suggested that the variables had a mediating impact, as in Fig. 3. According to the findings of the mediators, as both the direct relationship between the SOS variables and ROA, and the indirect effect also should a significant relationship (total effect) between the SPI and ROA as an FP indicator. Tables 1 states the total effect of the relationship between SPI and ROA with an R Square of (37%) of the variation explained by the model, with a (0.002 sig level).

Moreover, the indirect effect of the regression states a significant effect also between SOS and GI (path coefficient of 0.612, and 0.001 sig) and the also a significant relationship between GI and ROA (path coefficient of 0.406, and 0.036 sig). The results state the acceptance of the hypothesis, which is stated, “There is a mediating effect of GI on the relationship between SP and FP, measured by ROA,” as for both significant models (total effect and direct effect), the exogenous variable is significant. Which result in accepting the third hypothesis and rejecting the fourth.

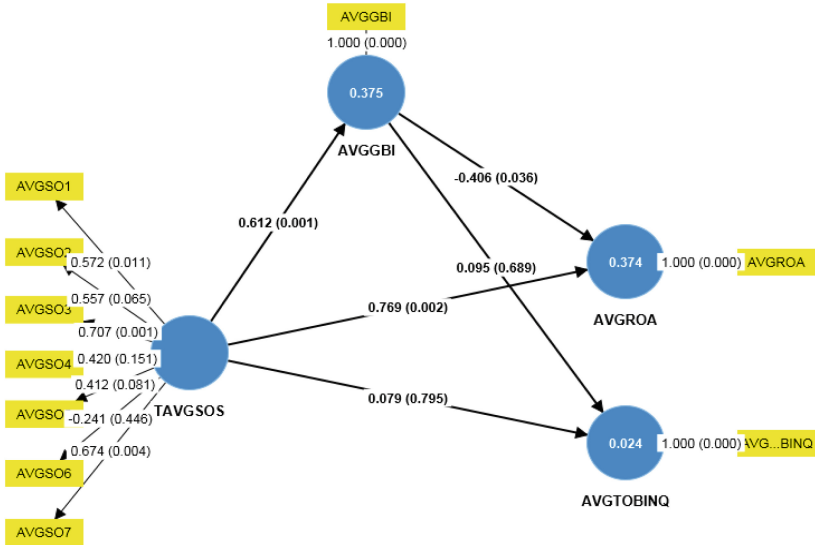


Fig. 3. (GI mediating analysis)

Table 1. Path Analysis Results

	Mean	(STDEV)	t- statistics	p- value
AVGGBI>AVGTROA	-0.368	0.193	2.102	0.0366
AVGGBI>AVGTBINQ	0.050	0.237	0.400	0.689
TAVGSOS>AVGGBI	0.599	0.193	3.179	0.001
TAVGSOS>AVGTROA	0.729	0.243	3.164	0.002
TAVGSOS>AVGTBINQ	0.140	0.305	0.260	0.795

5 Discussion and Conclusion

Governments, corporations, and people all have a part to play in halting global warming and building an environmental friendly society. Individuals must engage with financial institutions, particularly banks, which is essential in the current environment as it contributes to the development of robust and successful low-carbon economy investments.

They may need to use non-financial data more frequently when approving credit and choosing investments [29, 31]. Such projects will assist them in both proactive performance improvement and sustainable corporate growth. The return on invested capital, ROE, ROA, and other performance measurements and disclosures determine the effective association between sustainability and the financial performance of any company [51]. Which this investigation demonstrated, and came out with a positive relationship in states of ROA. However, according to [52] one of the topics that still requires a great deal of research attention is the connection between sustainability and business performance. Consequently, if a company publishes a high-quality SP initiative report, this enhances the firm's worth and the number of investors, it is possible to have a positive correlation between evaluating SP and the firm's value [17, 20, 53]. In view of [54] study, the study's findings indicated that GI had an effect on the relationship between SP and ROA performance measurement in Turkey, which corroborated the findings of our study for Jordanian financial institutions. Conclusions show that the indicators chosen for assessing success in attaining industrial SP goals in regards to increasing earnings, reducing expenditures, raising competitiveness in the marketplace, and enhancing the efficacy of resource usage, thereby improving stakeholder welfare; however, none were verified by GI in Jordan, based on this study variables.

The primary presumptions were first developed and backed by an updated and validated measurement model, then followed by a structural equation model. This gave actual proof of the significant impact accountability and governance [3] have on manufacturing competitiveness in developing nations. Corporate sustainability reports discovered a positive effect on ROA by considering how they influence the financial performance of small and medium-sized enterprises [55]. Businesses may maximize their resource use and set themselves up for success by using sustainability reporting. [56] demonstrated how corporate governance elements have an impact on social duty and environmentally friendly programs like philanthropy, reducing emissions, and waste disposal initiatives as stated by sustainability stewardship.

Stakeholders having non-contractual links to firms, according to [54], have an impact on GIs, which is a substantial incentive to eco-innovate. Contrary to projections, government agencies have a negative impact and hinder firms' efforts to implement GI [44]. Nonetheless, the results show that the GI level of development can sustain the economy's high-quality growth [57, 58]. Inclusive, directors' diversity can also improve the coherence of words and deeds in the presentation of non-financial information. They can also persuade companies to provide more information about sustainable development and GI within a specific spectrum. Future research should focus further on the characteristics of managers and stakeholders, the release of green data, and SP. To provide a comprehensive and objective set of developed GI evaluation criteria, more research is necessary.

6 Limitations and Recommendations

The results show contradictory conclusions, which calls for more in-depth investigation. Selected indicators and the little time span under analysis are the study's limitations. Inclusive, directors' diversity can also improve the coherence of words and deeds in

the presentation of non-financial information. They can also persuade companies to provide more information about sustainable development and GI within a specific spectrum. Future research may focus further on the characteristics of managers and Board of Directors, the release of green data, and SP. To provide a comprehensive and objective set of developed GI evaluation criteria, more research is necessary. Future research on Islamic banks and environmental sustainability, or even Islamic green financial instruments in particular, needs to take into account the practical consequences in order to find new managerial tools that can more effectively influence the interaction between SP disclosures and FP.

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Big Data Analytics and Sustainability Accounting and Reporting: Evidence from Canada

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Abstract. The purpose of this study is to examine how Big Data and Big Data Analytics (BDA) affect sustainability accounting and reporting. It provides qualitative evidence from financial managers perspective working in Canadian public firms listed on the Toronto Stock Exchange in the year 2023. This research evidence suggests BDA impact the proficiency and expertise of financial administrators when conducting engagement practices in public firms. Furthermore, the use of Big Data enables a more streamlined and precise reportage, increases profitability, enhances risk management techniques, and discovers potential for reducing costs. Finally, as with any technology, the comprehensive utilization of big data will incur certain adverse outcomes, some of which can be predicted, and a few, conversely remain completely unpredictable.

Keywords: Big Data · Big Data Analytics · Sustainability · Canada

1 Introduction

The compilation and utilization of Big Data (BD) have recently garnered significant attention from both academics and decision makers [1, 2]. BD has been widely recognized as an essential tool that can translate strategies into better firm performance through sustainability. Many firms have invested considerable resources in big data analysis to identify ways to improve their performance viably [3, 4]. Meanwhile, viability, auditing and publication have emerged as significant challenges for many firms that they confront daily [5, 6].

The pursuit of green firms and the environmental sustainability of businesses have become top priorities in the 21st century [7]. Although, the accuracy and quality of sustainability accounting and reporting have been widely condemned for sub-standard constructed and inadequate measurement frameworks [8], inconsistent data collection techniques and sources [9], following manual or semi-automatic processes affected

by delays and human errors and the manipulation of results and analysis to hide the weaknesses in the corporate performance [7, 10].

Therefore, financial managers will need to go beyond conventional tools to expand their decision-making tools in the era of BD and BDA [7]. Additionally, to unlock new opportunities and areas for development, financial managers can integrate massive data sets into their monitoring processes via BDA [11]. Given that BDA enable the application of sophisticated methodical techniques to derive crucial perceptions from vast quantities of data, many firms adopt BDA to enhance their performance and ensure survival [9]. Through its capacity to facilitate advanced data analytics, BDA can help firms obtain high operational efficiency and sustainable accounting and reporting.

Previous research has produced a substantial body of knowledge concerning sustainable practices. Nevertheless, limited comprehension exists regarding the incorporation of sustainability into accounting and financial activities within firms [12]. Even less is known about the integration of sustainability into accounting and decision-making. Therefore, our study investigates the intersection of sustainability accounting and reporting with Big Data. Specifically, we focused on the qualitative aspects of meaningful financial information and how they interface with Big Data. This research adds to the limited existing literature on the subject and builds upon prior research examining how BD and BDA can influence the perceptions of sustainable accounting and reporting from practitioners' perspective. Notably, our study is the first research on this topic in Canada, presenting valuable proof of the influence of BD on sustainability accounting and reporting, and contributing to the persistent discourse on the topic within the Canadian context. We underscore the importance of understanding and utilizing Big Data in consideration of these issues, emphasizing the need for accurate data collection based on the business extent and knowledge to enhance comprehension. Based on interview data, we share insights into how sustainable accounting and reporting in an inexperienced financial reporting context uses analytical tools to improve quality using information.

Finally, sustainable accounting and data analytics are of significant interest to various stakeholders, including finance executives, customers, overseers, and financial report recipients. The contemporary era is characterized by swift digital transformation and progress and as such, the use of data analytics is swiftly gaining momentum [2].

2 Literature Review and Research Questions

2.1 Sustainability Accounting and Reporting

In contemporary business, corporate social sustainability has taken on immense significance as a result of the possible impacts of firm decisions and actions on environments and communities [13, 14]. It is worth noting that such practices can also influence firm's profitability in the future [15].

Historically, firms have typically created their yearly sustainability reports as a hard/soft copy with a year-over-year comparison of sustainability data. This approach results in sustainability data being isolated from other reports, making it difficult to consolidate and provide valuable insights to stakeholders with decision-making power [13]. In addition, the sustainability accounting and reporting methods have been regularly

challenged for not being well integrated into routine operations, not providing reliable data, questionable, and not advancing sustainability efforts [16].

Sustainability accounting and reporting are often viewed as two separate practices, although both are important for firms to support sustainable growth. Sustainability accounting involves the use of innovative information management and accounting techniques to create relevant and premium-quality data that can help businesses achieve their sustainability goals [17]. Meanwhile, Sustainability accounting and reporting is a procedure that involves assessing and disseminating a firm's sustainable development goals to both internal and external stakeholders [18]. By using sustainability accounting and reporting, companies can demonstrate their journey to achieving sustainability goals and be accountable to their stakeholders.

As a result, the notion of transparency has emerged as a fresh framework for running a business, and the significance of sustainability reporting has attained prominence and attention from various interested parties [18]. Even firms that have primarily concerned with financial reporting have now come to realize that monitoring and assessing non-financial data and information can enhance their decision-making process. This enables them to recognize possibilities and risks that can significantly impact their ability to create and maintain enduring value [19].

With the vast information volume available in the era of Big Data, traditional sustainability accounting and reporting practices are becoming less relevant. The availability of instantaneous evaluation of organisational sustainability allows for prompt response to sustainability risks, prediction of future risks, improving decision-making and thus, the efficiency of sustainability accounting and reporting. Therefore, firms can publish sustainability reports more frequently, offering stakeholders precise, clear, instantaneous details, about their sustainability progress.

2.2 Big Data and Sustainability Accounting and Reporting

In the past, the primary organizational data, which formed the foundation of accounting and reporting, was the Enterprise Resource Planning system. Although, the emergence of emerging technologies such as cloud computing, IoT, and AI, as well as the Industry 4.0 revolution, has led to the availability of a wider range of data from various sources such as social media, smartphones, and websites. This has resulted in a significant increase in both the quality and quantity of data that can be utilized in reporting, financial accounting and decision analytics [19, 20]. Enterprise data is known as Advanced Big Data Analytics and comprises mixed data, as well as statistical and narrative data, which are available in diverse formats such as sensor recordings, videography, graphics, and audio messages [21, 22].

According to recent research, there is a growing consensus among scholars that BDA have the potential to offer superior quality data [1, 23], enhance corporate accounting [24], improve audit performance [2, 25], and increase the precision of monetary, non-monetary and corporate sustainability disclosure [9].

According to Wanner and Janiesch [9], Big Data cannot be analysed with conventional methods or databases, owing to its massive size. Green et al. [26] argue that Big Data is fundamentally changing our understanding of "data." For instance, organizations

may provide facts in an immediate context. As a result, accountants need to become proficient in Big Data analysis to carry out their responsibilities more efficiently. Richins et al. [25] maintain that continually computerizing accounting is challenging due to factors such as Information disclosure, communication breakdowns, and Information analysis. Bhimani and Willcocks [27] argue that accounting is prepared for digitization, but express concerns about the difficulty of translating accountants' perception of data into practice and the potential insights that data could provide if subjected to sufficient scrutiny. Quattrone [28], conversely, asserts that accounting needs to adapt to evolving technologies to solve challenging. For optimal utilization of Big Data, accountants need to monitor and document data, disclose to interested parties, and manage people and assets to secure assets, establish procedures, and provide precise information.

Utilizing Big Data analysis methodologies provides the ability to gather and analyse large amounts of monetary and non-monetary data from various sources, whether they be internal or external, in real-time. This allows interested parties and executives to obtain valuable insights that can aid in the creation of dynamic, engaging, and current sustainability accounting and reporting procedures. Through the use of Big Data, data quality and clarity of business disclosure mechanisms can be increased, leading to a reduction in an imbalanced knowledge distribution and an improvement in the enhancement of trustworthiness in financial and sustainability reporting [9]. Consequently, these advantages can be optimized for all stakeholders and enhance the corporate image. Accounting professionals and managers need to make informed decisions on how to integrate sustainability accounting and reporting with performance management systems to advance the firm's sustainability issues. This can be achieved by updating the current sustainability accounting and reporting procedures with BDA. The benefits of this integration include the implementation and dissemination of sustainable practices, leading to an increased investigation and progression in this trending issue. Therefore, further exploration of the positive outcomes of combining sustainability accounting and reporting with management control systems based on BD is crucial for directing financial executives in their decision-making framework [8, 9, 29].

As a conclusion, this study examines how Big Data and BDA affect sustainability accounting and reporting, and from the positive side, the current study formulates the following research questions:

Q1: Do financial managers need a deeper understanding of data analytics tools to achieve sustainable growth goals?

Q2: Does big data and big data analytics positively affect sustainability accounting and reporting?

3 Research Methodology

This study examines the impact of Big Data and BDA on sustainability accounting and reporting, as perceived by financial managers working in the Canadian public firms listed on the Toronto Stock Exchange in the year 2023. Additionally, it looks at the specific skills that financial managers need to perform their duties in an effective manner using BDA. Previous researchers assert that utilizing a qualitative method is more fitting than a quantitative method in this context, due to BDA being an emerging technology and not

fully utilized [1, 2]. Therefore, a quantitative approach solely relies on an insufficient empirical dataset that does not accomplish the research aims. As a result, the authors of this study employed unstructured questions incorporated into a partially formalized interview to collect qualitative data. Obtaining qualitative data through interviews will allow the authors to produce a more in-depth, detailed report on the topic. The authors utilized an exploratory design, as it is more apt for addressing the research inquiries and meeting the goals of the research. Throughout the data collection process, the researchers have implemented various methods including active listening and pertinent questioning to obtain accurate information.

4 Results and Discussion

This section divulges the findings of our investigation that respond to the research questions we posed. Our scrutiny revolves around ascertaining the prospects and advantages that the respondents acknowledge while segregating the crucial viewpoints, mindsets, and techniques surrounding them.

As mentioned earlier, financial managers require a deeper comprehension of data analytics tools to achieve sustainable growth aims. The respondents corroborated this notion, asserting that accountants must possess enhanced proficiency and expertise in data analytics.

“...Our approach prioritizes data comprehension over system knowledge thus individuals must comprehend data. However, currently, it seems that skills pertaining to accounting and finance are equally essential. [...] I would say, possessing business acumen and strategic thinking is paramount more than technical expertise.”
[P.5]

Nonetheless, our results indicate that respondents emphasized the significance of having a dedicated curriculum on BD technology in the business, despite the availability of current programs.

“... Although, one must inevitably acquire some level of analytical skills to comprehend the disparities while using BD”. [P.8]

Additionally, the respondents recommended that educational institutions should prioritize providing an ample quantity of theoretical knowledge on Big Data in their curriculums. Some participants also affirmed that several universities previously implemented integrated courses and study materials regarding Big Data into their educational programs.

“...On the other hand, it would be helpful if someone could guide me through the process of constructing this tool with the available data and exhibit the outcomes. This would need specialized instruction as well as instruction on how to approach data analytics.” [P.1]

BD replacing traditional firms' data collection methods with a comprehensive BD integrated system that leverages business-wide information as an innovative move. Moreover, utilizing BD tools for practical application in particular industries entails combining diverse data categories from the cost management system (such as revenues, and supply chain management) to be used to provide monthly and real-time economic reporting and sustainability accounting and reporting. Such vital data facilitate a proactive and predictive strategy to identify fluctuations and variations that might alert financial managers to possible risks.

“When Big Data is applied with data analytics methodologies, businesses can potentially gain various benefits, including enhanced risk management, customized offerings and streamlined processes. Such data can aid firms in making judgments informed by concrete information rather than conjecture or suppositions. Additionally, the expansive scope and scale of data-driven possibilities are transforming the firm sphere, and creating potential for disruptive new business models.” [P.16]

“... Businesses could utilize a BD-driven reporting system to integrate their sustainability data, encompassing historical and prospective information, with their core business data. This integration enables decision-making that prioritizes responsible practices while ensuring economic success.” [P.3]

“Big Data has the potential to enhance manufacturing procedures and productivity, leading to reduced operational expenditures and decreased emissions for the environment. By doing so, firms can improve their sustainability performance comprehensively.” [P.9]

“Big Data Analytics can assist financial managers in enhancing their audit testing for compliance, risk evaluation and substantive procedures. [...] this leads to more informed and effective decision-making that improves the overall sustainability of accounting and reporting practices.” [P.18]

However, they recognize that an excess of data can pose a challenge due to inconsistent data from various sources and the extensive categorization required to make the data useful. Our evaluation suggests that this challenge may be linked to the resources accessible by public firms. Generally, smaller firms have fewer employees and require less IT infrastructure to perform prompt data analysis. However, Big Data has resulted in sustainability accounting and reporting being more carefully filtered, leading to greater transparency and better decision process.

“The responsibilities of accounting heavily rely on data. Consequently, progress in the ability to collect, handle, stockpile, scrutinize, illustrate, and transfer information will hold particular significance in the way accountants execute their duties.” [P.6]

5 Conclusion

This study contributes to the current body of knowledge on Big Data, BDA and sustainability by examining the effectiveness of sustainability accounting and reporting, and their relationship with Big Data and BDA, as perceived by financial managers working in the Canadian public firms listed on the Toronto Stock Exchange in the year 2023. The study findings suggest that BDA play a vital role in enhancing sustainable accounting practices and reporting and contribute notably to improving both sustainability and accounting quality. The study further suggests that BDA will impact essential proficiency and financial managers' competencies. Moreover, the speed and precision offered by Big Data facilitate more efficient and accurate reporting, enhance risk management strategies, identify expense reduction opportunities, and improve financial performance. It is crucial for key decision-makers, financial analysts and managers to be aware of these findings to make informed decisions. Furthermore, the integration of data analytics in sustainable accounting can provide organizations with better insights into their environmental, social, and governance performance. This, in turn, can help organizations make more informed decisions regarding their sustainability initiatives, and thus enhance their reputation with stakeholders.

6 Implications

Our principal achievement is, to comprehend the impact of data analytics on the sustainability accounting and reporting procedure and provide a more insight into what skills and competence combinations are needed to accomplish the financial managers' activities. The study suggests that firms should adopt a comprehensive BD integrated system to collect and analyze diverse data categories to provide proactive and predictive insights that can alert financial managers to potential risks and opportunities for sustainable growth. This finding will be really valuable to external parties (e.g. Stakeholders). Additionally, accounting firms can utilize the findings obtained from our research as a system of measurement for assigning resources to engagement teams. Finally, our research also recognizes the critical abilities and skills that financial managers and accountants require in a Big Data environment.

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Perceived Service Quality of Mobile Banking and Co-creation Intention: The Mediating Role of Epistemic Value and the Moderating Influence of Digitalization Anxiety

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Abstract. In this paper, the Service-Dominant Logic (SDL) and the Electronic Service Quality Model (E-S-QUAL) are combined to assess customer value co-creation intention (CCI). To achieve this, participants among mobile banking users in Jordan were administered questionnaires. To evaluate the importance of mobile banking service quality (MBSQ), epistemic value, and digitalization anxiety in determining CCI, the SPSS, and Smart PLS software were used to perform mediation and moderation analyses. The findings confirm the assumption that MBSQ, epistemic value, and digitalization anxiety all impact CCI. Bank managers can use this research to help them allocate resources whilst developing m-banking platforms.

Keywords: Customer value co-creation intentions · Mobile banking · Service quality · Epistemic value · Digitalization anxiety · SDL

1 Introduction

The recent rise in popularity of mobile banking (m-banking) has significantly changed retail banking. M-banking now includes a variety of features and revenue streams, creating opportunities for forward-thinking banks [1] and countries focusing on financial inclusion [2]. M-banking has proven to be helpful during the COVID-19 epidemic [3] and has thus received more scholarly attention within the context of Cutting-Edge Business Technologies (CEBT) [4, 5]. Besides, [6] point out that the quality of mobile service is a key differentiator that can be employed by financial institutions to market banking services. Moreover, research into customer value co-creation is important because it has positive impacts on customer satisfaction and organizations' competitive advantages [7]. This entails sustainable value for financial enterprises because they interact with customers to raise their financial capacity [8].

Although prior studies examined the factors that influence m-banking adoption, few researchers have investigated what happens after this adoption [1, 9]. However, there is a lack of practical research on the effect of MBSQ on CCI in the banking sector [10]. Thus,

to address this gap in research, the current study employs a questionnaire to examine the effects that MBSQ has on CCI through epistemic value and how these effects are affected by digitalization anxiety. From a theoretical perspective, SDL and E-S-QUAL represent the constructs that support the current study issue. The epistemic value corresponds to experienced curiosity, novelty, or obtained knowledge [11, 12]. It was thus employed in this work because banking customers perceive epistemic value through the uniqueness and intrigue of mobile app services. In addition, many researchers have found that anxiety avoidance has a positive moderating effect on behavioral intentions. Therefore, digitalization anxiety was employed as a moderator (e.g., [13, 14]). Yet, few studies have specifically addressed this area in the banking industry [15, 16]. [17] thus contends that further banking research is required to examine how digitalization anxiety affects the use of m-banking services. For the aforementioned reasons, digitalization anxiety was employed in this work as a moderator between epistemic value and CCI.

The study's findings support the idea that MBSQ, epistemic value, and digitalization anxiety can all have an impact on CCI. This work adds two significant new ideas to literacy. The study's method for empirically examining the relationship between MBSQ and CCI in the context of Jordanian mobile banking users represents its first contribution. Thus, this study investigates epistemic value as a mediator and Digitalization anxiety as a moderator. The study's creative analysis of MBSQ in the Jordanian context represents its second beneficence. Jordan was chosen because the government has improved mobile banking methods as a response to the Covid-19 epidemic [18]. As a result, this work adds to the body of knowledge on mobile banking and service research while also raising awareness of service quality and CCI.

2 Theoretical Background and Hypotheses Development

In this work, two theoretical approaches to service provision are employed, namely SDL and E-S-QUAL. These approaches will be discussed in more depth below.

SDL. SDL's basic tenet is that through the service-for-service exchange, people can benefit from one another's skills whilst simultaneously using their own [19]. CCI and SDL are believed to work well together [9, 10, 20]. Value co-creation occurs when a company and its customers work closely together to create unique value for each client that is also sustainable for the company [21].

E-S-QUAL Model. In electronic contexts, perceived quality determines behavioral intentions [22]. A conceptual model for service quality termed SERVQUAL has thus been developed and later modified to reflect e-service quality assessment (E-S-QUAL) [23]. Others increased the scope of E-S-QUAL, including factors such as interoperability and ease of use [6], which are important determinants of the caliber of electronic services [24]. This study uses the expanded E-S-QUAL to calculate MBSQ. In the present work, MBSQ is used to evaluate customers' perception of the following m-banking variables:

- (1) Ease-of-use –the user-friendliness and comfortability of M-banking.
- (2) Efficiency –the extent to which customers can obtain what they want quickly and easily.
- (3) Interoperability –the speed and ease with which banking transactions can be performed.

- (4) Privacy/Security-the efforts made by M-banking service providers to protect the transactional data of their consumers.
- (5) Responsiveness -the services provided by M-banking providers.

According to a recent “market study examining the adoption of digital financial services” in Jordan, Jordanians are more familiar with m-banking than other digital banking services, with more than 50% of participants having some knowledge of m-banking services [25]. Consequently, it was decided to focus this study’s analysis on mobile banking. The current research predicts that by increasing the perceived service quality of mobile banking, the epistemic value is likely to increase, which will ultimately strengthen CCI.

2.1 Hypotheses and Conceptual Model

CCI and MBSQ. Several empirical studies [9, 10, 26] found that MBSQ aspects determine CCI. These serve as examples of how quantitative approaches can be employed to investigate the relationship between service quality and CCI. Thus, the following hypothesis is put forward in the current study.

H1. MBSQ positively influences CCI.

MBSQ and Epistemic Value. Epistemic value refers to the perceived benefit derived from the ability of an alternative product or service’s ability to pique consumers’ interest level, offer novelty, and satisfy a need for information [11, 27]. Building long-term ties with an organization requires epistemic value [28]. [17] and [29] have examined the banking and restaurant services respectively to show how perceived quality affects epistemic value. The following hypothesis is thus put forward:

H2. MBSQ positively impacts epistemic value.

Epistemic Value and CCI. Many researchers have examined the relationship between Epistemic value and CCI and findings indicate that CCI can be improved by increasing epistemic value. For instance, [30] examined the topic in hospitals, whilst [31] examined it in for-profit organizations and [20, 32] examined it in hospitality organizations. The following hypothesis is thus proposed:

H3. Epistemic value positively impacts CCI.

The Mediating Effect of Epistemic Value. Research highlights the mediating effect of epistemic value achieved via stimuli and behavioral intentions. For instance, [33] found that epistemic value is a significant mediator in the relationship between design aesthetics and customers’ adoption intentions towards mobile banking, while [34] found that epistemic value fully mediated the relationship between perceived service quality and patients’ behavioral intentions for hospitals. Besides, in a study conducted by [35], the epistemic value was found to mediate the relationship between e-attitude and behavior intentions in ridesharing services.

Thus, the following hypothesis is proposed.

H4. Epistemic value mediates the relationship between MBSQ and CCI.

The moderating role of digitalization anxiety. Digitalization anxiety was found to have a strong negative impact on behavioral intentions [36, 37]. Moreover, digitalization anxiety was found to affect epistemic value in several settings including smartphone usage [38], smartphone brand-changing conduct [28], health technologies [39], and

online learning [40]. However, no existing studies have shown that epistemic value and digitalization anxiety impact CCI in the m-banking sector. Thus, the subsequent hypothesis is proposed.

H5. Digitalization anxiety moderates the relationship between epistemic value and CCI is moderated through digitalization anxiety. Figure 1 presents the study model.

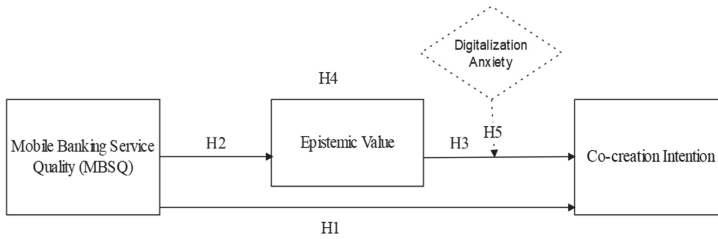


Fig. 1. Study Model

3 Methodology

3.1 Design

This study adopted a quantitative descriptive analytical approach to examine mediating and moderating mechanisms in a model that examines associations between MBSQ and CCI. Results are based on data collected using a structured questionnaire. The statistical model was examined using SPSS [v27] and structural equation modeling using the Smart PLS [v4] software, data coding and preliminary analysis were based on SPSS, meanwhile, Smart PLS provided a measurement model and structural model evaluation. Smart PLS was chosen for analysis as it can examine associations between multiple independent variables and multiple dependent variables by applying Partial Least Square [PLS] method [41].

3.2 Instrument

MBSQ: 5 dimensions were measured by using 15 items (3 items for each dimension). Items were modified based on the study of [6] and [42].

Epistemic Value: four items were used to measure this element. Items were modified based on the study of [28].

Digitalization Anxiety: four items were used to measure this element. Items were modified based on the study of [43].

CCI: four items were used to measure this element. Items were modified based on the study of [44].

A five-point Likert scale, with anchors of 5 for strongly agree and 1 for strongly disagree, was used to collect data for this survey.

The questionnaire items for these variables are shown in Table A.1.

3.3 Sample and Data Screening

Data reported in this study are drawn from a survey that was conducted using social media through an online survey using Google Forms. Data collection took place during Jan – Feb/ 2023, targeted respondents were mobile banking users in the context of Jordan. Overall, a total of 306 questionnaires were received, after data coding into SPSS, the validity of gathered questionnaires was assessed by examining STD. Coefficients for Likert-based items of each questionnaire, 20 questionnaires were found to score very low STD., therefore, were discarded from the sample, further, outliers were not an issue in the current dataset, the decision of outliers was based on Cook's distance coefficients that had a maximum value of [0.03921], which therefore below [0.1] cutoff suggested by [45]. Hence, the clear sample consisted of 286 valid questionnaires.

Data screening comprised examining data symmetry issues, skewness, and kurtosis coefficients were collected, by suggestions of [46], neither of the collected coefficients exceeded the proposed cutoff for data normally distributed ± 2.2 .

3.4 Respondents' Characteristics

Characteristics of respondents were gathered, the sample consisted of both genders equally, male counted [145, 50.7%] and female counted [141, 49.3%]. In terms of age, the sample had diversity, all targeted ages were represented in the sample as follows: 18 – 24 years [65, 22.7%], 25 – 34 years [50, 17.5%], 35 – 44 years [64, 22.4%], 45 – 54 years [65, 22.7%], 55 – 64 years [36, 12.6%] and 65 years or more [6, 2.1%]. In addition, [170, 59.4%] of respondents hold a bachelor, [87, 30.4%] hold a higher than bachelor's certificate, and [29, 10.1%] hold below bachelor's certificate. Further, income results showed also diversity in the sample, [44, 15.4%] receive less than 500 JD, [98, 34.3%] receive 501 – 1000 JD, [49, 17.1%] receive 1,001 – 2000 JD, [23, 8.0%] receive 2001 – 3000 JD, [18, 6.3%] receive more than 3,000 and [54, 18.9%] prefer not to say, finally, [121, 42.3%] were active users of m-banking systems before Covid-19 and [165, 57.7%] started using m-banking systems during/after Covid-19.

3.5 Descriptive Data and Correlation Matrix

Referring to results in Table 1, mean values were gathered, and all mean values were found above level (3) which is the middle of the Likert scale, entailing that respondents provided assessments in favor of the proposed aspects in this study. Furthermore, respondents perceived adequate levels of epistemic value and CCI toward m-banking systems, thereby is worth investigating the prediction role by proposed characteristics of m-banking systems on such favorable readiness aspects that developers of these systems seek to foster among their users. On the other hand, it's vital for the developers of these systems to consider that their users also have notable levels of digitalization anxiety, hence, their design and enhancement plans should consider reducing such concerns among their users.

Pearson correlations showed that components of MBSQ didn't have any high correlation exceeding the 0.9 thresholds, thereby indicating no concerns of high collinearity, further, initial support for proposed hypotheses was seen, MBSQ correlated significantly

in positive correlations to both epistemic values [0.660*] and CCI [0.645**], furthermore, epistemic value and CCI [0.666**] had a significant positive correlation, and finally, digitalization anxiety had very low direct correlations with model dependent variables.

Table 1. Descriptive data and correlation matrix (n = 286)

Measure	Mean	STD.	Pearson correlation									
			1	2	3	4	5	6	7	8		
MBSQ Dimensions	Efficiency	3.97	0.65	1								
	Ease of use	3.92	0.72	0.689**	1							
	Privacy/Security	3.59	0.75	0.466**	0.542**	1						
	Responsiveness	3.73	0.68	0.571**	0.467**	0.500**	1					
	Interoperability	3.74	0.66	0.559**	0.658**	0.606**	0.573**	1				
MBSQ	3.79	0.56	0.808**	0.834**	0.782**	0.768**	0.839**	1				
Epistemic Value	3.80	0.71	0.625**	0.533**	0.512**	0.486**	0.506**	0.660**	1			
Digitalization Anxiety	3.66	0.90	0.082	0.183**	0.088	0.090	0.174**	0.153**	0.129*	1		
Co-creation Intention(CCI)	3.90	0.89	0.630**	0.546**	0.427**	0.448**	0.562**	0.645*	0.666**	0.153**	1	

**Correlation is significant at the 0.01 level

*Correlation is significant at the 0.05 level

3.6 Examining The Measurement Model

For item individual factor loading [FL], all items gained FL above the preferred cutoff [0.70] except for one item which is R3 in the Responsiveness measure, however, as the FL of this item was above [0.50] minimum cutoff with no reduces in subsequent CR and AVE coefficients, this item was retained [47]. All items had significant FL at 0.01 significance level with *t-values* exceeding the 1.96 thresholds, thereby, contributing to individual item internal consistency. Furthermore, Cronbach alpha contributes toward the measure's reliability, meanwhile, CR contributes toward the measure's internal consistency. To the suggestions of [48] and [47], both coefficients should exceed the [0.70] cutoff which was found for all measures. Regarding convergent validity, Average

Variance Extracted [AVE] coefficients were above the [0.50] threshold for all measures contributing again toward model convergent validity. Finally, discriminant validity of model measures prevailed based on three approaches provided by Smart PLS, first one is the [49] method and the Heterotrait-monotrait ratio of correlations [HTMT] [50] and the results of the cross-loading approach.

3.7 Structural Model Relationships

The collinearity issue in the model was checked based on variance inflation factor [VIF] coefficients for the inner and outer model, VIF in the inner model should be below 3 threshold, and below 10 threshold in the outer model as proposed by [47], in our model all VIF coefficients in both inner and outer model were below-proposed thresholds, thereby accumulating that collinearity was not a concern. Furthermore, the amount of variance predicted in the endogenous variables by the exogenous variables which is the R2 coefficient was moderate scoring [44.2%] in epistemic value and [55%] in CCI. Two structural models were examined, the first one concerns for mediation mechanism only, and the next one introduces the moderator mechanism into the model. Figure 2 displays the structural model relationships estimate for the mediation mechanism.



Fig. 2. Structural model relationships estimate for the mediation mechanism

Support for H1 through H4 was found in the mediation mechanism, MBSQ had a significant positive direct influence on CCI [0.376, *t-value* (6.077)], hence, as MBSQ increases by 1%, CCI directly increases by 37.6%, findings support H1. Next, MBSQ was found also have a significant positive influence on epistemic value [0.665, *t-value* (15.379)], hence, as MBSQ increases by 1%, epistemic value increases by 66.5%, findings support H2. Further, the epistemic value had a significant positive influence on CCI [0.421, *t-value* (7.254)], accordingly, as epistemic value increases by 1%, CCI increases by 42.1%, findings support H3.

The mediation mechanism can be established through the indirect influence which accounted for $0.665 \times 0.421 = 0.280$, the indirect influence was significant having a *t-value* (of 6.338). The mediation mechanism was partly due to having direct and indirect influences in the model, results support H4. The earlier model entails that the total influence of MBSQ on CCI was [0.656].

Figure 3 displays structural model estimates introducing digitalization anxiety as a moderator between epistemic value and CCI, support for the moderation role was found, and the estimate of the interaction term between digitalization anxiety \times epistemic value on CCI was [-0.110, *t-value* (2.396)], showing a significant negative moderation influence, hence, digitalization anxiety was found as a dampening factor for the positive influence of epistemic value on CCI. Results would support H5. Table 2 collects a summary of structural model relationship estimates.

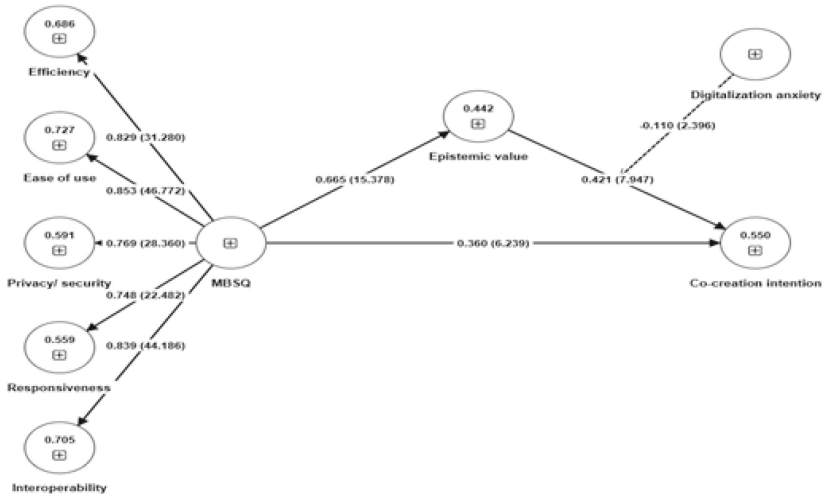


Fig. 3. Structural model relationships estimate for the moderation mechanism

Table 2. Summary of structural model relationships estimate (n = 286)

H	Path	Beta	Decision
H1	MBSQ → Co-creation intention	0.376*	Supported
H2	MBSQ → Epistemic value	0.665*	Supported
H3	Epistemic value → Co-creation intention	0.421*	Supported
H4	MBSQ → Epistemic value → Co-creation intention	Direct [0.376*] Indirect [0.280*] Total [0.656*]	Partial mediation
H5	Digitalization anxiety × Epistemic value → Co-creation intention	-0.110*	Supported

* $P < 0.05$

4 Discussion

MBSQ was found to have direct and indirect influences on CCI, thereby showing the extent to which developers of m-banking systems professionalize the design of their application by maintaining main design aspects, they can improve and foster CCI among their users, which is a goal that developers seek for, indeed, findings entail that actual design characteristics are associated with deep intentions of users, it's also gone beyond their intention to trigger their perception toward epistemic value among them based on sophisticated design efforts made by the developers. These findings are consistent with previous research findings [9, 10, 17, 20, 26, 28, 30, 39, 40].

Nevertheless, despite that designing sophisticated banking systems and applications are associated with users' CCI and epistemic value that in turn foster CCI, developers should consider that users are not isolated from other concerns that stem from the digitalization context, indeed findings were able to show that even better levels of epistemic value can improve CCI, an external factor such as digitalization anxiety can take a role in dampening such positive perceptions and make an inverse role. Hence, developers of m-banking systems should take into account maintaining aspects that are related to digitalization anxiety that users are concerned with, by providing all technical and design means that can protect user information, transactions, and all related financial needs while using the applications and systems, to ensure for users that other concerns that occur in digital space are maintained in their provided applications and systems.

5 Conclusion

To sum up, the results of the current research have added to our understanding of the influence of MBSQ on CCI, which is mediated by epistemic value. Also, the relationship between epistemic value and CCI is moderated by digitalization anxiety. In conclusion, the current research has investigated the moderated mediated model directing CCI. Also, this study provides knowledge that can help m-banking services developers create services that can meet user expectations and requirements and foster CCI.

Appendix

Table A.1. The Questionnaire Items for variables

Variable	Dimension	Items' code	Item	Reference
MBSQ	Efficiency	E1 E2 E3	The m-banking platform makes it easier to get any service I want The m-banking platform allows me to perform transactions quickly The m-banking platform is worked perfectly to my expectations	[6, 42]
	Ease of use	EU1 EU2 EU3	The m-banking platform is user friendly The m-banking platform provides me with clear user instructions I feel comfortable during using the m-banking platform	
	Privacy/ Security	PS1 PS2 PS3	I trust m-banking services I feel secure using m-banking services I believe the m-banking service provider does not share my personal/financial information with other third parties	
	Responsiveness	R1 R2 R3	I receive quick responses from the m-banking service provider M-banking service provider delivers quick digital services to me The m-banking service provider pays attention to my complaints well	

(continued)

Table A.1. (continued)

Variable	Dimension	Items' code	Item	Reference
	Interoperability	I1 I2 I3	I find it easier to navigate outside my bank's m-banking service platform My m-banking services can be accessed on other third-party mobile platforms Making financial transactions to other third parties platforms with my m-banking asset are easy	
Epistemic Value		EV1 EV2 EV3 EV4	when I use an m-banking services platform, I would obtain significant knowledge about the diverse technological developments in them I would obtain proficient knowledge about the different technological developments when using the m-banking platform I can find innovative knowledge when using the m-banking platform I like to search for new aspects when using an m-banking platform	[28]

(continued)

Table A.1. (continued)

Variable	Dimension	Items' code	Item	Reference
Digitalization Anxiety		DA1 DA2 DA3 DA4	I question why I need to use m-banking in the future I am afraid of using m-banking incorrectly I do not like the feeling of having to use M-banking I make use of m-banking the least possible	[43]
Co-creation Intention		C1 C2 C3 C4	I would like to personalize m-banking services in some way I would like to adapt m-banking services to meet my needs I would like to configure m-banking services based on my Ideas If necessary I would share personal information to use all functions the m-banking platform offers	[44]

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Influence of Data-Driven Digital Marketing Strategies on Organizational Marketing Performance: Mediating Role of IT Infrastructure

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Abstract. The purpose of this research was to investigate the function that IT infrastructure played as a mediator between data-driven digital marketing strategies and the marketing performance of organizations. Dimensions of data-driven digital marketing strategies adopted included (Data collection, Data analysis, Segmentation, Targeting, Personalization, Automation and Optimization). The quantitative method was used to successfully complete the study's objectives, a questionnaire was distributed on a sample of (84) marketing managers and leaders within delivery services companies which are licensed and operating in Jordan. Results of study indicated that IT infrastructure mediates the relationship between Data-driven digital marketing strategies and marketing performance. Study recommended before implementing any data-driven marketing strategy, it is important to have clear business goals and metrics in place. Further recommendations were presented in the study.

Keywords: Data-Driven Marketing · Digital Marketing · Data collection · Data analysis · Segmentation · Targeting · Personalization · Automation and Optimization

1 Introduction

Data-driven marketing is the process of making marketing choices and improving marketing efforts based on quantitative and qualitative data. [1, 10, 34]. In this approach, marketers collect and analyze large amounts of data about their customers, their behavior, and their preferences to gain insights into their needs and preferences [28]. These insights are then used to tailor marketing messages and campaigns that are more personalized and relevant to each individual customer [13, 29]. Data-driven marketing strategies can improve marketing performance by helping marketers to understand their target audience better by analyzing customer data, marketers can gain a deeper understanding of their target audience's needs, preferences, and behavior [16, 20].

Data-driven marketing strategies are able to support performance by optimizing campaigns for better ROI which can take place by tracking and analyzing the performance

of marketing campaigns so marketers can identify which campaigns are generating the most revenue and which ones are not, this allows them to optimize campaigns for better ROI and focus on the tactics that are most effective [33]. Data-driven marketing can test and iterate quickly, by using data to inform marketing decisions, marketers can quickly test and iterate campaigns to improve performance [5, 23].

This research set out to investigate the connection between data-driven digital marketing strategies and the marketing performance of organizations by means of a focus on the mediating function of IT infrastructure. Dimensions of data-driven digital marketing strategies adopted included (Data collection, Data analysis, Segmentation, Targeting, Personalization, Automation and Optimization) [3, 14, 22].

1.1 Digital Marketing

Digital marketing is the use of digital technologies and channels to promote and sell products or services. It includes techniques like search engine optimization (SEO), social media marketing, email marketing, pay-per-click advertising, content marketing, and mobile marketing, among others [25]. Digital marketing allows businesses to reach and engage with customers in a more targeted and personalized way, as well as track and measure the effectiveness of their marketing efforts more accurately [6]. Digital marketing also provides opportunities to interact with customers in real-time, create and deliver more relevant and timely content, and build stronger relationships with them [21, 26].

1.2 Data-Driven Marketing Strategies

Data-driven marketing is a way to advertise and promote goods or services that depends on collecting and analyzing a lot of information about how people act and what they like [31]. This data can come from various sources, including website analytics, social media interactions, email campaigns, and customer surveys [4]. By analyzing this data, marketers can gain insights into what drives customer behavior and tailor their marketing efforts to better meet their needs and preferences [27]. This can include developing targeted campaigns, personalizing messaging, and optimizing marketing channels to reach the right audience at the right time with the right message [32]. Overall, data-driven marketing is focused on using data and insights to improve the effectiveness and efficiency of marketing efforts [15].

1.3 Marketing Performance

Marketing performance involves keeping track of and analyzing different measures, such as sales income, customer acquisition costs, customer lifetime value, conversion rates, website traffic, social media interaction, brand recognition, and so on [2, 8]. Marketing performance measurement allows companies to assess the impact of their marketing efforts on business outcomes and make data-driven decisions to optimize their marketing strategies and tactics [7, 24].

1.4 IT Infrastructure

IT infrastructure refers to the foundational components and systems that support the operation and management of an organization's information technology (IT) environment [30]. IT infrastructure includes hardware, software, networks, data storage, and other technologies that are necessary to deliver IT services and solutions to users [12]. The IT infrastructure plays a critical role in enabling business operations and providing services to customers, as it provides the necessary resources and capabilities to store, process, and transmit information. It also supports the development, deployment, and maintenance of various applications and systems used by employees, customers, and partners [9, 19].

1.5 Related Studies

[28] Explored the impact of data-driven digital technologies on marketing practices. The authors argue that marketing has undergone a significant transformation due to the proliferation of digital data, which has allowed for more targeted and personalized marketing strategies. The authors argue that digital technologies have expanded the scope of marketing beyond these traditional elements, and have enabled marketers to engage with consumers in new ways.

[10] Discussed how companies can use data to enhance their marketing efforts and achieve growth and profitability. The author argued that firms may learn much about their clients' habits, inclinations, and requirements by collecting and analyzing consumer data. Authors highlighted several key steps that businesses can take to implement a data-driven marketing approach, including (Defining clear business objectives and KPIs, Collecting and analyzing customer data, Segmenting customers based on behavior, preferences, and needs. The author emphasizes the importance of investing in the right technology and tools to effectively collect and analyze data, and provides examples of successful data-driven marketing campaigns from companies such as Amazon and Netflix.

[29] Discussed the challenges and opportunities presented by the growing volume of data in marketing. The author explained that while data-driven marketing has become increasingly popular in recent years, there is still a need for research to develop new techniques and approaches to effectively manage and utilize large amounts of data. Authors highlighted several key areas where research is needed in data-driven marketing, including (Developing new analytical techniques to handle big data, integrating different types of data (such as social media, transactional, and customer feedback) to gain a comprehensive understanding of customer behavior and preferences.

[16] Examined the effects of market size and data-driven marketing on sales mode selection in an internet platform-based supply chain. The authors use game theory and a numerical simulation to model the interactions between suppliers and an internet platform that facilitates their sales. They find that larger markets lead to a higher likelihood of suppliers adopting direct sales modes over using the platform, while data-driven marketing can incentivize suppliers to use the platform instead.

Launching from above argument, the hypotheses were extracted:

H1: Data-driven digital marketing strategies have a statistically significant influence on marketing performance

H2: Data-driven digital marketing strategies have a statistically significant influence on IT infrastructure

H3: IT infrastructure has a statistically significant influence on marketing performance

H4: IT infrastructure mediates the relationship between Data-driven digital marketing strategies and marketing performance

2 Material and Methods

The current study relied on a quantitative method to reach its goals; a questionnaire served as the primary instrument of analysis. The questionnaire was created by the researcher with the help of prior research; it was divided into two main parts: demographic information and statements pertaining to the study's sub-variables. There were 47 Likert-scale statements covering various aspects of the research project included in the questionnaire. There was a total of 106 delivery service firms in Jordan, all of which were included in the study's population of marketing managers and leaders. The study population was represented by a sample of 103 people who were selected at random. Eighty-four (84%) complete questionnaires were received after the application procedure was complete, representing a statistically significant response rate of 81.5%. SPSS, a statistical program used in the social sciences, was used for preliminary data analysis.

2.1 Validity and Reliability

The validity of the questionnaire was evaluated by presenting it to a group of subject matter experts; after taking their comments into account, the final version of the survey was issued. Cronbach's alpha was used to determine the reliability of the scale, and the table shows that alpha values suggested a trustworthy scale since they were more than the universally recognized threshold of 0.70 (Table 1).

Table 1. Reliability Test

Variable	Alpha value
Data collection	0.70
Data analysis	0.722
Segmentation	0.716
Targeting	0.716
Personalization	0.719
Automation	0.761
Optimization	0.768
Marketing Performance	0.775
IT Infrastructure	0.90

3 Results and Discussion

3.1 Demographic Results

According to frequencies and percentages of study sample, it was seen that majority of the sample were females forming 54.8% of total sample, with an age that ranged between 31–36 years forming 57.1%, in addition to that, majority of the sample had an experience in marketing that ranged between (12–16) years forming 41.7% of the total sample, and most of them held BA degree forming 34.5% of the sample.

3.2 Questionnaire Results

The mean and standard deviation of the responses to the questionnaire's questions indicated that the sample population had a favorable outlook on the assertions under consideration. The automation variable had the highest mean score (4.1/5.00) and the IT infrastructure variable had the lowest (3.93/5.00), although both were positive.

Table 2. Questionnaire Analysis

Variable	Mean	Std. Deviation
Data collection	3.9690	.53728
Data analysis	4.0214	.56910
Segmentation	4.0619	.58985
Targeting	3.9714	.55636
Personalization	4.0286	.56325
Automation	4.1214	.56740
Optimization	3.9821	.63505
Marketing Performance	4.0643	.60293
IT Infrastructure	3.9360	.72822

3.3 Multicollinearity Test

In order to assess whether or not there is multicollinearity between the variables, VIF and Tolerance were computed for each of the independent variables. The results that were discovered are as follows (Table 2).

The data in Table 3 reveals that the VIF values are lower than 10, while the Tolerance values are higher than 0.10; this indicates that there is no evidence of multicollinearity [11].

Table 3. Multicollinearity test

Variable	Tolerance	VIF
Data collection	.641	1.560
Data analysis	.656	1.524
Segmentation	.944	1.060
Targeting	.866	1.154
Personalization	.738	1.355
Automation	.939	1.065
Optimization	.705	1.418

3.4 Hypotheses Testing

Table 4 demonstrated that all of the aforementioned indicators have reached or beyond the values suggested by the pertinent references and studies. This enabled the researcher to use the results that were generated from the study model and to appropriately disseminate them throughout the study.

Table 4. Fit model

Indicator	AGFI	$\frac{\chi^2}{df}$	GFI	RMSEA			
Value Recommended	> 0.8	< 5	> 0.90	≤ 0.10			
References	[18]	[18]	[18]	[17]			
Value of Model	0.846	1.472	0.911	0.075			
		Direct impact	Indirect impact	C.R	P	result	
IT infrastructure	←	Data-driven digital marketing strategies	0.471	0.112	3.127	.002	Accept
marketing performance	←	IT infrastructure	0.238		2.013	.044	Accept
marketing performance	←	Data-driven digital marketing strategies	0.35		2.276	.023	Accept

Based on Table 4 , following results were reached:

H1: Data-driven digital marketing strategies have a statistically significant influence on marketing performance: This hypothesis was accepted (C.R. = 2.276; P

< 0.05; = 0.023). This means that Data-driven digital marketing strategies have a statistically significant influence on marketing performance.

H2: Data-driven digital marketing strategies have a statistically significant influence on IT infrastructure: This hypothesis was accepted (C.R. = 3.127; $P < 0.05$; = 0.002). This means that Data-driven digital marketing strategies have a statistically significant influence on IT infrastructure.

H3: IT infrastructure has a statistically significant influence on marketing performance: This hypothesis was accepted (C.R. = 2.013; $P < 0.05$; = 0.044). This means that IT infrastructure has a statistically significant influence on marketing performance.

H4: IT infrastructure mediates the relationship between Data-driven digital marketing strategies and marketing performance: This hypothesis was accepted (C.R. = 3.127; $P < 0.05$; = 0.002) and the indirect effect is 0.112 which is significant at 0.05 level. This means that IT infrastructure mediates the relationship between Data-driven digital marketing strategies and marketing performance (Fig. 1).

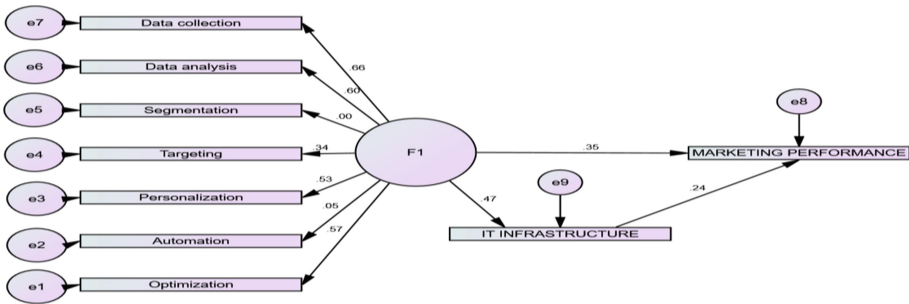


Fig. 1. Hypotheses Testing

3.5 Discussion

Data-driven digital marketing is able to support marketing performance

Marketing performance may be significantly impacted by data-driven digital marketing strategies. Businesses may improve their marketing strategies and make better judgements overall by analysing customer data to learn more about their consumers' habits, likes, and dislikes. Findings from the study also showed that businesses might improve their chances of contacting potential clients who would be interested in their items by using data-driven digital marketing. In addition, data-driven digital marketing enables businesses to continuously optimize their campaigns based on real-time data and insights, resulting in improved performance and ROI over time. This is made possible by collecting and analyzing customer data in order to develop campaigns that speak directly to the interests and needs of the target audience.

Data-driven digital marketing strategies supports IT infrastructure

According to results of study, it was seen that data-driven digital marketing strategies can support IT infrastructure through scalability, meaning that leveraging cloud-based solutions, companies can scale their IT infrastructure to handle increased demand during peak marketing periods. This can help ensure that marketing campaigns run smoothly and that data is collected and analyzed efficiently. Also integration appeared to be of great benefit for organizations as they can gain a more holistic view of their customers and improve their marketing strategies accordingly. Also, automation and analytics as data-driven digital marketing relies on automated processes to collect, analyze, and act on data in real-time. This can help support IT infrastructure by reducing the need for manual processes and streamlining workflows, and in terms of analytics, data-driven digital marketing strategies rely heavily on data analytics to inform decision-making. By leveraging analytics tools and technologies, companies can gain insights into customer behavior and preferences, which can help support IT infrastructure by providing valuable information for product development and IT system improvements.

IT infrastructure mediates the relationship between Data-driven digital marketing strategies and marketing performance

The study's findings support the idea that an organization's IT infrastructure acts as a mediator between data-driven marketing and marketing performance across several dimensions, such as data gathering and processing. Information technology allows businesses to gather and analyze information from a variety of sources, including customer databases, social media, and website analytics. Organizations may improve their marketing strategies by learning more about client habits and preferences via data collection and analysis. In addition, IT allows for marketing automation, which is the programmatic execution of marketing operations like as email blasts, social media updates, and website revisions. Improved marketing performance may result from the use of marketing automation software, which increases the efficacy and efficiency of marketing efforts.

4 Conclusion

In conclusion, it was seen through study that IT infrastructure mediates the relationship between data-driven marketing and marketing performance by providing the necessary tools and technologies to collect and analyze data, automate marketing activities, personalize marketing messages, and integrate marketing activities across different channels. By leveraging IT infrastructure to support data-driven marketing strategies, organizations can improve their marketing performance and achieve their marketing objectives. Examining the influence of data-driven digital marketing strategies on organizational marketing performance and the mediating role of IT infrastructure can make both theoretical and practical contributions. In terms of **theoretical contributions**, this research contributes to the literature by examining the effect of data-driven digital marketing strategies on organizational marketing performance, which will help to understand how organizations can use data to improve their marketing performance. As for **practical contributions**, the findings of this research will provide practical guidance to marketers

on how they can use data-driven digital marketing strategies to improve their organizational marketing performance, also helps organizations to develop IT infrastructure: This research highlights the importance of IT infrastructure in enabling data-driven digital marketing strategies.

4.1 Limitations of Study

Generalizability: Research results from one field or industry may not be transferable to another. Sample Size: The sample size of the study may be small, which can limit the statistical power and reliability of the findings. Human Factors: The effectiveness of digital marketing strategies may also depend on factors such as user behavior, attitudes, and perceptions, which may not be captured by IT infrastructure data alone. Based on above discussion and conclusion, here are some recommendations:

1. Analyzing customer data can help businesses develop a deeper understanding of their target audience, and tailor their marketing efforts accordingly.
2. Optimizing marketing campaigns based on data insights help businesses improve their marketing performance over time.
3. It is important to ensure that customer data is handled in a secure and ethical manner.

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The Relationship Between the Environmental Performance Index and the GDP Growth Rate in Emerging Countries in Europe

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Abstract. In the last decade, corporate sustainability has received considerable attention from decision-makers, authorities and investment community, continuing to be the main theme for decades to come. As EPI score provides a basis for effectively comparing the environmental performance of countries, the purpose of this research is to reveal the relationship between Environmental Performance Index (EPI) and GDP growth rate, in order to give another reason to companies from emerging countries to prepare sustainability reports. The research carried out is based on secondary data sources, the data obtained being analyzed using the descriptive statistics, namely tabular and graphical representations. Analysis of the EPI against the GDP growth rate revealed a weak positive correlation over the past decade. Future researchers can investigate the relationship between EPI and GDP growth rates in Romania and the Republic of Moldova. Reasons for the lack of a strong correlation between EPI and GDP growth rates can also be investigated. In addition, the impact of trade on environmental issues in countries such as Romania or the Republic of Moldova can be studied.

Keywords: Environmental Performance Index · GDP Growth · Emerging countries · Sustainability

1 Introduction

In recent years, the role of entities in our society has evolved from maximizing profit to creating value and protecting the interests of all stakeholders. In today's economic environment, entities face intense scrutiny and pressure from authorities, investors and various stakeholders regarding sustainable performance.

The true measure of success for entities should be determined not only by reported revenue, but by governance, social responsibility, ethical behavior and environmental performance. The measurement and evaluation of sustainable performance for many companies continues to be an unexplored field, accompanied by many uncertainties. For entities from the Republic of Moldova and Romania, it is a real challenge to identify relevant sources that describe all aspects related to the measurement, evaluation and

reporting of sustainable performance. The issue of sustainable development is in everyone's sights, but businesses and other interested parties do not have relevant sources of information, as in other countries.

The purpose of this research is to reveal the relationship between Environmental Performance Index (EPI) and GDP growth rate, in order to give another reason to companies from emerging countries to prepare sustainability reports.

To achieve the proposed goal, the following research objectives were determined and established:

- Identifying and explaining the Environmental Performance Index (EPI);
- Presentation of researchers view and findings on EPI;
- Investigating the correlation between EPI and GDP growth rate in emerging countries in Europe.

2 Literature Review

The global climate is constantly changing and many experts argue that humans are largely responsible for this change. Burning fossil fuels, deforestation and depletion of other resources lead to increased greenhouse gas emissions. The economy and the environment are closely linked, and EPI explains how productive and commercial activities affect the environment. EPI is an index that was developed by the Yale School of Environment and the Earth Institute of Columbia University in collaboration with the World Economic Forum and the Joint Research Center of the European Commission, this is an index that is oriented towards estimating performance, and is based on the Pilot Environmental Performance Index launched in 2002. The main reason for developing the EPI score is to reduce environmental pressures on human health, loss or degradation of ecosystems and natural resources.

EPI enables interstate evaluations to determine best practices, thus providing the opportunity to analyze performance dynamics to achieve objectives. These goals are based on existing international agreements, scientific evidence of the harmful effects of pollution on people and ecosystems, and economically viable environmental protection strategies [11]. In addition, more detailed cross-country assessments can be made by comparing each country's performance in areas such as air quality, water resources, biodiversity and habitat, productive natural resources, climate change and environmental health [5].

The EPI quantitative measures consist of 25 indicators that were selected through an extensive literature review, considering the views of practitioners and expert findings. It is worth noting that the EPI uses the best available global dataset on environmental performance, but the quality and availability of data provided by different countries is still unsatisfactory. The lack of widespread and methodologically consistent indicators for even the most basic issues such as water quality has hampered efforts to make pollution control and natural resource management an easy task. To address these gaps, policy makers should invest in environmental data monitoring, indicators and reporting; develop clear policy objectives on all issues; and provide comprehensive information on performance indicators at global, regional, national, state/provincial, local and entity levels.

Standard accounting measures are often criticized for not taking into account environmental degradation and resource depletion. This issue is particularly important in emerging countries that are highly dependent on natural resources. If a country deforests, depletes soil fertility and pollutes water sources, sooner or later the country will surely become poorer. The dissonance of the system arises because the national income accounts only record the market value of timber, agricultural products and industrial production as positive contributions to GDP [7], but do not take into account the factor of limited resources that are required to be used rationally.

The analysis of the Web of Science and Scopus databases resulted in 66 articles that were published between 1998 and 2023. According to the figure below, it is possible to observe the increasing interest in the topic of EPI, but there is not an impressive number of works in the field, which emphasizes the necessity and actuality of the topic addressed (Fig. 1).

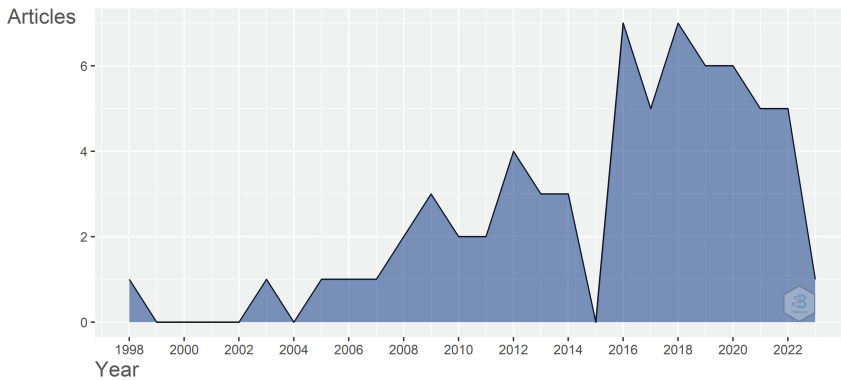


Fig. 1. Annual scientific production on the topic “Environmental Performance Index” *Source: Biblioshiny data processed.*

In 2016 and 2018, the most works were published in which the phrase "Environmental Performance Index" was included in the title, 7 each year. In 2022, a slight decrease in the number of articles was attested, with only 5 published. We believe that these results are motivated by the fact that researchers and the public are not sufficiently informed about the concept of EPI (Fig. 2).

As it is presented in the figure above, the most frequent words in EPI researches are: environmental management, environmental performance indices, sustainable development, environmental performance, environmental impact, environmental protection, performance assessment, decision making and environmental indicator. These keywords can be used to understand the perspective of the authors, and also to delineate the future direction of research.

According to an analysis by Spanish researchers Gallego-Alvarez et.al., environmental performance can be improved by considering the following factors: corruption control; education; population density; institutional factors; political factors; wealth; good governance [6].

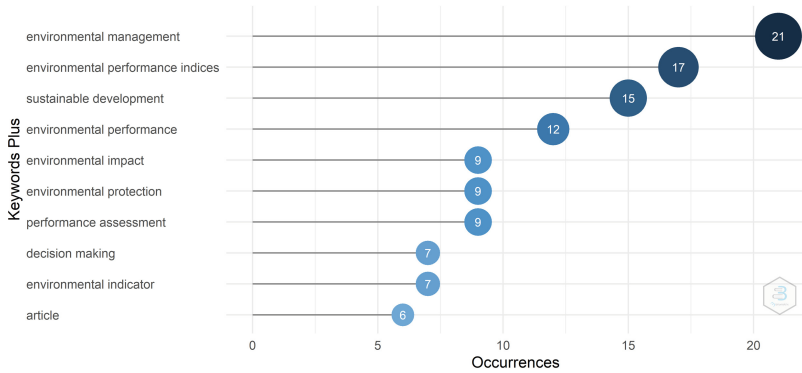


Fig. 2. Most frequent words in EPI researches *Source: Biblioshiny data processed.*

Researchers Duasa et al. found that economic development and high income levels contributed positively to a country's environmental performance. On the other hand, population size has been found to have a negative impact on a country's environmental performance [3]. Another research examined the effects of environmental performance indices, foreign direct investment and trade liberalization on economic growth in developing countries over the period 1983–2013 using panel unit root tests, ARDL tests and diagnostic. The results showed a positive and significant impact of EPI on economic growth [4]. On the other hand, Lee and Thiel found that EPI scores neither increased nor decreased as the GDP growth rate increased [8]. Samimi et al. assessed the relationship between EPI and economic growth in developing countries, finding an inverted U-shaped curve in the relationship between environmental sustainability and economic growth [10]. If we compare the studies developed by Duasa et al. And Samimi et al. With this research, then we can outline that they provided an analysis of different aspects implication on country's environmental performance, but this study shows the correlation of EPI and economic growth from a general perspective.

The study undertaken by Alam et al. aimed to investigate the relationship between economic growth and environmental performance in East and Southeast Asian countries. Combined analysis and empirical modeling determined that increases in GDP per capita have a positive impact on pollution measures [1].

Ukrainian experts Pimonenko, Lyulyov and Chygryn examined the correlation between GDP per capita and EPI. As in most of the cases previously exposed, the researchers identified a positive relationship, with countries with higher GDP per capita also ranking in the top positions in the EPI rankings. As a model of sustainable development for Ukraine, the study highlights Denmark as a model for the implementation of environmental practices and policies, which over the years has achieved high EPI scores [9].

3 Methodology

In order to achieve the established objectives, a documentary research was carried, using an approach based on the observation method, the analysis of documents and the comparison of the results recorded in different works. The analyzed papers were identified in the most ranked databases known to date, namely Web of Science and Scopus. Also, several relevant researches were identified with the help of the Google Scholar search engine. The quantitative method incorporated the analysis of data provided by the World Bank and the Yale Center for Environmental Law and Policy at the level of developing countries in Europe between the period 2010–2020, and the determination of the correlation between EPI and GDP growth rate in 16 countries. The research carried out is based on secondary data sources, the data obtained being analyzed using the descriptive statistics, namely tabular and graphical representations.

4 Results

In order to achieve the main objective of the study, namely, to examine the relationship between EPI scores and GDP growth rates, the usual descriptive statistical techniques, namely tabular and graphical representations, were used. The data were collected during the period 2010–2020 (6 years), all observations being annual. The scores shown in the table were collected from the World Bank website and the Yale Center for Environmental Law and Policy.

The study describes the relationship between the EPI score and the GDP growth rate from 2010 to 2020, with the interval of two years, for emerging countries in Europe. The scores obtained by these countries are shown in the table below.

Analyzing the data from the table, it is possible to delineate the leading countries every year in terms of climate change performance, environmental health and ecosystem vitality. In 2010, Albania and Slovakia scored over 70 points, with GDP growth rates of 3.71% and 6.29% respectively, ranking among the top developing countries concerned with issues related to sustainability. These countries maintained their preeminence in 2012 as well, but in the dynamics a slight decrease in the score is observed, being just over 60.

In 2014, Albania was replaced by Hungary with a score of 70.28. This did not change until Albania and Slovakia took over the top positions again in 2018, with Albania achieving the highest score ever -85.46. In 2020, Slovakia remains in its position, but for the first time in the top of the countries with a sustainable performance, Romania ranks, with a score of 64.70.

If the average score for each year is considered, it can be seen that 2016 had the best result with 77.78, but the GDP growth rate was only 2.20% compared to 4.04% in 2018. Thus, just by observing it is not possible to make a definite finding on the relationship between the EPI variation and the GDP growth rate, which motivated the illustration in the figure below of the EPI scores and the GDP growth rates during limited years.

Interpreting the above data, we can highlight some countries that show strong positive correlations, namely: Albania, Georgia, Montenegro and Moldova. For the countries listed, the Pearson coefficient exceeds 0.5, indicating that an increase or decrease in

Table 1. EPI score and GDP growth rate in emerging countries in Europe 2010–2020

Country	2010		2012		2014		2016		2018		2020	
	EPI	% ↑ GDP	EPI	% ↑ GDP	EPI	% ↑ GDP	EPI	% ↑ GDP	EPI	% ↑ GDP	EPI	% ↑ GDP
<i>Albania</i>	71,40	3,71	65,85	1,42	54,73	1,77	74,38	3,31	85,46	4,02	49,00	-3,48
<i>Armenia</i>	60,40	2,20	47,48	7,20	61,67	3,60	81,60	0,20	62,07	5,20	52,30	-7,40
<i>Azerbaijan</i>	59,10	5,05	43,11	2,17	55,47	2,75	83,78	-3,10	62,33	1,50	46,50	-4,30
<i>Belarus</i>	65,40	7,80	53,88	1,69	67,69	1,73	82,30	-2,53	64,98	3,15	53,00	-0,90
<i>Bosnia and Herzegovina</i>	55,90	0,87	36,76	-0,82	45,79	1,15	63,28	3,15	41,84	3,74	45,40	-3,12
<i>Georgia</i>	63,60	6,25	56,84	6,37	47,23	4,43	64,96	2,91	55,69	4,84	41,30	-6,76
<i>Macedonia</i>	60,06	3,36	46,96	-0,46	50,41	3,63	78,02	2,85	61,06	2,88	55,40	-6,11
<i>Moldova</i>	58,80	7,10	45,21	-0,59	53,36	5,00	76,69	4,41	51,97	4,30	44,40	-7,38
<i>Montenegro</i>	69,40	2,73	38,40	-2,72	55,52	1,78	78,89	2,95	61,33	5,08	46,30	-15,31
<i>Poland</i>	63,10	3,74	63,47	1,32	69,53	3,38	81,26	3,14	64,11	5,35	60,90	-2,54
<i>Romania</i>	67,00	-3,90	48,34	2,04	50,52	3,61	83,24	4,70	64,78	4,47	64,70	-3,75
<i>Serbia</i>	69,40	0,73	46,14	-0,68	69,13	-1,59	78,67	3,34	57,49	4,50	55,20	-0,94
<i>Slovakia</i>	74,50	6,29	66,62	1,36	74,45	2,72	85,42	1,93	70,60	3,79	68,30	-4,36
<i>Turkey</i>	60,40	8,43	44,80	4,79	54,91	4,94	67,68	3,32	52,96	2,98	42,60	1,79
<i>Ukraine</i>	58,20	4,09	46,31	0,15	49,01	-10,08	79,69	2,44	52,87	3,49	49,50	-3,75
<i>Hungary</i>	69,10	1,08	57,12	-1,26	70,28	4,22	84,60	2,19	65,01	5,36	63,70	-4,46
Medium values	64,11	3,72	50,46	1,37	58,11	2,07	77,78	2,20	60,91	4,04	52,41	-4,55

Source: Prepared by the author based on data provided by the Yale Center for Environmental Law and Policy and the World Bank

one indicator will lead to the same change in the other indicator. Moderately positive associations were identified in the case of Poland, Bosnia and Herzegovina, Slovakia and Turkey. Therefore, changes in EPI and GDP growth rates will have the same direction, but the correlation between them will be averaged, with a Pearson coefficient between 0.3 and 0.5. Romania, Macedonia and Serbia recorded values between 0 and 0.3, indicating a weak positive correlation, changes in the indicators have the same significance, but less interdependence. In addition to positive correlations, negative correlations were also identified, such as the results obtained in the cases of Armenia, Azerbaijan, Belarus and Hungary. The negative correlation between the indicators means that as GDP increases, the EPI value decreases.

Overall, the correlation coefficient between EPI and GDP growth rates of different countries from 2010 to 2020 is 0.2647, which is determined to be a weak positive correlation. Future researchers can investigate the relationship between EPI and GDP growth rates in Romania and the Republic of Moldova. Reasons for the lack of a strong correlation between EPI and GDP growth rates can also be investigated. In addition, the

Table 2. Correlation between EPI and GDP growth rate in emerging countries during 2010–2020

Country	Indicator	Result	Country	Indicator	Result
Albania	r	0.8405	Montenegro	r	0.6083
	p-value	0.03615		p-value	0.2001
	Covariance	31.2729		Covariance	67.8744
Armenia	r	-0.07106	Poland	r	0.3222
	p-value	0.8936		p-value	0.5334
	Covariance	-4.2616		Covariance	6.6455
Azerbaijan	r	-0.2268	Romania	r	0.02154
	p-value	0.6657		p-value	0.9677
	Covariance	-11.848		Covariance	1.0915
Belarus	r	-0.204	Serbia	r	0.2922
	p-value	0.6892		p-value	0.5742
	Covariance	-7.8074		Covariance	8.605
Bosnia and Herzegovina	r	0.3724	Slovakia	r	0.3045
	p-value	0.4672		p-value	0.5574
	Covariance	9.1901		Covariance	7.2748
Georgia	r	0.6883	Turkey	r	0.3594
	p-value	0.1306		p-value	0.4841
	Covariance	31.4255		Covariance	7.8271
Macedonia	r	0.2995	Ukraine	r	0.4436
	p-value	0.5642		p-value	0.3783
	Covariance	12.4393		Covariance	29.8005
Moldova	r	0.5858	Hungary	r	0.3699
	p-value	0.2218		p-value	0.4705
	Covariance	36.8976		Covariance	12.3746

Source: Prepared by the author based on data provided by the Yale Center for Environmental Law and Policy and the World Bank

impact of trade on environmental issues in countries such as Romania or the Republic of Moldova can be studied.

Researchers Harris and Roach believe that environmental issues must consider environmental degradation and resource depletion, which should also be one of the deciding factors for measuring GDP growth rate [7]. This is important not only for developing countries but also for developed countries. Also, Romania and the Republic of Moldova can modify their GDP calculation procedures, including environmental aspects. National accounting procedures should include environmental impacts that decision makers need to address.

Reducing pollution is much easier for developed countries, for developing countries it becomes a real challenge, but the importance of applying sustainable practices and policies should not be overlooked, because the use and depletion of resources in an irrational way will generate consequences of economic as well as social order.

5 Conclusions

Sustainability involves continuous planning, organization, measurement, adaptation and accountability of a vast information base. Although systems for observing and collecting data and indicators need continuity and consistency, there is also a need for periodic adjustment and improvement to ensure broad coverage of emerging issues and to ensure that resources are not allocated to collecting irrelevant data. The costs of systematic data collection, monitoring and reporting are often grossly underestimated, and statistical data collection budgets are easy targets for cost optimization in times of crisis.

Analysis of the EPI against the GDP growth rate revealed a weak positive correlation over the past decade. This result applies to developing countries, which usually invest all their efforts in GDP growth, but do not take sustainability issues into account. Among the countries that were researched, several leaders such as Albania, Slovakia and Hungary were identified, which directed their efforts to economic growth, taking into account sustainable development. As previously mentioned, future researchers can investigate the relationship between EPI and GDP growth rates in Romania and the Republic of Moldova. Reasons for the lack of a strong correlation between EPI and GDP growth rates can also be investigated. In addition, the impact of trade on environmental issues in countries such as Romania or the Republic of Moldova can be studied. Also, Romania and the Republic of Moldova can modify their GDP calculation procedures, including environmental aspects. National accounting procedures should include environmental impacts that decision makers need to address.

All beginnings are difficult and complicated, and implementing sustainable practices is no exception, especially in developing countries. There is a long way to go, but the efforts to discover and address sustainability methods and reporting are justified by the long-term benefits. The vision for the future, sustainable development or sustainability, whatever we call it, is the same, the desire for an environment, society, economy for many future generations.

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