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# Supply Chain Management, Inventory Management & Financial Performance: Evidence from Manufacturing Firms

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***Abstract*---**Supply chain management has always been fascinating to study. Not only goods but also the integration of logistical complexities to meet the requirements of customers or corporations (Extron, 2012). At the same time, inventory management is also fundamental in supply chain management (Dorfman, 1954; Hult et al., 2004). Warehouse management systems play an important role in logistics to maintain effectiveness, controlling movement and storage of materials. This system is critical because it involves chain management. This study strives to find evidence on order picking systems to maximize warehouse space and warehouse performance. Also, this study attempts to test the likelihood that inventory management has a significant influence on financial performance in the manufacturing industry. The methodology relies on qualitative and quantitative approaches to note the successful implementation of the order picking system, and the financial impact. This study provides evidence on the substantial relationships among SCM, inventory management & financial performance.

***Keywords*---**financial performance, inventory management, order picking system, supply chain management, warehouse management.

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## Introduction

The era of mass production had originally introduced the term supply chain management (SCM) to refer to the network of collaborations (Bae, 2017), such as; logistics (Bartholdi & Hankman, 2011; Lau, 2014; Lee & Woo, 2019), inventory management (Dorfman, 1954), transportation (Mitchell & Kovach, 2016; Robb & Silver, 1998), information (Lee & Woo, 2019; Lee & Nam, 2016), sourcing and competitive pricing with the high level of flexibility (Song & Song, 2009), and relationship to the customer or market demand (Extron, 2012). While ensuring a high level of product availability, SCM strives for customer value, and low cost (Carmelita, 2019; Irhamsyah, 2015). The 6 areas of SCM include; facilities, inventory, transportation, information, sourcing, and pricing (Chopra & Meindl, 2007; Heizer et al., 2016; Hugos, 2018). The market competitiveness pushed for the term of logistics (Bartholdi & Hankman, 2011; Lau, 2014; Lee & Woo, 2019), and inventory management (Apptricity, 2017; Bonney, 1994; Dorfman, 1954; Prempeh, 2015; Robb & Silver, 1998; Song & Song, 2009), to focus on customer satisfaction and market position since this becomes the revenue generation for firms and contribute to the country's economy (Kumar et al., 2015; Mekel et al., 2014).

Logistics represents one main function in firms though it consists of a highly inter-related independent network to constantly move materials (Bandara et al., 2015). Logistics direct smooth movements of goods and any related documents (Carmelita, 2019; Irhamsyah, 2015). Along with the SCM (Cho & Pak, 2011; Kumar et al., 2015; Lee & Woo, 2019; Lee & Nam, 2016), inventory management (Dorfman, 1954; Mekel et al., 2014; Song & Song, 2009), and warehousing (Bartholdi & Hankman, 2011; David, 2018), logistics have boosted businesses to become the last frontiers for the century (Anandnair, 2011). Though the basic guidance from the Accounting principles still hold, FIFO, LIFO, and weighted average, firms most likely incorporate multiple door policy and order picking (Koster, 2008; Koster et al., 2007), in their inventory management to maximize returns (Alam & Loh, 1998; Fosbre et al., 2010; Harris & Dilling, 2012; Rahmi, 2015).

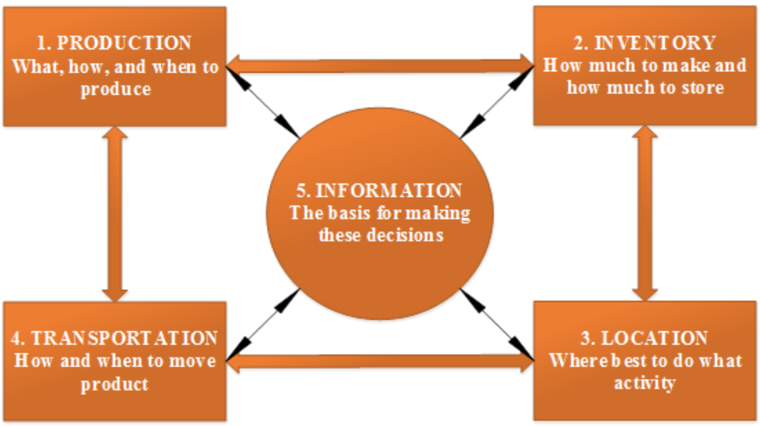


Figure 1. Areas of SCM
Source: (Chopra & Meindl, 2007; Hugos, 2018)

Logistics cannot be separated from warehousing. Along with the SCM, warehouses cannot be overlooked, most likely to act as temporary storage facilities before arriving in the hands of the end-user. A few notable roles of warehouses include; consolidating products, pushing for the economies of scale in large batches, and value-added processing (Bartholdi & Hankman, 2011; David, 2018). To do this, the warehouse management system is a must to track the movement of goods (Bartholdi & Hankman, 2011; Palacios, 2014; Parmenter, 2015). The smoother the operation, the happier the customers and the better organizational performance (Kumar et al., 2015; Lee & Woo, 2019).

Inventory management cannot get away from production and distribution processes in companies, including with constant improvement to continuously exceeding the customers' expectations (Apptricity, 2017; Bonney, 1994; Carmelita, 2019; Dorfman, 1954; Irhamsyah, 2015). Inventory management is crucial as large funds are relatively tied (Bandara et al., 2015; Dorfman, 1954). Firms are constantly looking for better inventory management around the clock (Cha et al., 2008; Mitchell & Kovach, 2016; Prempeh, 2015). With the advancement of technology, and the push toward online, streamlined activities have become cutting-edge for all companies. Speed becomes the driving force (Anantadjaya & Mulawarman, 2010). Delays become intolerable (Pasha et al., 2021). Customer power has drastically increased. Demand for low inventory level for cost reduction (Chin et al., 2012), frequent but small batches requests from customers, yet customized, are rising (Chin et al., 2012; Eisenhardt & Graebner, 2007; Koster, 2008; Koster et al., 2007). Order picking appears to provide a fast response to customers.

**Method**

The data was obtained from the firms' records and interviews with those, who are managing the logistics and warehouse. The representatives of the warehouse were interviewed. The emphasis on the interviews was on the activities, system, and warehouse operation. The firms' records are sourced out of the work instruction, and procedures to ensure the KPI, particularly on the level of accuracy, shrinkage, and tracking. The variables used are order picking (Koster, 2008) and warehouse performance (Parmenter, 2015), including their respective indicators of layout, zoning, batching, stock accuracy, inventory loss, and wrong parts supplied (Koster, 2008; Parmenter, 2015). PowerSim is used to show the dynamic modeling and evaluate the data connectivity, including analyzing the potential delays and incidents (Fujita et al., 2020; Vanhoucke, 2015).

**Discussion**

Warehouse Management System (WMS) is an ERP system. Just like the ERP, MFG/PRO software is grouped by modules to include; distribution, manufacturing, financial, service support, master files, and supply chain. According to the interview sessions, the WMS uses more sophisticated software to possibly reduce workforce expenses, inventory optimization, productivity, space usage, and eventually boosting customer services (Anantadjaya & Mulawarman, 2010).

The Powersim model is based on the warehouse processes, including related activities, which may likely influence the warehouse performance. Assumptions are based on the interviews and the company's available data.

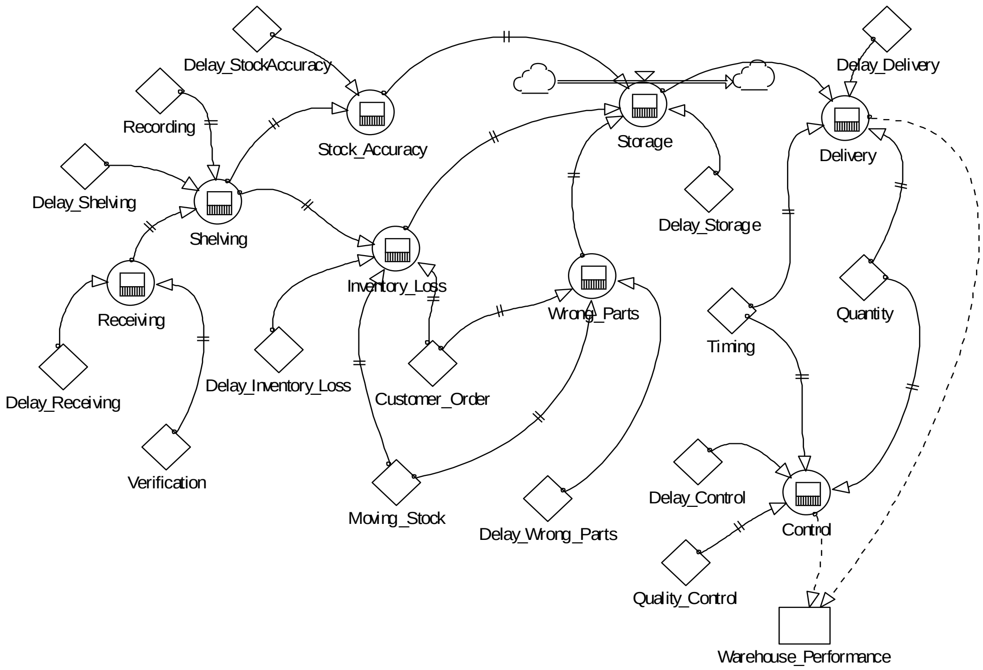


Figure 2. Modeling on powersim
Source: PowerSim


Figure 3. Stock accuracy
Source: Interview & Warehouse Records

The drastic drops into 87% indicate the inaccuracy in stock. Otherwise, the warehouse has shown relatively stable records on accuracy. Despite the sudden spike, the following graph shows also the relatively steady level of losses


Figure 4. Inventory loss
Source: Interview & Warehouse Records

Based on the interview sessions and document investigation, the following model can be illustrated to show the interconnectivity among processes. According to the interview sessions, this incident was solely due to the additional stocks in a warehouse following the closing of a manufacturing plant (Fanani et al., 2021; Kazakov et al., 2021). The inventory physical count was not the same as the records in WMS. This was where the order picking system restored the stock stability by maintaining the placement stocks. The historical data showed that no parts have been wrongly supplied. With such information, assumptions should be formulated for PowerSim.

Table 1
Assumptions

| Variables | Delays | Notes |
|---|---|---|
| Stock Accuracy | 33% | This is 20 minutes delay |
| Inventory Loss | 25% | This is 15 minutes delay |
| Wrong Parts | 25% | This is 15 minutes delay |
| Storage | 25% | This is 15 minutes delay due to human errors. |
| Warehouse Performance | 50% | This is 30 minutes delay in storage, delivery, controlling activities, and human errors. |

Based on the above assumptions for delays, the development of the PowerSim model is as follows;

Table 2
Formulas on PowerSim

| Process | Notes |
|---|---|
| Verification & Delay Receiving | 15 minutes and 30 minutes potential mistakes |
| Receiving | 50% potential delay for manual labor. |
| Recording & Delay Shelving | 15 minutes each for potential mistakes |
| Shelving | The potential delay is set at 50% receiving and 25% shelving |
| Delay Stock Accuracy | 20 minutes potential mistakes |
| Stock Accuracy | The potential delay is set at 25% for |

| Process | Notes |
|---|---|
| | manually moving stocks to shelves. |
| Moving Stock, Customer Order, and Delay Inventory Loss | 30 minutes moving stock, 15 minutes customer order, and another 15 minutes potential mistakes |
| Inventory Loss | The potential delay is set at 25% for stock movement and any related documents |
| Delay Parts | 15 minutes potential mistakes |
| Parts | The potential delay is set at 25%. |
| Delay Storage | 15 minutes potential mistakes |
| Storage | The potential delay is set at 25% |
| Quantity, Timing & Delay Delivery | 20 minutes of potential mistakes in quantity delivery process, time spent in delivery, and 25 minutes in the actual delivery |
| Delivery | 41.67% to account for accumulated potential mistakes |
| Quality Control & Delay Control | 30 minutes potential mistakes |
| Control | 50% accumulate potential mistakes |
| Warehouse Performance | The warehouse performance depends on control and delivery activities |

The following illustrations show the baseline, and normalized modes based on the assumptions previously set.

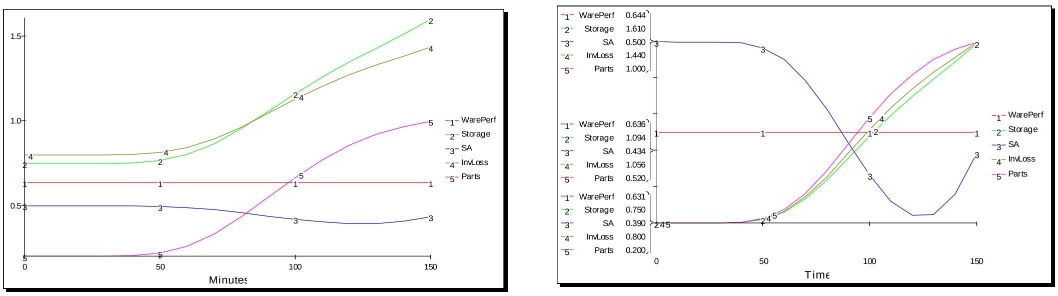


Figure 2. Base-Line & normalized modes
Source: PowerSim

The baseline mode shows the crucial first 50 minutes of physical stock items arrivals into the warehouse and the receiving processes are initiated. The stock accuracy drops slightly thereafter. Though the impact appears small, from 0.5 to 1.5, this shows the potential variations of delays of any stock items. The normalized mode shows that stock accuracy slides downward as soon as storage and losses start experiencing delays. However, it is also interesting to see that the level of stock accuracy bounces back. A closer observation indicated that commonly at about 120 and 130 minutes following the arrivals of stocks in the warehouse, management starts to initiate physical controls (Hult et al., 2004; Tan, 2001). The following table summarizes the assumptions above to better understand the inter-connectedness of activities, duration, and costs of the processes in receiving, storing, and supplying/delivering steps. The 30 minutes, 15 minutes, and 20 minutes are used as the most likely occurrence on certain activities in the next analysis.

Table 3
Process costs assumptions

| Categories | Process Time | Average Labors | Estimated Costs |
|---|---|---|---|
| Receiving | 0.5 hours | 2 | 31,250 |
| Storage | 0.25 hours | 2 | 15,625 |
| Supply | 0.33 hours | 4 | 41,667 |

* regional minimum wage is Rp. 3.4 million per month

Following the trends of calculations and approximation on potential delays, as discussed above, the underlying activities are adjusted accordingly to show the scenario on optimistic, the most likelihood of occurrence), and pessimistic durations.

Table 4
Warehousing activities

| | Activity | Optimistic (15% off) | Most Likely (see to the previous table) | Pessimistic (7.5% tolerance) | Avg | Predecessor | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | 1 | 2 | 3 |
| Verification | 1 | 12.75 | 15.00 | 16.13 | 14.81 | | | |
| Receiving | 2 | 25.50 | 30.00 | 32.25 | 29.63 | 1 | | |
| Recording | 3 | 12.75 | 15.00 | 16.13 | 14.81 | | | |
| Shelving | 4 | 12.75 | 15.00 | 16.13 | 14.81 | 3 | | |
| Moving Stock | 5 | 25.50 | 30.00 | 32.25 | 29.63 | | | |
| Customer Order | 6 | 12.75 | 15.00 | 16.13 | 14.81 | | | |
| Stock Accuracy | 7 | 17.00 | 20.00 | 21.50 | 19.75 | 4 | | |
| Inventory Loss | 8 | 12.75 | 15.00 | 16.13 | 14.81 | 5 | 6 | 4 |
| Wrong Parts | 9 | 12.75 | 15.00 | 16.13 | 14.81 | 5 | 6 | |
| Storage | 10 | 12.75 | 15.00 | 16.13 | 14.81 | 7 | 8 | 9 |
| Time | 11 | 17.00 | 20.00 | 21.50 | 19.75 | | | |
| Quantity | 12 | 17.00 | 20.00 | 21.50 | 19.75 | | | |
| Delivery | 13 | 17.00 | 20.00 | 21.50 | 19.75 | 11 | 12 | |
| Quality Control | 14 | 25.50 | 30.00 | 32.25 | 29.63 | | | |
| Control | 15 | 25.50 | 30.00 | 32.25 | 29.63 | 11 | 12 | 14 |
| Warehouse Performance | 16 | 25.50 | 30.00 | 32.25 | 29.63 | 15 | | |

For the work schedule, this study computes calculations to know the potential slacks (Heizer et al., 2016; Heizer & Render, 2011), as follows;

Table 5
Summary on slacks

| Steps | ES | EF | LS | LF | Slack | Critical Path? |
|---|---|---|---|---|---|---|
| 1 | - | 14.81 | 44.44 | 59.25 | 44.44 | No |
| 2 | 14.81 | 44.44 | 59.25 | 88.88 | 44.44 | No |
| 3 | - | 14.81 | 24.69 | 39.50 | 24.69 | No |
| 4 | 14.81 | 29.63 | 39.50 | 54.31 | 24.69 | No |
| 5 | - | 29.63 | 29.63 | 59.25 | 29.63 | No |
| 6 | - | 14.81 | 44.44 | 59.25 | 44.44 | No |
| 7 | 29.63 | 49.38 | 54.31 | 74.06 | 24.69 | No |
| 8 | 29.63 | 44.44 | 59.25 | 74.06 | 29.63 | No |
| 9 | 29.63 | 44.44 | 59.25 | 74.06 | 29.63 | No |
| 10 | 49.38 | 64.19 | 74.06 | 88.88 | 24.69 | No |
| 11 | - | 19.75 | 9.88 | 29.63 | 9.88 | No |
| 12 | - | 19.75 | 9.88 | 29.63 | 9.88 | No |
| 13 | 19.75 | 39.50 | 69.13 | 88.88 | 49.38 | No |
| 14 | - | 29.63 | - | 29.63 | - | Yes |
| 15 | 29.63 | 59.25 | 29.63 | 59.25 | - | Yes |
| 16 | 59.25 | 88.88 | 59.25 | 88.88 | - | Yes |
| Maximum Project Duration | | 88.88 | | | | |

The Gantt chart for the above calculations is shown below.

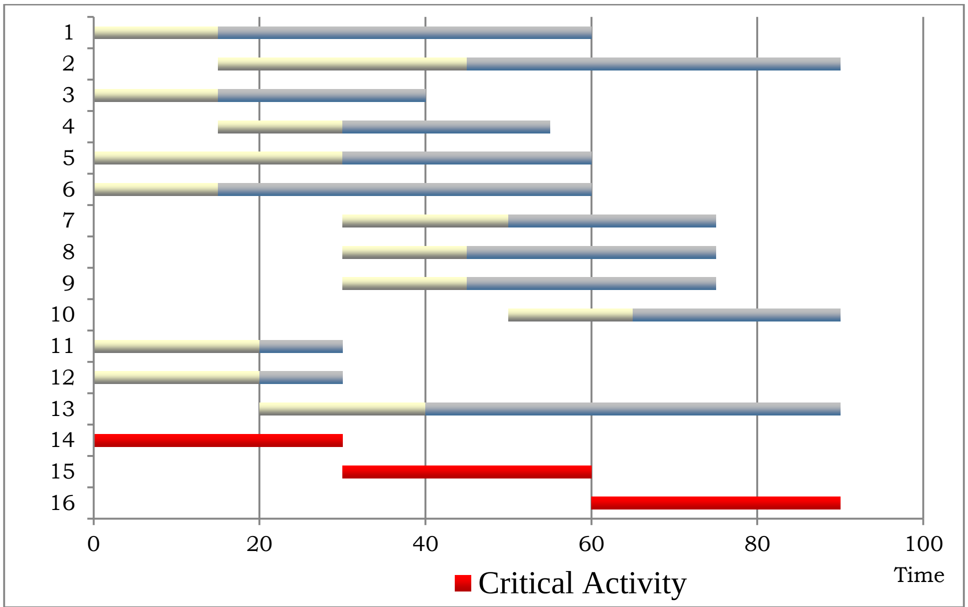


Figure 6. Gantt chart

The critical path is 14 (quality control activity), 15 (managerial control processes), and activity 16 (overall warehouse performance). The project crash cost can be calculated with some assumptions. The predecessors' activities are then assumed to be following the steps.

Table 6
Project crash costs

| Steps | Normal | | Crash | | | |
|---|---|---|---|---|---|---|
| | Time | Cost (Rp) | Time | Cost (Rp) | Cost/Day (Rp) | limit |
| 1 | 15.00 | 15,625 | 12.75 | 71,786 | 24,961 | 2.25 |
| 2 | 30.00 | 31,250 | 25.50 | 284,198 | 56,211 | 4.50 |
| 3 | 15.00 | 15,625 | 12.75 | 71,786 | 24,961 | 2.25 |
| 4 | 15.00 | 15,625 | 12.75 | 71,786 | 24,961 | 2.25 |
| 5 | 30.00 | 31,250 | 25.50 | 284,198 | 56,211 | 4.50 |
| 6 | 15.00 | 15,625 | 12.75 | 71,786 | 24,961 | 2.25 |
| 7 | 20.00 | 20,833 | 17.00 | 126,965 | 35,377 | 3.00 |
| 8 | 15.00 | 15,625 | 12.75 | 71,786 | 24,961 | 2.25 |
| 9 | 15.00 | 15,625 | 12.75 | 71,786 | 24,961 | 2.25 |
| 10 | 15.00 | 15,625 | 12.75 | 71,786 | 24,961 | 2.25 |
| 11 | 20.00 | 41,667 | 17.00 | 503,931 | 154,088 | 3.00 |
| 12 | 20.00 | 41,667 | 17.00 | 503,931 | 154,088 | 3.00 |
| 13 | 20.00 | 41,667 | 17.00 | 503,931 | 154,088 | 3.00 |
| 14 | 30.00 | 62,500 | 25.50 | 1,130,896 | 237,421 | 4.50 |
| 15 | 30.00 | 62,500 | 25.50 | 1,130,896 | 237,421 | 4.50 |
| 16 | 30.00 | 62,500 | 25.50 | 1,130,896 | 237,421 | 4.50 |

Based on the calculations on project crash cost above, the project crash limit can be computed from differences in the normal times versus the crash time;

Table 7
Project crash

| Steps | Crash | | |
|---|---|---|---|
| | Cost (Rp) | Limit (minute) | Total (Rp/minute) |
| 1 | 24,961 | 2.25 | 32,233 |
| 2 | 56,211 | 4.50 | 158,215 |
| 3<br>4 | 24,961 | 2.25 | 32,233 |
| 5 | 56,211 | 4.50 | 158,215 |
| 6 | 24,961 | 2.25 | 32,233 |
| 7 | 35,377 | 3.00 | 63,810 |
| 8<br>9<br>10 | 24,961 | 2.25 | 32,233 |
| 11<br>12<br>13 | 154,088 | 3.00 | 294,287 |
| 14 | 237,421 | 4.50 | 691,431 |

| Steps | Crash | | |
|---|---|---|---|
| | Cost (Rp) | Limit (minute) | Total (Rp/minute) |
| 15 | | | |
| 16 | | | |
| Total | | 28.5 | 2,367,334 |

The tasks can be performed faster at approximately 28.5 minutes at a total estimated cost of Rp. 2,367,334. Based on the project crash cost, project completion can be estimated. The assumptions are; duration of the optimistic condition is 15% faster and the pessimistic is 7.5% slower than initially planned.

Table 8
Probability on task completion

| Time (minute) | Probability | |
|---|---|---|
| | Comma | Percent |
| 19 | 0.1948913962 | 19.48913962% |
| 20 | 0.3643666191 | 36.43666191% |
| 21 | 0.5660746401 | 56.60746401% |
| 22 | 0.7516177518 | 75.16177518% |
| 23 | 0.8835241116 | 88.35241116% |
| 24 | 0.9559950160 | 95.59950160% |
| 25 | 0.9867631027 | 98.67631027% |
| 26 | 0.9968561700 | 99.68561700% |
| 27 | 0.9994139636 | 99.94139636% |
| 28 | 0.9999146317 | 99.99146317% |
| 29 | 0.9999903132 | 99.99903132% |
| 30 | 0.9999991459 | 99.99991459% |
| 31 | 0.9999999416 | 99.99999416% |
| 32 | 0.9999999969 | 99.99999969% |
| 33 | 0.9999999999 | 99.99999999% |
| 34 | 1.0000000000 | 100.00000000% |

From the probability table above, the likelihood of the task or project should be completed is within 26 to 33 minutes. A different graphical illustration is necessary to show the estimated project or task completion at least by the 26th minute.

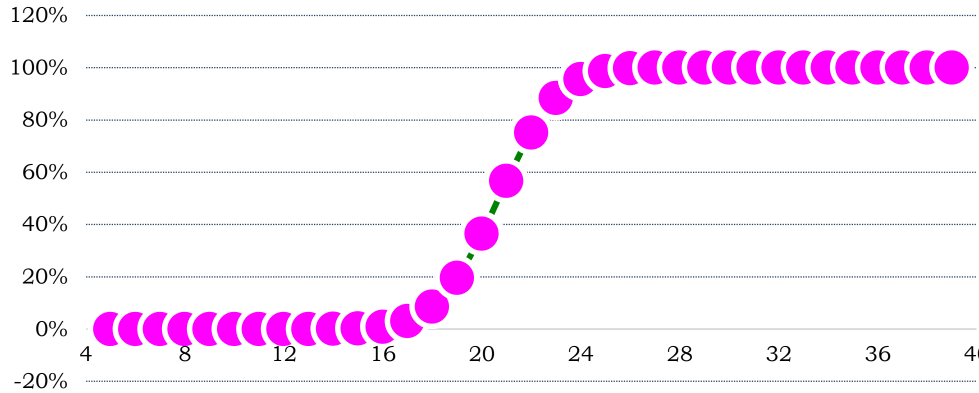


Figure 7. Probability on task completion

As shown in the graph, with faster completion, order picking should bring about a substantial likelihood of cost savings. This result is consistent with the previous studies from the publicly-listed firms and provides support to such findings. That is a relatively substantial impact between warehouse management, inventory management, and proper handling of the movements of goods into the financial performance (Carmelita, 2019).

## Conclusion

Order picking system shows benefits in storage space and speed in catering for requests in the warehouse. There is supporting evidence for successful order picking based on FIFO with an appropriate width with the stock accuracy almost reaching 99%, inventory loss, and the numbers of wrong parts are drastically reduced. Eventually, efficiency is achieved. Hence, the likelihood of inventory management has a significant influence on financial performance in the manufacturing industry is unarguably satisfied. Improvement in packaging in terms of the shapes and SKUs are also beneficial to smooth out the dynamic storage systems while reducing the order picking travel time. This directs for higher productivity, undoubtedly. Future studies can investigate the financial records of the domestic and international manufacturing firms to see if the finding in this study and previous studies holds and/or show signs of improvements.

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