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Improvement of an Order Fulfillment Process: A Case Study in a Vietnamese Distributor

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Abstract

This study aims to present a case study in which the methodology of Six Sigma or Define-Measure-Analyse-Improve-Control (DMAIC) is used to improve an order fulfilment process in a small-sized distributor in Vietnam. The DMAIC cycle will be used as the methodology to improve the order fulfilment process of the case company. The goal of the process improvement project is to enhance the flexibility in order fulfilment by increasing the fill rate of customers' special and urgent orders. The simulation shows that by modifying the inventory policy (i.e., the ordering quantity and interval), the company can save from 48% to 78% of the lost revenue caused by rejecting special and urgent orders. By evaluating financial benefits, there are two options for the company: one option would be using a constant ordering interval and the economically optimal quantity of 60,000 units; the other option would be to implement a ROP inventory policy using the same ordering quantity. The second option is more sustainable in the long run due to its adaptability to the change in demand and overall higher service level. Based on the result of numerical simulation, the selected solution shows the gained profit of approximately 367 million VND. Through the positive outcomes, the research serves as a valuable case study for small firms to realize the benefits of business process improvement, as well as the applicability of DMAIC method in improving process performance.

Keywords: DMAIC Cycle; Special and Urgent Orders; Inventory Models; Numerical Simulation; Long-run Adaptability

1. Introduction

A business process is a structured and repetitive flow of activities in a form of a chain or network that, in the end, produce a result or serve an objective of one or more companies (Uko, 2023). Among the business processes, order fulfilment can be seen as one of the most vital processes to a company's profit equation. An order fulfilment network of a product involves the companies that handle the physical transportation, the companies that handle legal procedures, and the companies that provide and/or manage the storing facilities at each node of the transportation (Schwarz, 2022). Since order fulfilment is such an important process to most companies' business model, there is a need for improvement and optimization of this process. However, it is often challenging for small companies to optimize business process due to the lengthy research and substantial amount of data required for these projects. On the other hand, the concept of lean management and continuous improvement are simpler and more feasible given the constraints that small firms have. The basis of process improvement in the framework of lean management is that through the project, the company seeks methods and techniques, often a change to existing systems, that would better the performance indicators of the process. By improving these indicators, the resulted performance is often increased profit, reduced cost or better performance in certain beneficial areas such as higher brand loyalty, more goodwill, etc.

The methodology we applied in this research is DMAIC, Define-Measure-Analyze-Improve-Control. Although this method is widely-known, few small-sized companies have utilized it to enhance their process performance according to my preliminary literature review. The best way to demonstrate the applicability and practicality of this method is through conducting a case study.

The case study is conducted on a real-life order fulfilment process of a company among the small and medium enterprises (SMEs). SMEs make up 98% of all legal entities in Vietnam and their revenue constitutes 40% of the country's Gross Domestic Product (Zorrilla, 2022). The Vietnamese SMEs impose a promising growth and a high potential for foreign investors as the economic forces from globalization reaching Vietnam (Vuong, 2020). In 2023, the global water treatment industry was valued at USD 38.56 billion, and 36.2% of which is accounted for by the Asia-Pacific market (Grand View Research, 2023). The water treatment equipment market in Vietnam still relies heavily on foreign imports, as claimed by the company's founder and CEO, Ms. Xuan Vo. She said more than 90% of the company's products come from suppliers overseas. This shows how the performance of the order fulfilment process determines the success of the company's business model and profit margin. At the moment, small Vietnamese distributors in water treatment product industry and other industries faces many challenges due to the general market configuration, as in Figure 1.

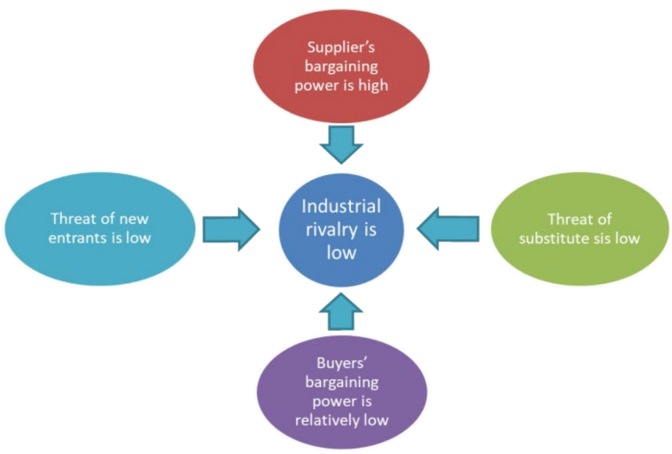


Figure 1: Porter's Five Forces diagram

This analysis was drawn based on the descriptions of concerns stated by Ms. Xuan Vo and other CEOs of similar firms. The diagram shows that suppliers, especially overseas have a substantially stronger bargaining power in the supply chain and thus, forcing small distributors like the case company to adjust and change in other to provide the most competitive service for their customers. Therefore, it is very important for the company to continuously improve the performance of their order fulfillment process in order to maintain customer satisfaction and loyalty. In the research, we aim to help the company improving its order fulfilment process and through that, promoting the use of DMAIC cycle in BPI projects across the industry.

1.1 Literature Review

The focus of the research is on the order fulfilment process of an intermediary in Vietnam. The order fulfilment process, also known as "Order Management Cycle" or OMC, is a business process whose focal point is to manage the creation, motion and completion of the orders. As the economy grows with the emergence of new technologies and management concepts, the process moves its focal point to the satisfaction of its stakeholders which are suppliers, supply chain members and customers. Therefore, in the new management mindset, the order fulfilment process involves receiving orders, fulfilling the orders, making delivery and providing further services to the customers regarding their orders. Shapiro et al. (2004) stated that "what customers want is to have their orders handled quickly, accurately and cost effectively". The saying basically summarizes the objective and function of the order fulfilment process. It means the OFP is responsible to physically move the products or services from the manufacturers or suppliers to the customers who have placed the orders, in a timely and accurate manner while maintaining reasonable costs. Lin and Shaw (1998) described the process as a series of activities, with a start and an end, which is broken down into upstream and downstream activities. They also emphasized on the complexity of this process, due to the interconnectivity of the activities, or sub-processes and the involvement of many business functions in a supply chain. Each member of the supply chain is considered as a functional entity in this case, rather than a shipment node. The OFP is "a network that permits a firm to meet the customer requests while minimizing the total cost", (Croxton, 2003). Because of the focus on cost minimization, many order fulfilment processes are designed so that the objectives are achieved at the lowest cost possible and with the trade-offs of other parameters such as customer satisfaction or service level.

The theoretical basics of this research are the process improvement method. Such a method is usually applied through a business process improvement project (BPI) project. The definition from the Association of Business Process Management Professionals in the BPM- CBOK Guide stated that "Business Process Improvement (BPI) is a singular initiative or project to improve the alignment and performance of a particular process with the organizational strategy and customer expectations" (Kirchmer, 2019). The purpose of BPI is to seek the best process design that reduce time and eliminate waste and friction, or "bottleneck", in the process which could cause unwanted outputs such as delays, downtime, lateness, non-optimal machinery's capacity, reduced productivity, etc. Other objectives for a BPI project are to ensure that the process meets regulated standards and established rules, to refine customer satisfaction through better experience, to discover the root causes of the frequently occurred problems and to pinpoint deficiencies to be solved (Pratt, 2023). Specifically, for the order fulfilment process, there have been several diverse and innovative methods being developed and proposed for improving process performance. Some of the notable methods are warehouse network design (Korpela & Lehmusvaara, 1999), the re-evaluation of real-time order fulfilment (Xu et al., 2008), the integrated order fulfilment system with product customization using configure-to-order approach (Zhang et al., 2010), the dynamic allocation of orders (Acimovic & Graves, 2014), an LP-based scheme for multi- item order fulfilment (Jasin & Sinha, 2015), the decision support system for handling shipments (Leung et al., 2016), the package consolidation and order consolidation for last- mile delivery (Zhang et al., 2017 & Zhang et al., 2019). Many research was done to validate the use of DMAIC based method in process improvement such as the case study conducted in an Indian fasteners manufacturing organization (Kumar et al., 2021) and another in a bogie manufacturer of the railcar industry (Daniyan et al., 2022). Despite the advancement in concepts and tested results, the lack of practical examples done in similar setting and company size is the main reason why DMAIC methodology is not widely adapted by Vietnamese SMEs. Bach (2021) presented four examples, among which one is in manufacturing setting, one is in healthcare industry, one deals with qualitative data and the last example is something you could utilize at home. The examples are diverse and unique but results are non-substantial and thus, not convincing to the businesses.

The significant difference of the findings in this research as compared to existing literature is that it is derived from a case study, thus making it a more applicable and realistic results. The applicability of the findings is also shown through the fact that the conclusion and suggestions were considered by the firm to be implemented in the near future. The originality of this research is that it used a new approach in conducting process improvement project.

To aligning this research with the existing literature base, we can look at a few other case studies where the method of DMAIC is used to solve similar problems, such as increasing completion rate (Sedorovich, 2019) and improving delivery efficiency (Tennakoon & Palawatta, 2015). Within recent works, we found that DMAIC methodology has become increasingly popular as a method to elevate performance metrics for companies in growing economies like Vietnam (Wang et al., 2024), in India (Mittal et al., 2022), etc. Although the number of research using DMAIC is high and increasing in recent years, most research focus on large-volume production and service tasks. These projects deliver excellent results and outcomes to the case study firms; however, they are costly and too complicated for small- and medium-sized enterprises to implement. Therefore, this research aims to fill the knowledge gap in terms of feasibility and applicability of BPI projects for SMEs.

1.1.1 Research Framework

This BPI project will be carried out using the five steps in the DMAIC method, namely Define, Measure, Analyze, Improve and Control.

2. Methodology

This research shows a new and unique case where DMAIC could be applied with impressive results in a SME. DMAIC is a

2.2 Case Study

In this research, we conducted an applicative study on the Vietnamese medium-sized provider of water treatment products and solutions. This company acts as a supplier for water treatment plants in Vietnam, and as a distributor for foreign suppliers of water treatment products. Their business model represents a typical B2B-business relationship and environment. The company has been a prominent player in the industry within the market of Vietnam for over two decades.

In the order fulfilment process, the company acts as a mediator between the supplier and the customer. The products are transported from the supplier all around the world to Vietnam via air cargoes or sea freights. A forwarder which the company had carefully selected is responsible for this part of the transportation. Once the products arriving in Vietnam, the delivery will be completed by the company, using either their own transportation fleet or a third-party logistic provider (3PLSP). The process is illustrated in Figure 2.

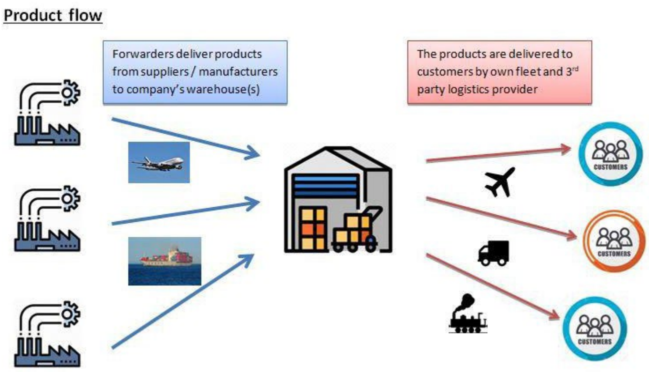


Figure 2: Product flow in order fulfilment process

The order fulfilment process of the company starts with processing the order. This encompasses the reception and record of the order into the system as well as the settlement of price and the delivery date. Next, the items need to be ordered from the suppliers. Following that, the suppliers would produce, and the forwarder would transport the items to Vietnam (the left-hand side of Figure 1). This action is considered as "importing" by the company. Subsequently, the order will be warehoused; this step also includes the clearance for the items at the border custom, the payment of tax, and other necessary documentation. Because the amount that is imported would serve more than one customer or more than one order, the next sub-process required is an order picking. This sub-process consists of picking the order correctly and packing them in a suitable manner for delivery. Then finally, the order is delivered to the customer (the right-hand side of Figure 1). The entirety of the company's OFP can be seen in Figure 3.

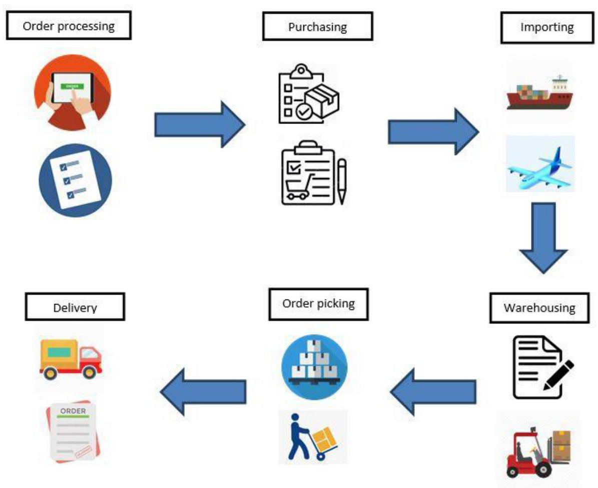


Figure 3: Steps in order fulfilment process

2.3 DMAIC Methodology

After understanding the set-up of the company, its order fulfilment process and its industry, we can start to apply the DMAIC methodology to improve the performance of this process.

2.3.1 Define

In order to make the problem more manageable, the company is asked to select a specific product to focus on in this project. The company aims to improve their customer's experience of their order fulfilment process for product X. Product X constitutes 80% of the company's sales revenue and is the one of the company's strongest revenue drivers. This is because product X is a chemical used in water treatment. Among the water treatment equipment, chemicals are the most crucial and constitute the largest part of the industry's revenue (Anjumnisha & Prasad, 2023).

To collect the voice of customers (VOC), a questionnaire is developed to collect feedback from the customers on those matters. Ten prominent customers, comprising of 60% of the product X's sales, are asked to rate the company's service and the quality of its order fulfilment process on the scale of 1 to 5. Overall, the rating of "1" means the worst performance and "5" means the best performance. The higher the score means the better the performance of the company. The questions, as shown in Table 1, are grouped into 8 categories: (1) Responsiveness, (2) Accuracy, (3) Timeliness of delivery, (4) Customer service quality, (5) Service level, (6) Process complexity, (7) Flexibility and, (8) Cost effectiveness. These categories are derived from the customer-oriented metrics the company most concerns with, suggested by the company's management.

Table 1: Customer survey questions and their corresponding process metrics

#	Questions	Category
1.1	How timely does the representative from the company respond to your order request?	Responsiveness
1.2	How well does the representative from the company resolve the problems with your order?	Responsiveness
2.1	How often does the problem occur with your order (wrong items)?	Accuracy
2.2	How often does the problem occur with your order (wrong quantity)?	Accuracy
3.1	How quick is an order usually fulfilled?	Timeliness
3.2	How often does an order being delayed?	Timeliness
4.1	How well is an inquiry or complaint from you addressed by the company?	Customer service
4.2	How often are you disappointed by the company's order fulfillment process handlings? (Please specify below)	Customer service
5.1	How often is an order from you rejected/postponed due to inadequate stock?	Service level
5.2	How well does the company try to accommodate your demand?	Service level
6.1	Is the process of placing order and receiving the order easy in your perspective?	Process complexity
6.2	Are the steps in the process easy to cope with and follow?	Process complexity
7.1	Is it possible and easy to make changes to your order?	Flexibility
7.2	Is it possible and easy to place special, urgent orders?	Flexibility
7.3	How well does the company accommodate your special orders?	Flexibility
8.1	In general, how do you perceive the company's service based on cost perspective?	Cost effectiveness
8.2	Cost management, in term of contingency, is well done?	Cost effectiveness

The questionnaire was sent to and replied by ten companies among the hundreds of customers. These ten companies are some of the company's most prominent customer for Product X. Figure 4 details the results of the questionnaire.

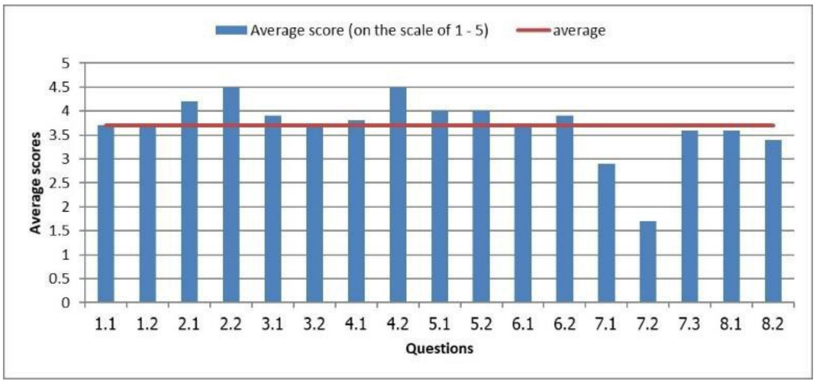


Figure 4: Questionnaire results

From the chart, we can identity the weakness of the company's order fulfilment process is its flexibility. The lowest-score parameter is 7.2 which represents the company's ability to fulfill S/U orders. At the moment, the company faces the problem of low flexibility. This problem has been confirmed by the executive due to the ongoing dissatisfaction of the customer with the current fulfilment process performance.

2.3.2 Measure

Knowing the problem, the goal of project is to solve the company's inability to fulfill their special and urgent orders (i.e. orders that placed less than 3 months ahead). To address this problem, we need to study the company's current process capability to fulfill S/U orders. To find the cause of the problem, we need to look at the data on the company's order fulfillment process. The order data of the year 202 was retrieved from the company's order management database and formatted into columns of "Date of received", "Inbound order amount", "Outbound order amount", and "S/U orders (Yes/No)". Inbound orders are orders sent from the supplier and had arrived at the company's warehouse. Outbound orders are the orders sent out by the company and had arrived at the customer's warehouse. S/U orders are defined as orders which were placed less than 3 months from the date of received. In the original state, all S/U orders are rejected to prevent the risk of running into stock shortage according to company policy.

From this data pool, the data on number of rejected S/U orders in the year of 2020 is extracted and tabulated. Figure 5 expresses the process capability in controlling number of rejected S/U orders per month using Poisson distribution. The number of rejected S/U orders per month can be expressed as number of defects per unit (DPU) with a "unit" in this case, equals to one month. In this case, DPU indicates the amount of S/U orders rejected per month.

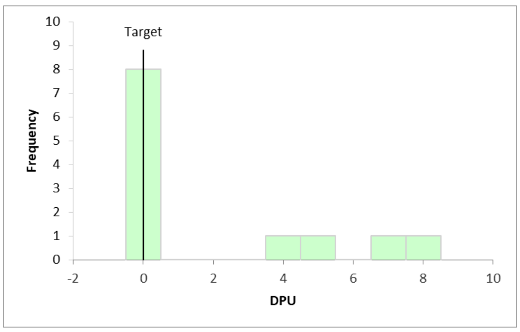


Figure 5: Poisson distribution of "Number of rejected S/U orders per month"

Figure 6 shows the u-chart of the process variation. U-chart is known as the control chart for defects per unit (Hessing, 2023). With u charts, the number of defects per single unit is plotted on the y-axis, and the number of units or lots is on the x-axis. The centerline (u-bar) is the total number of defects in a sample divided number of inspected items in a sample. The inspected item is the number of S/U orders each month, and a defect is a rejected S/U order. UCL and LCL of the KPI can be calculated using the mean KPI of 2 and σ of 2.97, based on this formula: CLs = mean ± 3σ.

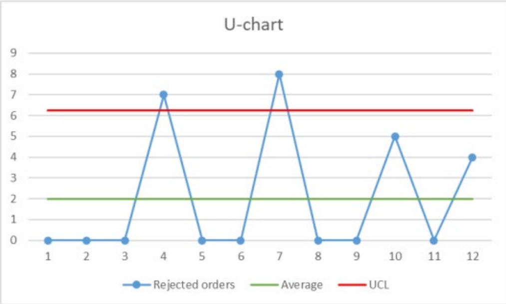


Figure 6: Control chart of "Number of rejected S/U orders per month"

2.3.3 Analyze

If any of the points in the chart are outside of ± 3σ limit, then consider the process is out of control (Hessing, 2023). In the u-chart example, there are two instances where the process exceeds the upper control limit (UCL) or lower control limit (LCL). Hence, we assume the process is in control. In this step of DMAIC, we would like to identify possible cause of the problem and path for improvement.

Causality analysis

The company currently plans their restocking based on the expected lead time of 3 months. However, in practice, the lead time that the supplier and forwarder offer can fall at any value between 3 and 5 months. Using the expected length of 3 for lead time, the company only orders an amount enough to cover the demand of 3 months plus a small safety stock for the buffer period and special requests occurred. This is the main reason why the company has to reject more S/U orders whenever a restocking order or supply arrives later than the expected time. The problematic variation in number of rejected S/U orders occurs in the months of April and July. Those rejections are explained by the reason: Late arrival of stock, as shown in Figure 7. Therefore, this is the main root cause of the problem the company is facing.

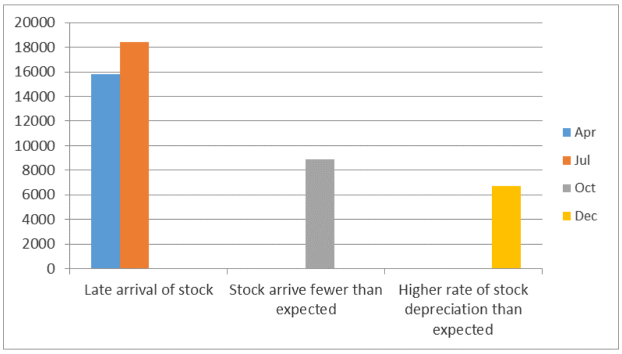


Figure 7: Reasons for rejecting S/U orders

Designing path for improvement

Based on the process design and mechanism, the controllable and non-controllable variables are shown in Table 1.

Table 2: Controllable and non-controllable variables

Variable name	Description/Definition of variable	Variable type
Order details	the committed due date and order quantity	Controllable
Priority of fulfillment	the way the company decides which of the orders to be fulfilled first and later	Controllable
Restocking quantity	the quantity that would be placed with the supplier	Controllable
Re-Ordering Point (ROP)	the point of time in which a restocking order is placed by the company; can be defined as a regular interval or as a criterion	Controllable
Supplier's lead time	the time it takes for the supplier to deliver their products, consisting of the shipment time, and time for other shipment-related tasks	Non-controllable
Supplier's quantity	the restocking quantity the supplier has shipped out for the company	Non-controllable
Customer's lead time	the time the customer would want the fulfillment of their order to take, which is determined as due date minus committed date	Non-controllable
Demand occurrence point	the time the customers place their order	Non-controllable

In DMAIC project, the improvement methods are derived from changing or modifying the performance of controllable variable(s) which we know have a direct causal effect on the process KPI. Knowing that the long lead time is the main cause of the problem, however, the supplier's lead time is not controllable, we have to change other variables. To address the long lead time without switching to new suppliers, the company could try to modify the controllable variables in the ways that would result in an improved flexibility of the process. The controllable variables that can directly impact the order fulfillment capability are restocking quantity and re-ordering point which defines the restocking point (i.e., the point at which the stock arrives at the company's warehouse). These two variables constitute the inventory policy. So, we can conclude that applying a different inventory policy is the way to solve the problem.

2.3.4 Improve

Proposing solutions

After discussion with the case company, we have chosen to focus on the evaluation of these following four options:

1) Increasing and maintaining a fixed restocking order quantity
2) Employing a desirable inventory level, S with certain ordering interval
3) Employing a dynamic restocking scheme using Reorder Point (ROP) where safety stock level is required

The three approaches are based on often-used standardized inventory policies, namely: Economic Order Quantity (EOQ) ordering model (Fernando, 2024.), Order-up-to-S model (ERP Informers, 2023), and (Q, R) inventory model (Linnworks, 2020). These solutions are proposed due to their popularity as an improvement method for inventory policy and feasibility given the company's setup.

Evaluating solutions

Among the solutions, we will compare only solution no.1 and no.3 because solution no.2 shows to be more complicated to be implemented according to the company and would be remove from the consideration set.

4) Solution no.1: Using EOQ

In this first method, we aim to increase the overall supply per period of one year in order to enhance the company's ability to fill orders regardless of urgency. The improvement in S/U fill rate can be realized through the higher inventory level that would allow the company to have more confidence in committing and fulfilling S/U orders in any circumstances. However, ordering high quantity from supplier can lead to over-stocking. Therefore, it is beneficial to apply the concept of EOQ, or Economically Optimal Quantity, which can be calculated by:

$$EOQ = \sqrt{ [(2 * RC * D) / HC] }$$

In which,

- RC = reordering cost per order,
- D = annual demand (expected), and
- HC = annual holding cost per unit (as percentage of unit cost).

The ordering cost and unit cost is set by supplier, while annual demand is provided by the company. The holding cost would be calculated based on the fixed unit cost based on the data provided by the company that HC = 4% of unit cost. However, the supplier's pricing for unit cost is given as follows:

- 5,000 VND per unit: for unit 1-60,000
- 7,000 VND per unit: for unit 60,001;

The procedure used to find the best EOQ is to calculate the best order quantity for each price level until a feasible EOQ is found (Singla, 2018). The EOQs would be 73,000 units or 62,000 units respectively as shown in table 3 (rounded-up).

Table 3: Calculation of EOQ

Variables	Values 1	Values 2	Units
Ordering cost (Rc) =	2,000,000.00		VND
Unit cost (Uc) =	5,000.00	7,000.00	VND
Holding cost (Hc) =	200	280	VND
Annual demand (D) =	265,685.00	265,685.00	unit
EOQ =	72,895	61,607	unit
Best feasible order quantity	60,000	62,000	units
Total cost of selected Q	41,424,666.67	42,961,935.48	VND

The first EOQ, which was calculated using unit cost of 5000 VND, is higher than 60,000 units. Therefore, this EOQ is not feasible and the feasible order quantity closest to EOQ, 60,000 units, is selected. For unit cost of 7,000, the EOQ is also higher than 60,000 units. Thus, the second EOQ (EOQ = 62,000) is feasible. After comparing the total cost for the selected order quantity, of unit cost =7,000 with the highest feasible order quantity of unit cost = 5,000 (EOQ = 60,000), the order quantity of 60,000 is selected.

5) Solution no.3: Using (Q, R) inventory policy

In this method, we aim to calculate an inventory level at which the company should place a constant restocking order. There are two components of this model: first, a fixed Q (which is the EOQ used in Proposed solution #1) and second, a reordering point must be determined. In order to determine when to place a restocking order, we must calculate the Reordering point (ROP), the point when: If Inventory position (IP) < ROP, then a restocking order should be placed. IP and ROP can be determined using the steps below:

IP, or Inventory Point, is calculated as:

Inventory point (IP) = On-hand Inventory – Backorders + On-order Inventory, where:

- On-hand Inventory (IoH) = end of the month inventory
- Backorders = orders that were not fulfilled in the given month
- On-order Inventory = Inventory ordered and to be received

ROP is expressed as the summation of Safety stock and Demand during lead time: Reorder Point (ROP) = SS + Demand LT, where:

Safety stock (SS), for process with uncertain demand and lead time, is found by:

$SS = z * \sqrt{(Avg\ LT * \sigma_d^2 + Avg\ D * \sigma_{LT}^2)}$

In which,

- Z = service factor that represents the desired service level based on normal distribution
- Avg LT = mean of lead time in months
- σ_d = standard deviation of demand per month
- Avg D = mean of demand per month
- σ_{LT} = standard deviation of LT in months; and

Demand LT (demand during lead time) is calculated using the formula below:

Demand LT = Avg LT * Avg D

So, the calculation for suitable ROP of this process is as shown in Table 4. The mean and standard deviation of demand are the same values that were used in proposed solution #2, while mean and standard deviation of lead time are found by the lead times of restocking orders occurred in the year of research, as provided by the company. The value of Z, is selected based on service level of 95%.

Table 4: Calculation of ROP

Variables	Values	Units
Z =	1.65	
σLT =	0.5	months
σD =	9,850.02	units
Avg D =	22,140.42	units
Avg LT =	3.50	months
Safety stock =	27,764.00	units
Demand LT =	77,491.46	units

Compare solutions to find best solution

A financial analysis is necessary to determine the benefit and implementation costs for each of the solutions. Table 5 presents the details of the financial analysis based on the comparison between different solutions' outcome with the outcome where no change is made. Among the costs, there are:

- Ordering cost = 2 million VND per restocking order; 4 orders per year
- Holding cost = the average holding cost of the order quantity (For example, an order of 62,000 units will have (60,000*200 + 2000*280)/ 62,000 = 202.58 as the holding cost). For the method where the order quantity is not constant, the yearly average holding cost is the average of the holding cost for each order.
- Shipping cost = 60 million VND per restocking order
- Ensurance cost is a special cost, which is a fee needed to be paid to the supplier in order to ensure that the restocking orders would arrive at the right time and with the right quantity = 6 million VND.
- Premium cost = 2000 VND for any units above 60,000 for a single order. Order quantity of less than 60,000 would not incur such cost
- Inventory cost = 5,000 VND which is the basic unit cost of product X
- Goodwill cost (loss of goodwill) is presumably a fine per lost order = 3 million VND.

The first column represents the main costs, revenue and profit of the order fulfillment process. Based on this financial analysis, we see that solution #1 and #3 yield the highest and second-highest profit gained with a small margin of difference. Therefore, we will evaluate both solutions in the control phase.

Table 5: Solution comparison based on financial analysis

Costs/ Earnings	Original	Solution #1 - EOQ	Solution #3 – (Q, R)
Ordering cost per order	2,000,000	2,000,000.00	2,000,000.00
Number of orders	4	4	4
Ordering cost in a year	8,000,000	8,000,000.00	8,000,000.00
Holding cost per unit	200.00	200.00	200.00
Total holding units	206,000	475,025	595,025
Holding cost in a year	41,200,000	95,005,000.00	119,005,000.00
Shipment cost per order	60,000,000	60,000,000.00	60,000,000.00
Orders per year	4	4	4
Shipping cost in a year	240,000,000	240,000,000.00	240,000,000.00
Order ensurance cost per order	6,000,000	6,000,000.00	6,000,000.00
Number of orders in need of ensurance	-	4	4
Order ensurance cost in a year	-	24,000,000.00	24,000,000.00
Premium fee	2,000	2,000.00	2,000.00
Units in need of premium			
Order premium cost in a year	-	-	-
Inventory cost per unit	5,000	5,000.00	5,000.00
Total inventory units in a year	206,000	240,000	240,000
Inventory cost in a year	1,030,000,000	1,200,000,000.00	1,200,000,000.00
Goodwill cost per order	3,000,000.00	3,000,000.00	3,000,000.00
Number of lost orders	24	-	-
Goodwill cost in a year	72,000,000	-	-
Number of units sold	215,845	265,685	265,685
Unit price	10,000	10,000.00	10,000.00
Revenue in a year	2,158,450,000	2,656,850,000.00	2,656,850,000.00
Total costs	1,391,200,000.00	1,567,005,000.00	1,591,005,000.00
Net Profit	767,250,000.00	1,089,845,000.00	1,065,845,000.00
Net Profit Gained	498,400,000.00 [1]	391,608,000.00	367,608,000.00
Percent improvement		78.57	73.76

[1] This number represents the **ideal case** where the lost profit from the S/U orders could be obtained without any change implementation

2.3.5 Control

Before and After Implementation

The company has to devise a plan to adopt the new change. However, since adaptation of new policy will be permanent, the company desires to see the change be applied first in the form of a simulation. The data used for this simulation is the order data of two consecutive years, 2020 and 2021. The change in the process using the improvement method will result in an improved inventory line in terms of potential inventory deficit.

As shown in Figure 8, without implementing any method, the OFP would fail to obtain a high fill rate for S/U orders without incurring a stock negativity. Both solutions will produce positive results in inventory since there are no inventory deficit.

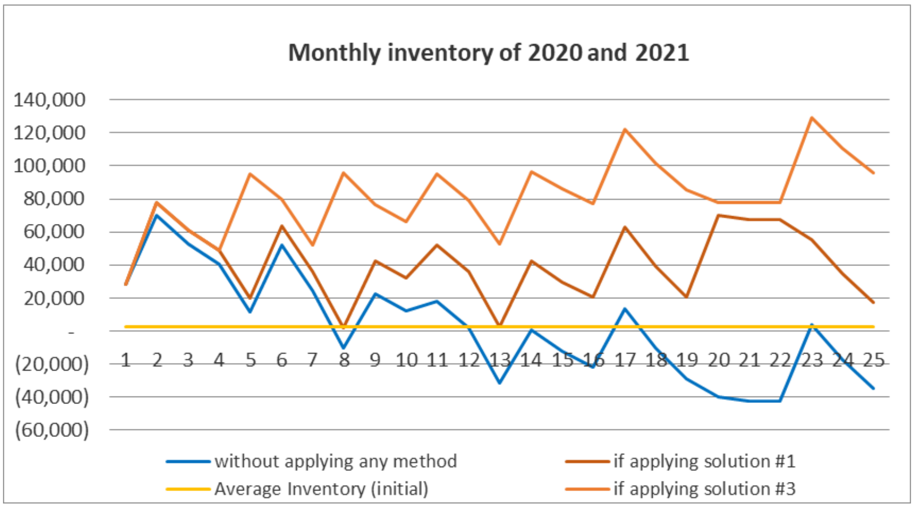


Figure 8: Monthly inventory before and after implementation

The KPI used in the control phase is the service level or monthly order fill rate. Figure 9 shows the performance of KPI before versus after the implementation of the improvement method. As we aim to achieve the target fill rate of 100%, the graph shows that the process has met the KPI after the improvement method was implement.

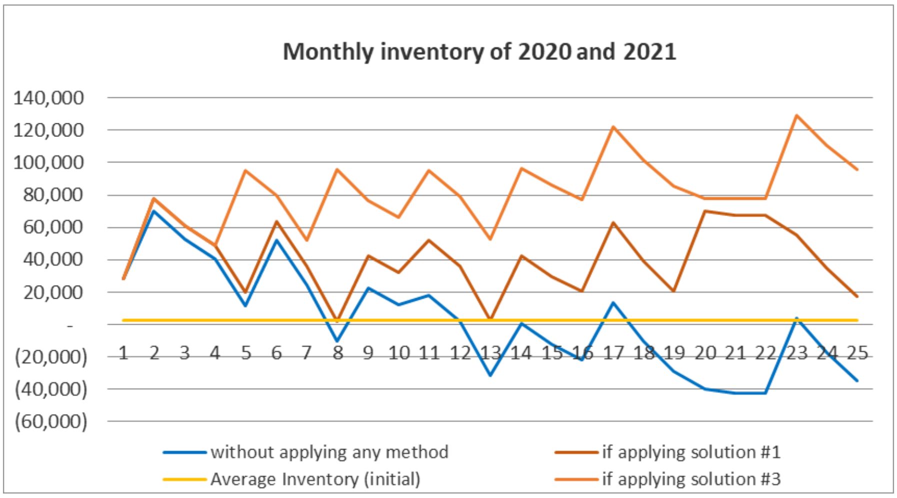


Figure 9: Fill rate before and after implementation

Monitoring the process in the future

To maintain a stable process, its main performance metrics have to be stable and lie within the control limits (CLs). As for an OFP, the inventory level is very important for the company since either understocking or overstocking will incur costs and other drawbacks, and thus it need to be monitored. Using the actual data of monthly inventory in the year of 2020 and 2021, the limits for monitoring the level of month inventory can be calculated. The formulas for calculating the control limits are followings:

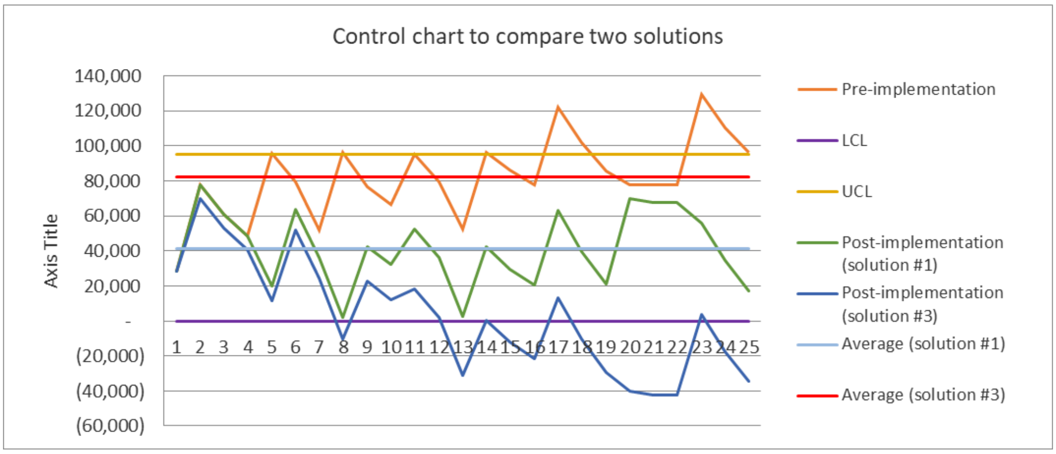
$$\text{CLs} = \text{Average} \pm 3\sigma$$

Given that, the average monthly inventory level is 45,438 units and the standard deviation (σ) is 16,141 units, then:

- The lower control limit (LCL) is -2.985 units, and
- The upper control limit (UCL) is 93,861 units.

The monthly inventory level after implementation should stay within +3σ and -3σ (6σ) from the average, thus called Six Sigma method. Figure 10 shows the control chart monitoring the monthly inventory level before and after implementation. This chart could be used to monitor the process in the future. Any outlier should be investigated and the DMAIC cycle may need to be used repeatedly.

Figure 10: Control chart of monthly inventory level



3. Conclusion

3.1 Results and Discussion

The two best solutions are: solution #1 which uses a fixed EOQ with a fixed reordering interval of 3 months, and solution #3 which uses changing ordering interval based on IP with a fixed order quantity (using EOQ). In the end, despite having similar profit gain, solution #3 was chosen by the company due to its sustainability which is shown through the average monthly inventory. Since the company would anticipate higher demand after the period of Covid ends, solution #3 which has an increasing trend in monthly inventory will be able to sustain the high service level. The prerequisite of solution #3 is that the company has to apply continuous inventory review and re-ordering.

In the ideal case, the fulfillment of S/U orders would result in a profit gain of 498.4 million VND (100% profit gain). However, ideal case is impossible to achieve because in order to solve a problem or modify a process, investment is needed. In this case, the implementation of solution #3 would incur an approximately 130.8 million VND additional cost. This cost is associated with the change in inventory policy in terms of higher holding cost due to the change in inventory review and higher inventory cost due to the increase in overall stock level. Therefore, in conclusion, the implementation of solution #3 would bring the company a recovery of 73.76% of lost profit, equivalent to 367.6 million VND. There is also an 38.9% increase in net profit as compared to before implementation.

The results show the improvement in terms of reduced special and urgent orders rejection, in other words, increased fill rate of S/U orders and the increased profit. Through such improvement, the company would achieve higher customer satisfaction in the metrics of "Flexibility". The company should conduct a follow-up interview with the customers to see the effect of the new inventory model on customer satisfaction, specifically on whether customers' S/U orders are fulfilled.

The advantages of using DMAIC as research methodology are that DMAIC is a comprehensive method which can be easily understood by practitioners, while at the same time it is based on statistical analysis and strong logic to provide good recommendations for companies (Tanner, 2025). DMAIC is often cited as a cycle rather than a linear method, thus repeating the methodology occasionally is required to ensure that the improvement is set in place. In case the status quo changes, for example there is an increase in order quantities or order frequencies, another solution may emerge as more effective.

3.2 Value of the Research and Key Learning

The research applied the concept of DMAIC cycle, to improve an important process, Order Fulfillment Process, for a trading company. For the company, the research proposes a verified solution that would bring about great financial gain and other benefits. Even though the concept of lean management is popular, it was not widely utilized and applied by many firms, particularly in Vietnam. This research shows that lean management and improvement methods are applicable and useful to companies of all sizes and all industries. For fellow practitioners, the research wants to show a real-life context in which DMAIC cycle is used and the implications associating with the context of the SMEs.

The key learning from this project is that companies should apply DMAIC cycle and other Six Sigma methods to improve their processes. It also emphasizes the importance and relevance of customer survey and listening to the Voice of Customer (VOC) in process improvement and business growth. Through this research, we can see that when there are multiple profitable options, the best solution should be one that is both profitable and feasible for the firm. Depending on the business model, corporate culture and strategy, and industry configuration, certain solution would be more suitable for a firm.

The implications of this research are the significance of process improvement in small- and medium sized enterprises and the benefits such a project can bring. The project has not only produced financial gain for the company but also improved the customer satisfaction towards the company's process. Another advantage in using DMAIC methodology in this research is that the cycle could be repeated when encountering new business setting or unexpected changes in the order fulfillment process. The same method can be used to improve other sub- processes within the company such as warehouse management, supply chain management, etc. To be more specific, DMAIC could be applied to solve problems such as optimizing the warehouse space, selecting forwarders or suppliers based on certain criteria or metrics (i.e., distance from warehouse, customer ratings, cost competitiveness, so on), etc.

3.3 Limitations and Further Research Opportunities

The limitation of the research is that it presents the company situation in the years of 2020 and 2021. The company should conduct further research to study the performance of the order fulfillment process after the year 2021 until now.

Recent research could provide a more up-to-date approach to the application of DMAIC methodology in process improvement. Since the concept of Lean Six Sigma continues to become more popular among practitioners, BPI projects should become more applicable and practical. In term of further research opportunities, companies can put forth BPI project on another process or sub-process such as CRM, Aftersales, R&D, etc. The applications of DMAIC are vast and diverse since the concept itself is truly dynamic. Most commonly, DMAIC is used in manufacturing contexts but nowadays, the methodology could be applied to solve problems in the services industries.

Fellow researchers can also apply the approach presented in this paper to improve the order fulfillment process and other processes in a different SME, with hope that this method will become a common practice in any industry regardless of the company size. Suggestion for SMEs is applying the DMAIC methodology to achieve discrete goals and solve clear-cut problems such as reducing customer complaints, increasing productivity or precision in production, reducing downtime of a machine or waiting time for customers, and more.

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