Sosyal Mucit Academic Review

Computer Program Development for Unloading Containers to The Warehouse

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Abstract

The research aims to develop and create a computer program capable of managing inbound low-priority containers that take up lots of spaces in the unloaded area that are unnecessary for production. This makes it impossible to utilize high-priority inbound containers. Hence, it grows increasingly harder to continue the production lines due to shortages of inputs. As the consequence expenses such as demurrage and unloading costs. The contribution of this study is to apply heuristics technique that are First Come, First Served (FCFS) and Early Due Date (EDD) to accommodate continuous production without waiting for necessary inputs by using Microsoft Excel VBA to develop the algorithm for incoming containers. The outcome of this study reveals that after implementing the program, it helped to reduce the planning time of containers up to 99.5%. According to data obtained from March 2020, the framework successfully mitigates the issue of a lack of inputs that are still loaded in the port. Furthermore, additional expenses are reduced up to 86.6%, with demurrage downed by 87.9%, as well as increasing the unloading capacity by 31%. Finally, this framework proves to be resilient and flexible against changes in production plans.

Keywords: Operation Management, Heuristics, VBA

Article Type: *Research*

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Konteynerlerın Depoya Boşaltılması İçin Bir Bilgisayar Programı Geliştirme

Özet

Bu araştırma; yükleme alanına gelen, üretim için gereksiz olan ve çok fazla yer kaplayan düşük öncelikli konteynerları yönetebilen bir bilgisayar programı geliştirmeyi amaçlamaktadır. Bu gereksiz konteynerlar yüksek öncelikli olarak gelen konteynerların kullanımını imkansızlaştırmaktadır. Dolayısıyla, girdi kıtlığı nedeniyle üretim hatlarının devam etmesi giderek zorlaşmaktadır ve aynı zamanda bu sonuç bekleme süresini ve yük boşaltma maliyetini de artırmaktadır. Bu çalışma, Microsoft Excel VBA sayesinde, gelen konteynerlara yönelik bir algoritma geliştirerek, gereksiz girdileri beklemeksizin sürekli üretimin temin edilmesi adına, İlk Gelene İlk Hizmet (İGİH) ve Erken Teslimat Tarihi (ETT) esaslarına "buluşsal tekniklerin" uygulanması yönüyle katkı sağlayacaktır. Çalışma bulguları sonucunda görüldüğü üzere, programın uygulanması konteynerların planlama süresinin uzunluğunun %99.5 oranında azalmasını sağlamıştır. 2020 Mart ayının verilerine göre, bu sistem limandaki yetersiz girdi meselesini başarıyla azaltmıştır. Ayrıca, ek masraflar %86,6'ya kadar azalırken, bekleme süresi %87,9 oranında azaldı ve boşaltma kapasitesi %31 artırıldı. Son olarak, bu sistem üretim planlarındaki değişikliklere karşı kolay adapte olabilen, esnek bir yöntem olduğunu kanıtlamıştır.

Anahtar Kelimeler: Operasyon Yönetimi, Sezgisel Tarama, VBA

Makale Türü: *Araştırma*

1. INTRODUCTION

In order to create economic connectivity with global for increasing employment rates in Thailand, Thai government has issued announcement investment promotion in free zone area which will be granted incentives free duty for import material, therefore, making many companies interested to invest in Thailand free zone due to this privilege especially companies that need to import raw materials from abroad to use in production the free zone area will allowing the company to reduce the cost of custom duty and VAT on purchase or importation of raw materials. In addition, Thailand has relatively lower labor costs and more skilled labor as well. Besides, Thailand has the infrastructure suitable for investment, especially the port that will help to support the companies that need to import material for production because the port will be a seaborne transport point. Sea transportation is considered to be the most important and most popular transportation due to the low transportation cost and the ability to transport huge volumes of products at a time that made economies of scale. Most forms of sea transportation today are container box systems that products will be stuffed into containers and the containers were transported by special vessel calling container vessel. The vessel also needs a seaport that has a facility suitable for containers loading and unloading which Thailand has this kind of port called Laem Chabang port located at east of Thailand. Another thing that those companies need to consider is warehouse management because warehouse is stored imported raw materials without tax under the customs regulations which are more special than regular storage that means the cost of operation and lead time and uncertainty of sea mode both are also the critical variables to consider for suitable of warehouse management for resulting in systematic operations worthwhile for investment, quality control of storage picking products, preventing the loss of operating to ensure the lowest operating costs and taking full advantage of the area. To summarize, the high objective is to reduce total costs to the most economical but still maintain quality and service level.

The company researcher has studied a premium grade motorcycle manufacturing company targeting the specific groups of customers and the company located in the duty-free zone in Rayong province. The proportion of parts imported for production from the United States is 74 percent, Mexico 10 percent, China 5 percent, Thailand 5 percent, Vietnam 3 percent, India 2 percent and others 1 percent. Due to 95 percent of importing parts, there are containers arriving port up to 8 to 14 containers per day or 150 to 400 containers per month but capacity of unloading have only 5 to 6 per day. In December 2019, there are 255 containers exited at the port waiting for delivery to company's warehouse for unloading and some of the containers that arrived at the port did not arrive in order of shipping scheduled date due to uncertainty of sea mode that means some containers were shipped from origin port in the first date may arrive after containers were shipped at the fifth date, so it is not mean first come first served. The company's logistics department has made a delivery plan by first come first served: FCFS for priority containers at the port to deliver at warehouse follow with capacity of unloading without considering there are parts going to shortage soon inside the container or not, that is why some

containers were shipped by unnecessity. And the resulting of delivered unnecessary containers as figure 1.

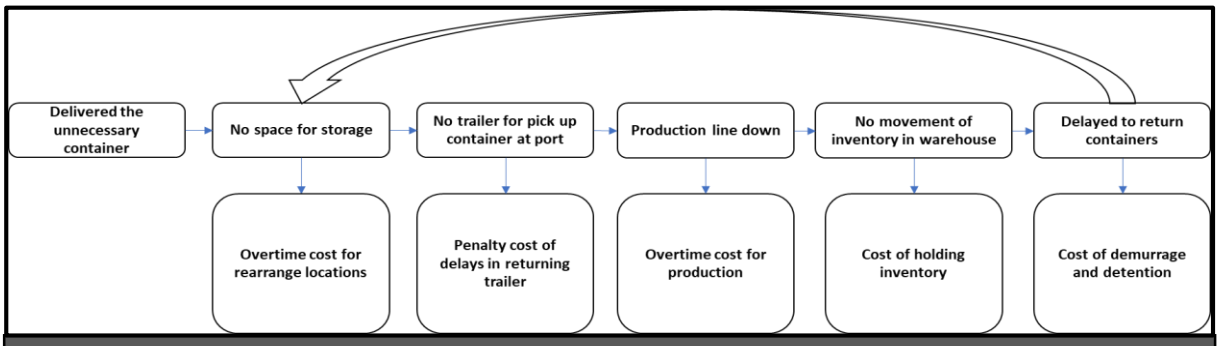


Figure 1. Resulting of delivered unnecessary containers

The resulting of delivered unnecessary container that will adversely affect each other in a chain.

The first issue of the resulting that the company is faced with no space in warehouse for storage part and no space for unloading part from container to warehouse this causes of the warehouse to stop unloading and re-arrange area in the warehouse for making space for unloading and storage it is lost time and increase the cost of overtime payment.

1.2. After the issue of stopping unloading but the delivery plan of containers still continue until the supplier of trailer no trailer for picking container at the port the next issue is no parking area for the truck and trailer containers what next is the delay in returning the trailer to supplier and there is penalty cost of delaying 1500 THB per day per trailer.

1.3. When the unloading and the delivery plan have stopped, the necessary container also stuck at port due to no space, no trailer, it affects the production line stop and made downtime recording. The production needs to work overtime for covering backlog order and resuming to a normal situation that means lost time and increased cost.

1.4. After production stopped no consuming part from warehouse no movement and no finish goods produced from the part at the warehouse, that means no space clearing for unloading and extend holding inventory cost.

1.5. While waiting for re-arrange and solving space issue, the time is not waiting still continue, that means the free time after containers arriving port be consumed every day until the time runs out it will increase the cost calling container demurrage and if delay after container moves out from port calling detention. From recording in December2020 the company have been paid the extract cost of delivery containers 1,756,900 THB (Not including overtime)

As discussed above, the root cause is from delivery unnecessary containers regarding inappropriate containers delivery plan that considered only first come first served method but did not consider the shortage date of each parts inside the container because it is difficult and need to spend time around 3000 minutes for manual calculation to find the shortage date of

each part and priority containers to delivery with first come first served method. Therefore, the researcher has developed a computer program with Microsoft VBA for implement the program of priority containers for unloading by applies the principle of heuristics to quickly and effectively. The outcome of this study reveals that after implementing the program, the researcher found out that it helped reduce the planning and sorting time of containers up to 99.5%. According to data obtained from March 2020, the framework successfully mitigates the issue of a lack of inputs that are still loaded in the harbor. Furthermore, additional expenses are reduced up to 86.6%, with demurrage downed by 87.9%, as well as increasing the unloading capacity by 31%. Finally, this framework proves to be resilient and flexible against changes in production plans regardless of the number of containers.

2. LITERATURE REVIEW

2.1. Port Operation

Klomperee, (2000) studied the international trade in Thailand mainly depends upon sea transport mode. The port is the main gateway to the country. As is widely accepted, containerization has risen rapidly; in Thailand Bangkok Port is one of the major ports who plays a very important role as the logistic platform for Thai economy. According to the government policy to limit the number of container throughput via Bangkok Port at one million TEUs/year, hence, Bangkok Port has to emphasize on the increment of its efficiency of operations and services instead of expansion. Recently, Bangkok Port has improved its performance tremendously. However, the port still has problems creating inefficient operations and service systems. Based on the analysis, the major problems are long berthing time, low occupancy ratio, low productivity, high cost, congestion, dangerous conditions and inadequate cargo security. These problems are caused by both internal and external factors, for instance the economic crisis of the country, lack of proper plan, shortage of some equipment, shortage of skilled labor and know-how in the new system and deficient management.

2.2. Warehouse Management

Warehouse management is the art of movement and storage of materials throughout the warehouse. Warehouse management monitors the progress of products through the warehouse (Charlotte, 2011). It involves the physical warehouse infrastructure, tracking systems, material handling and communication between product stations. Warehouse management deals with the receipt, storage and movement of goods usually finished goods and includes functions like warehouse master record, item/ warehouse cross-reference lists and such things as on hand, allocated, transfers in process, transfer in process, transfer lead time, safety stock, fields for accumulating statistics by location.

A warehouse manager needs to perform several crucial functions such as overseeing and recording deliveries and pickups, loading and unloading materials and supplies, maintaining inventory records and tracking system, determining appropriate places for storage, rotating

stock as needed and adjusting inventory levels to reflect receipts and disbursements. A manager needs to have knowledge about inventory control and warehousing systems, loading and unloading procedures, risky, materials storage and mathematical knowledge.

A warehouse management system is a critical component of an effective overall supply chain management system solution. The warehouse management system is performed as a system to control the movement and storage of materials within a warehouse. Today it even incorporates tasks such as light manufacturing, transportation management, order management, and entire accounting systems.

2.3. Heuristic Method

The scheduling of production with heuristics method is the easy way for finding satisfying results but it is not proof that the answer is the best outcome. The method can find the answer that is huge information with simple calculations and do not waste the time (Baker and Trietsch, 2013)

The priority dispatching rules is the priority following condition that the popular criteria as below.

i. SPT (Shortest Processing Time) is the rule that considers the condition of the job with the shortest processing time to be processed ahead of all other waiting jobs. The use of this rule for sequencing will minimize the average time a job spends at the work center.

ii. LPT (Longest Processing Time) is the rule of considering the condition of the jobs by their processing time. If processing time longest, it will be assigned first.

iii. FCFS (First Come First Served) is the simplest scheduling simply queues job that considers the job arrives first will be executed first and the next job starts only after the previous.

iv. EDD (Early due date) is the rule consideration of the due date by choosing the job that is due beforehand to do first.

We apply hybrid heuristics method by selecting FCFS and EDD. The reason is sorting port arrival with first come first served (FCFS) method will consider on the condition of demurrage. This means that it will help to reduce the cost of charging from the liner and early due date (EDD) method for considering the shortage date of parts inside the containers. This method will help to find the necessary containers for unloading.

(Phatapipong et al., 2018) used hybrid heuristics method for production schedule of the precast slab the paper presents the heuristic approaches such as Earliest Due Date (EDD), First Come First Serve (FCFS), Shortest Processing Time (SPT), Minimum Slack Time (MST), Critical Ratio (CR), and determines products list for finished goods inventory and they developed new method is Shortest Processing Time (SPT) + Slack Time1 (Slack1) and found out that SPT+Slack1 is the number of tardy jobs decreased from 170 to 95 (decreased 44.12%) and

finished goods inventory decreased from 5,085 to 4,164 sheets/day (decreased 21.32%) then utilization of warehouse 52.96% and save total cost 1,278,938 baht/year (decreased 8.34%)

Butdee and Tangchaidee, (2010) considered the relation between production and transportation system is considered as a core process in order to provide good service according to time frame constraints. To cope with these problems, the combination of production and transportation scheduling algorithm is proposed in order to optimized lead times from received order until the product reach to a customer site. The heuristic rules are applied consists of EDD, SPT and LPT. The hybrid heuristic is to select two shortest times order resulted from the heuristic rule and then production schedule is created. The transportation routing related to such a plan is defined using best-first search rule. Finally, the final plan is created by connect the production and transportation plan.

2.4. Microsoft Excel VBA

Phaophuree (2011) applied heuristics algorithm for fuel vehicle routing problem with multiple products, multiple fleet sizes and multiple compartments. The heuristics tool was developed on Microsoft Excel by coding a Visual basic for application the program. The program could quickly find a good solution and be customized to add or reduce the number of delivery locations by the user.

Lumjuan et al (2014) developed a decision support system for production scheduling in sheet metal stamping section: a case study of an automotive part industry. This decision-support system is developed with computers, using Visual Basic for Application (VBA) Language to process data on Microsoft Excel. In this research, the integrated heuristic methods e.g., EDD-SPT, EDD-LPT, EDD-WSPT, SPT-EDD, LPT-EDD and WSPT_EDD are chosen for process scheduling with the number of tardy jobs as the major indicator and mean tardiness as the minor indicator. From the results scheduling production with this decision-support system by using past production data, it shows that number of tardy jobs and means tardiness time decreased 31.82% and 25.79%, respectively compared with computing results from the original method. That is this decision support system for production scheduling is efficient and easy to use.

3. METHOD

This research uses quantitative method for analysis of computer program development for unloading containers to the warehouse. It applies the design science in information systems research (Hevner et al., 2004). It is the high-quality design-science research that describes the performance of design-science research in information systems via a concise conceptual framework because it focuses on how to build and evaluate the program to meet the business need. This study follows the design science framework as shown in Figure 2.

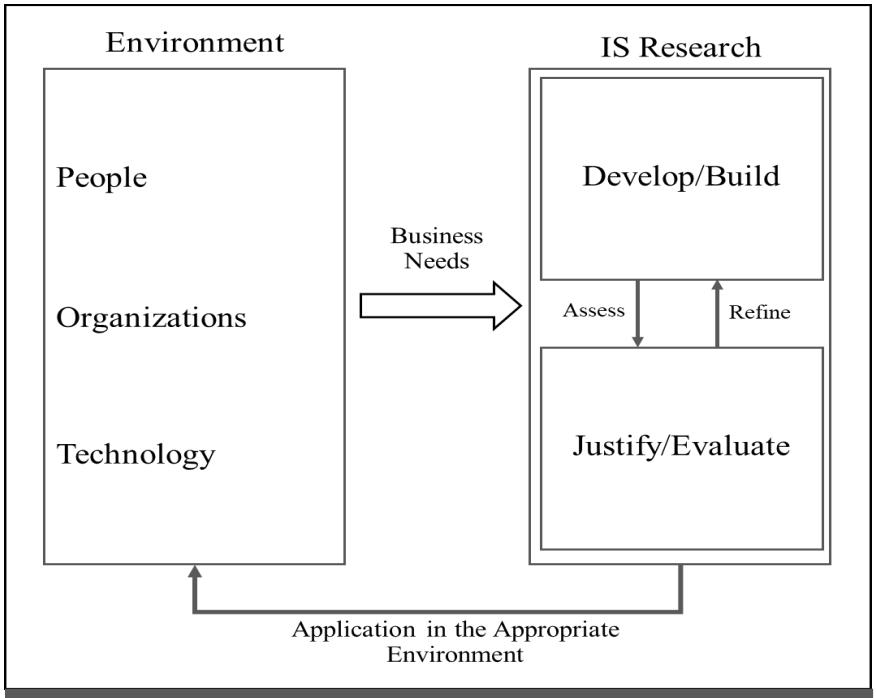


Figure 2. Design science framework

From figure 2. the framework shows how to conduct research from the design science framework to meet the needs of the business. The input factors related to this are people, organizations, and technology. These factors help develop or build the artefact. After it was built, it is evaluated whether it is applicable for the real world system.

3.1. Design as an Artifact

The purpose of this paper is to develop a computer program with Microsoft VBA by using the heuristic method. Regarding the studied company is the company located at the free zone area at Rayong that has to import part more than 95% for production and there are a lot of containers exiting at a port on queue for delivering at warehouse need to prioritize for delivering to the warehouse for unloading because all containers cannot be shipped all at once due to the capacity of unloading and limit of space for storage, if ship all containers without considering the date of requirement for production and the date of arriving port or ship the unnecessary container. It will create a lot of problems in a chain that means it will increase total cost in the supply chain. So, the program should prioritize containers exiting at the port to deliver to a warehouse under the criteria FCFS (First come First Served) + EDD (Early Due Date) both criteria of heuristic will sort necessary containers that need to deliver to the warehouse for unloading to avoiding production line down and create the problem in supply chain and of the process to find the early shortage date as below.

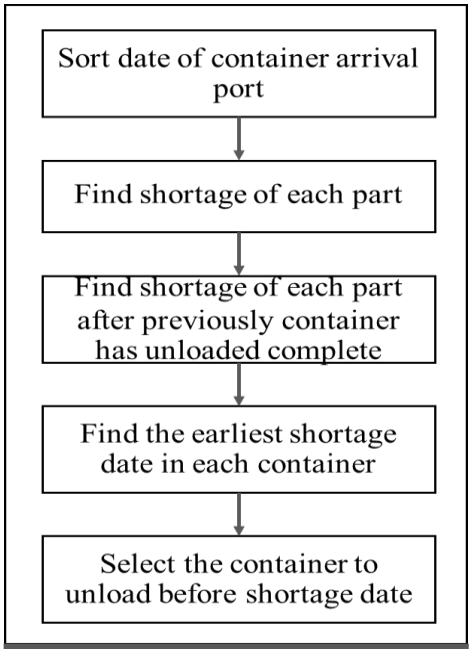


Figure 3. Processing Design

3.2. Formulation Design

In order to find the required date or the due date of each part in each container for delivering, it needs to calculate by taking the remaining quantity of each part in the warehouse to deduct with demand until shortage date after that find the first container of each part and identify the first shortage date and take the remaining of shortage date plus with the quantity of each part in the container for finding the next shortage date.

Set variable as below

S = Stock

D = Daily Demand

L = Daily Delivery Quantity

a = Number of dates

P = Product

c = Number of containers

3.2.1 Daily ending balance

$$Spn = Sp(n-1)-Dpn$$

3.2.2. Finding the shortage date each part in each container

Spn = Sp(n-1)-Dpn

If Spn < 0 then

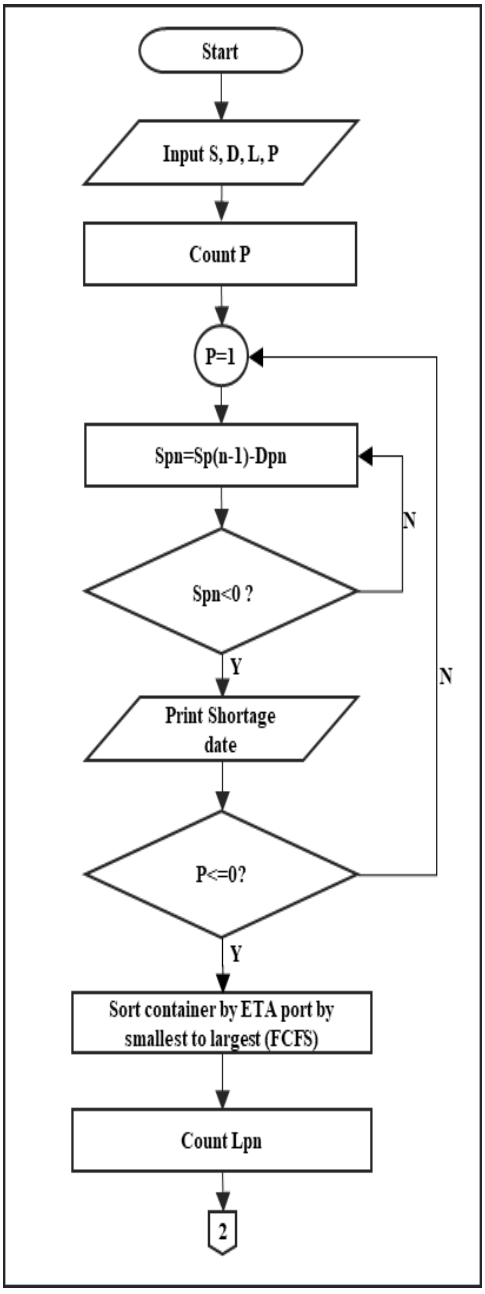
Print shortage date

Else

Spn = Sp(n-1)-Dpn

End if

3.3. Algorithm Design



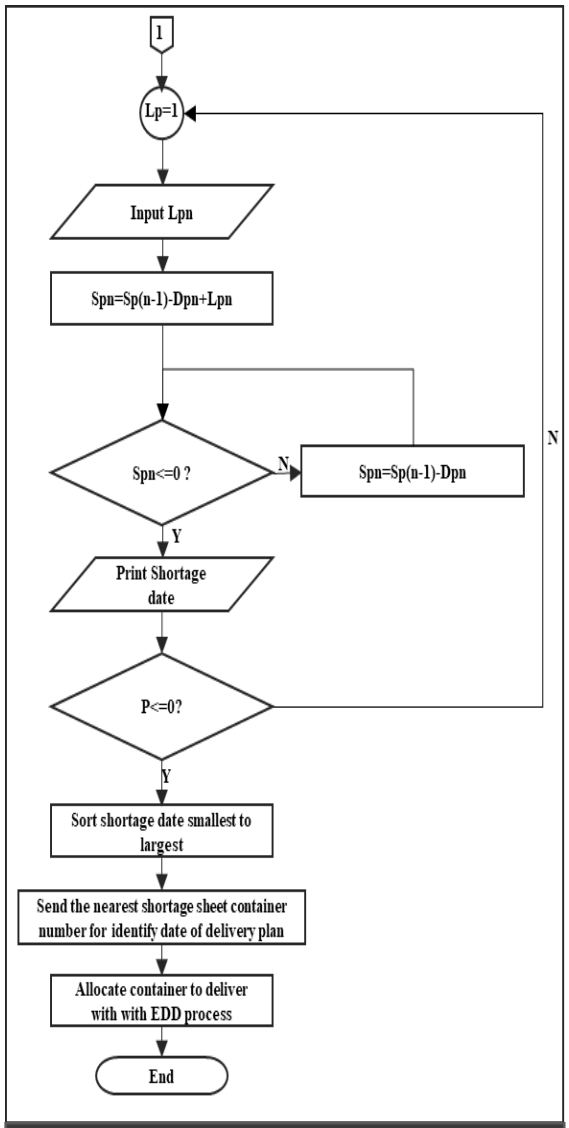


Figure 5. Algorithm page 2

3.4. Excel Sheet Design

This program will use an excel spreadsheet for input raw data and calculation that need to set up 2 format temple sheets for the storage database.

3.4.1. Sheet balance

This sheet will be a calculation sheet to find the shortage date of each part for sending shortage to sheet priority container for identification shortage date on each part and it will show data of daily demand, inventory remaining at the warehouse, and formula for finding shortage date as below formula

$$Spn = Sp(n-1)-Dpn$$

If Spn < 0 then

Print shortage date

Else

Spn = Sp(n-1)-Dpn

End if

3.4.2. Sheet priority container

This sheet shows shipping information mainly data using for calculation is container number, the part number inside the container, quantity of part and estimate arrival date. The program will take quantity in each container back to sheet balance for calculation and get the result of the shortage date to identify on the part number in each container; after that, the program will sort early shortage date of each part and summarize the delivery plan.

3.5. VBA Coding

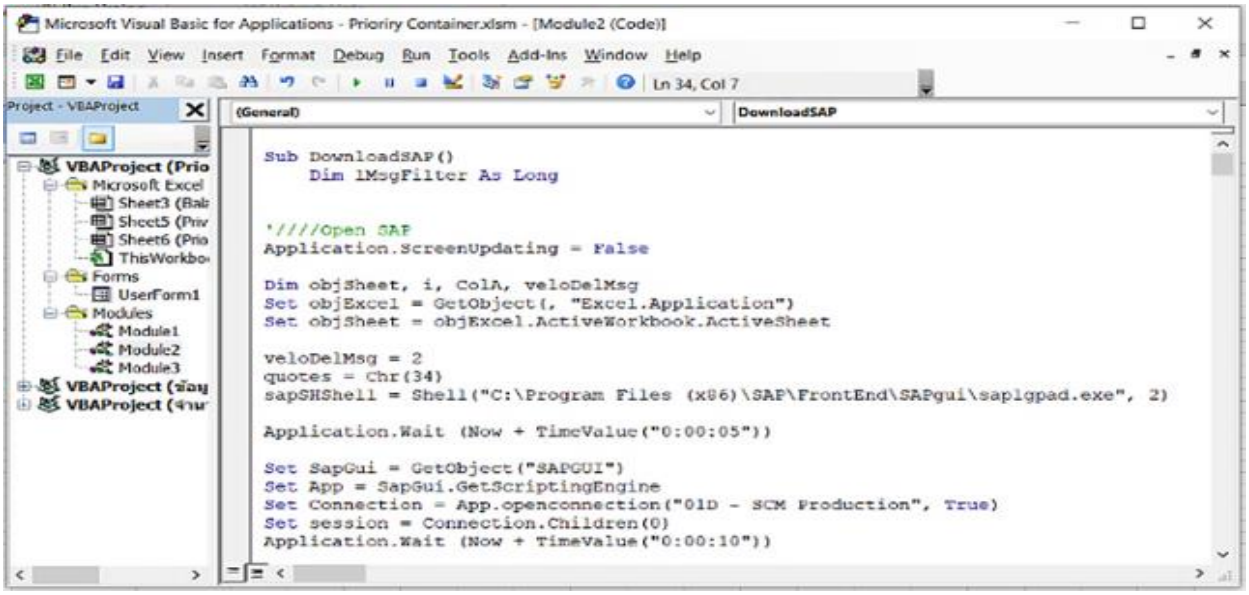


Figure 6. Example of VBA code

There are three modules of this program

3.5.1. Module1: Connect SAP for downloading daily demand and current stock.

3.5.2. Module2: finding a shortage date.

3.5.3. Module3: Sort and finding the earliest shortage date of the part in the containers.

Process	Input Data	Testing method
Down load data from SAP	- Start date of demand - End date of demand	Take sample 2 part number for manual download from SAP and compare the result
Calculation shortage date	- Daily demand - Ending inventory at warehouse	Take sample 2 part numbers for checking with MD04 in SAP that the result of shortage is the same or not
Calculation of identify shortage date of each part in each container	- Daily Demand - Ending inventory at warehouse - Shipping information	Take sample 2 part number for finding shortage date every container of both part and compare with the result from program
Container delivery plan	- Shipping information - Shortage date of each part	Take sample 2 part number and check the delivery date before real shortage date or not

Table 1. Program Testing Method

3.6. Program Testing

The purpose of this testing for making sure that every module runs smoothly without error and gets the correct result.

4. DISCUSSION

4.1. Time Reduction

Previously, when logistics department needs to calculate and priority container, there is a need to take 3 minutes per part number and there is average, 1000 parts number that existed at port need to calculate. this means that it will use around 3000 minutes for calculation, so it made them do not need to check the shortage date. They just use only the FCFS method that creates a lot of issues in the supply chain. The program takes around 16 minutes for processing to get the result of the container delivery plan or time, reducing 95.5%.

Before use program	
Job	**Time (Minute)**
Download date from SAP	10
Calculate shortage date	3,000
Priority container	5
Make delivery plan follow unloading capacity	10
Total (Minute)	3,025

Table 2. Operation time before use program

After use program	
Job	Time (Minute)
Download shipping information	1
Program processing	5
Priority container	0
Make delivery plan follow unloading capacity	10
Total (Minute)	16

Table 3. Operation time After use program

4.2. Production Downtime Reduction

The as-is process shows that there are the part shortages from the reason of part existing at port pending for delivery is 14 case from 22 case. However, after implementing the program, there is no issue of part shortage due to waiting for a delivery container at the port as presented in table 5 production downtime at March2020.

Production Downtime Report December 2019 (Before use Program)		
Root cause	number	Minute
Part shortage	22	1,440
Quality issue	9	846
Tooling Machine and system break down	2	576
Total minute		2,862
Total hour		47.70
Total shift		5.96
Total day		2.98

Table 4. Production Downtime at December 2019

Production Downtime Report March 2020 (After use Program)		
Root cause	number	Minute
Part shortage	5	480
Quality issue	3	720
Tooling Machine and system break down	0	0
Total minute		1200
Total hour		20
Total shift		2.5
Total day		1.25

Table 5. Production Downtime at March 2020

4.3. Cost Reduction

Regarding to the program, it can manage and make a delivery plan for container smoothly and also the program can plan to the delivery container before shortage 1 day, it reduces double handling, the operator can take part from container and send the part to the production line and regrading to the program can prioritize to deliver the necessary container first it makes production smoothly nonstop due to no part shortage that means the inventory at warehouse also consuming and there is free space for unloading on time without delay to return container. This is shown in the comparison in table 6 comparison delivery cost before use program at December2019 and after use program at March2020.

	Before	After	
Issue	Amount (THB)	Amount (THB)	Amount Reduction (THB)
Penalty of trailer	616,500	82,500	534,000
Demurrage	1,366,400	158,900	1,207,500
Detention	15,400	0	15,400
Total cost reduction			1,756,900

Table 6. Comparison delivery cost before (Dec2019) and after (Mar2020) use program

5. CONCLUSION AND RECOMMENDATIONS

This program can be used for solving the issue of delivery unnecessary container to the warehouse by using Microsoft Excel VBA for development program automatic calculation and use algorithm to for select containers by the concept of heuristics: First Come-First Served: FCFS and Earliest Due Date: EDD to prioritize delivery necessary container to the warehouse which results in a more efficient. After implement to use the program in full month at March2020 there is no case of production downtime due to waiting delivery part existed at the port or reduce 100% of the case, increase efficiency in unloading capacity from 9.75 containers per day in Decamber2019 to 12.8 containers per day in March2020, or an increase of 31% of unloading capacity, increase the productivity of the process of unloading containers from the previous 11.5 containers per person per month to 26.9 containers per person per month or an increase of 135% of productivity and reduce the cost of delay from 1,998,300 THB in Decamber2019 to 241,400THB in March2020 that reduced 1,756,900 THB or 87.9%. The program can work with all computers that have Microsoft excel programs without having to install additional and program development found that the first algorithm design makes program development easier.

From data collection for analysis of computer program development for unloading containers to the warehouse, we found that the demand for production is a very important factor because it determines the delivery date of the container. If the container does not arrive in time for production, it will cause the production line to stop because of no parts in the warehouse. When production stopped, this results in no space for storage because parts do not consume from the warehouse. This is the reason to consider the demand of production first. The second factor is the date that containers arrive at the port because if we do not consider this factor, it may need to spend the cost of demurrage and detention. But if considering these two factors, it will take a long time and production plan is constantly changing, it is impossible to consider both conditions by manual with our programing support. This paper has brought these two important

factors into the program for increasing work efficiency by arranging containers to unload with heuristics and just in time method to deliver the necessary container to the warehouse.

The limitation of this study is that the company only needs to import part from another country and there are a lot of containers pending at is waiting for delivery to unload at the warehouse and there is no enough space and capacity at a warehouse for unloading. This program also still has a manual process to input data of shipping information from the logistics team. Therefore, there is a room to further improve this program by linking the program with SAP software to import the data automatically.

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