

**Determination of Working Method to Improve Productivity in Construction Process :
Installation process of mobile device transmitter platform, CCS Comservice Co., Ltd. (Thailand)**

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Abstract

Productivity decline in the construction industry can result in lower yield of products, causes the delay, and also affect the time and cost. By applying the techniques of Method Study to the current working process, the issues as mentioned above can satisfactorily be decreased. This research aims to improve construction productivity for installing the platform of mobile device transmitter using a better determination of working method. By using the techniques of Method Study, it can give an idea about the sequence of the manufacturing processes as well as the way to apply 'The 7 Wastes in Lean Manufacturing ' as an indicator of the processes so that the cause of wastes are aware and also be integrated into the Process and Wastes Chart (PaWC). This chart shows clearly the lack of performance in the manufacturing process, and then the analysis is performed systematically by using 5W1H technique. From the study, by reducing one activity and changing the way of working, it can

help reduce the operating time of the original work by about 360 minutes/station, increase the productivity, and improve the operation by using the existing data. These contribute to the development of new efficient working method that is applicable in practices.

1. Introduction

Construction industry have adopted modern technology to get involved with the working process and has more roles in supporting the operations. However, entrepreneurs in construction industry are still experiencing productivity decline and loss of work which lower the yield of products , cause a delay, and also affect the time and cost [1,2]. One of the main reasons may be wastes in the process due to the improper working method and lacking to improve working method [3]. Therefore, in order to handle such problems, it is necessary to improve productivity wisely through the use of existing resources for each different activities of the construction project. The process model is

comparable to industrial manufacturing processes which consist of 5M factors: Man, Material, Machine, Money, and Method. All of these factors are combined together to yield construction productivities by using Determined Working Method such that good productivities and value adding products can be achieved [4]. The process model is shown in Figure 1.

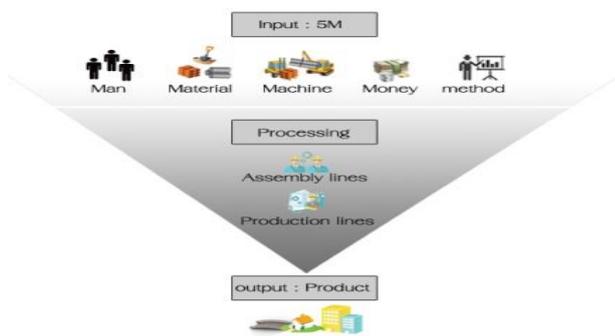


Figure 1. Pattern of General Construction Process.

Determination of the construction method by using techniques of Methods Study is performed by recording the process in the current working area, and then displaying the data in symbolic form to indicate the operation of the process such as moving, checking, waiting, and storing which are the sequence of the process as well as the way to apply 'The 7 Wastes in Lean Manufacturing ' as an indicator so that the cause of wastes that are hiding in the process can be aware and integrated into the PaWC. This chart shows clearly all details of the process and lacking of performance in the sub-level of manufacturing process, and clearly shows the

overall picture of the process from the beginning to the end. This contributes to a better understanding of the manufacturing operation. After that, the analysis is then performed to identify the details, and the working method is examined systematically by using 5W1H technique in order to find ways to reduce the non-value activities or wastes. This leads to improved working method that suit the construction by focusing on activities that cause wastes. It can also be used as a guide to determine the new working method that efficiently enables the continuous operation [5]. This results in improved productivity, reduces working time and cost of construction effectively when compared with the other techniques [6] as shown in Figure2.

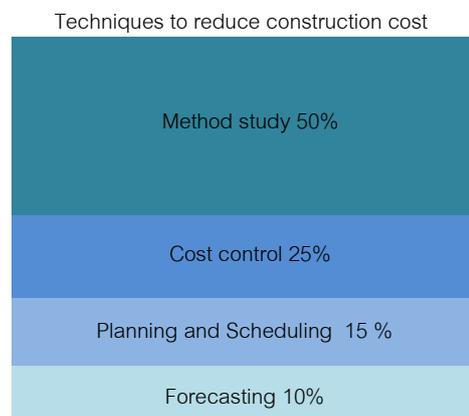


Figure 2. Comparison of the weighted score, the technique that reduces the cost of construction (adapted from Oglesby, Clarkson H., Parker, Henry W., and Howell, Gregory).

CCS Comservice Co., Ltd. (Thailand) is a private company in Thailand that provide installation services for communication system throughout the country and also works cooperatively with the Chinese government and Huawei Company. The Civil Upgress 1800MHZ900MHZ is one of the projects that deals with communication system installation and also has the process for installing platform to support on main leg of the transmitter for both old and new stations throughout the country. In the Northeast of Thailand, there are approximately 5,000 stations that have successfully been installed. From the initial assessment of the current working process to install the platform of mobile device transmitter (Platform Support on main Leg), it can be seen that each station mostly has the tasks in a repetitive manner and has too many unnecessary processes such that it results in longer installation time.

Therefore, determination of working method that suit the construction is one of the methods that can increase productivity, reduce delays in construction work, and is useful in planning the working process. Furthermore, it also help define new methods that are the basis for improving the standard and leading to the new development process. This help create the working performance in the future, and it is better

than trying to expand the business that require additional investment.

This research aims to reduce process steps and reduce the time to install the platform of mobile device transmitter (Platform Support on main Leg) by determining the working method using the techniques of Methods Study and then create the PaWC in order to indicates the manufacturing processes that are connected in sequence, as well as to identify the causes of wastes in the working process by using the principle of 'The7 Wastes in Lean Manufacturing' in symbolic form. Then, the analysis is performed systematically to examine the working process that create waste by using 5W1H technique, thus contributing to reduce waste and properly improve the working process. This help determine the better working method, then resulting in improved productivity and reduce delays in construction.

2. Methods study

consist of 6 steps [7] as follow

1. Work consideration, the work should be considered and analyzed by using questions, interviews, and the preliminary report of the meeting that indicate the characteristic of the work such as the deviation of work from the plan, the productivity is lower than the standard, the occurrence of wastes, the work requires

consumable materials, the work has waiting time in the process, the work require long distances transportation of material, the work require many workers. Furthermore, the work that is appropriate to be considered or analyzed is the process that has high-value in contract, or the complex construction process. In particular, the construction process that is performed in a repetitive manner. It can be seen that if the process have studied well in advance, the time and cost of production can obviously be reduced.

However, in order to transition to the new working methods, the reaction of workers should also be considered and reduced as much as possible.

2. Record information of the current working method by using charts, diagrams, figures, models. These are the standard forms of information that can be easily understood and are important techniques for studying the working method in order to improve productivity [8]. The details of techniques can be seen in table 1.

Table 1. Techniques of Method study (Adapted from Olomolaiye, P.O., Jaya, Ananda K.W. and Harris, F.C.,)

Type	Technique	Usage
Figure	Photo, Video	Assessing the site layout, Recording the operating conditions
Model	2-dimensional model, 3-dimensional model	Supplementary to site layout planning, Supplementary to complex construction procedure
Diagram	String diagram, Flow diagram	Monitoring the movement of people, machines, and traffic in the working area
Chart	Outline process chart, Multiple activity chart, Process chart	Studying the activities in the construction process, examining the inefficiencies and imbalances in the team, proposing new management method, studying the construction process, and monitoring the effectiveness of workers, materials, and machines

3. Study and analyze the current working method by using the techniques to answer questions in a systematic way. There are 2 types of question as follow: 1. Closed-ended question, this type is suitable to analyze the existing standard processes and it is a checklist question which is consistently implemented in a systematic way such as daily monitoring of the machines, 2. Open-ended questions, this type use the question words (5W1H) such as 'What', 'Where', 'When', 'Who', 'Why', 'How'. This technique start

from 'What' - What is the objective? Why? Is there any other way to do?, 'Where' - Where is the location? Why? Can it be other location?, 'When' - When to start? Why? Can it start later?, 'Who' - Who will do it? Why? Can other people do it?, 'How' - How to do it? Why? Any other ways to do? All of these questions is used to determine the cause of the problems by using the method of brain storming to improve productivity that contribute to the development of working process. [9,10]

4. Develop the new working method to increase productivity by reducing non-value added activities that could pose a waste in the process such as the non-value-added activities that do not serve the purpose, the activities that have unclear objective or no valid objective, the activities that do not create benefits to the current working process, the activities that change the sequence of operation, and the activities that combine operations in order to make the process work properly. In addition, the activities that separate the work into too many small procedures in the production process can also cause problems. In order to do so, it is necessary to improve the working processes so that it is easier to implement by using the equipment or tools to facilitate the operation under the appropriate standards.

5. Present the new working method with the approval of responsible authorities of the project. Then, starting the operation on the actual work site since it may be related to worker productivity, cost of production, and also the other budget supports.

6. Monitor and evaluate the performance to find defects, errors, and improve efficiency even more.

3. Determination of Working Method to Improve Construction Productivity by Using Technique of Method Study

Step 1. Researcher and the productivity improving team start the Civil Upgress Project and restructure the telephone system network that is currently being expanded throughout the Northeastern part. In the construction process, the installation of the platform of mobile device transmitter are operated in a repetitive manner for every stations. The operation of the current station receives an initial assessment, and the team shares a common opinion among members. It is found that the current working method has too long installation time, and too many sub-procedures in the construction process due to lack of proper management. If there is a proper plan for studying, analyzing, and determining the new working method, then the operation of the next stations can yield higher productivity and shorten the installation time.



Figure 3. Platform of mobile device transmitter

Step 2. Researcher and the team select the process chart to be used as a tool for recording data, study the construction process, and install the platform of current mobile device transmitter. This chart is a table containing the detail information, and the path of process in a symbolic form. Circle  represents operation. Arrow  represents movement. Square  represents checking. Letter 'D'  represents waiting. Triangle  represents storing [11]. Symbol will be the intermediary for communication, exchanging ideas and brainstorming of the persons involved in the analysis as well as the way to apply 'The 7 Wastes in Lean Manufacturing' as an indicator so that the 7 causes of inefficiencies and wastes in the process can be aware and become a part of a process chart. The details [12-18] are as follow. 1. Defects  :D, wastes resulting from a non-standard production and the process must be revised. This causes the loss of time and resources to investigate and fix the problem. 2. Transport  :T, wastes resulting from unnecessary transportation and movement of materials. In order to transport parts from one place to another, the distance must be taken into consideration, and the layout must be planned in order to reduce the transportation distance to a minimum. 3. Storing Too Much Inventory  :I, wastes resulting from an

unnecessary material storage, excessive cost of storage as well as the deterioration of the material. 4. Overproduction  :O, waste resulting from too much production regardless of the requirements of the next process. Lack of planning and forecasting the optimal volumes of production such that the process has waiting time between consecutive procedures. 5. Delay  :DI, waste from any unnecessary waiting during the production such as waiting for material, waiting for machine installation, waiting for repair, and waiting for product delivery resulting in a delay of production. 6. Unnecessary processes  :P, wastes resulting from the operations that do not add value to the product, the complex production process, work priority is improper, the machine does not match the size of work. 7. Unnecessary motions  :M, M, wastes resulting from the movement, gestures, body movements of workers, tools usage, machines, layout, and inappropriate work priority. Such details as mentioned will be displayed as a symbolic indication of wastes in the construction process of mobile device transmitter platform. The PaWC is shown in table 2.

After recording the data of the current working method, the overall condition of the work site is jointly evaluated, and the details of all working procedures are displayed. The

construction process that consist of 8 activities takes the installation time approximately 970minutes. Then, the wastes of inefficient activities are identified, and the details of work are jointly analyzed. From table 2, it is found that the six-wheels truck transportation activities cause waste of time in transit. In the activity for sorting steel parts, and assembling the main

legs piece by piece at the high level to the structure causes waste due to the improper work priority. Therefore, the technique (5W1H) is used for determining the cause of the problem, finding a better working method with brainstorming, and also monitoring and analyzing the working methods that cause waste in the process.

Table 2. Process and Waste Chart (PaWC) shows the construction and installation of mobile device transmitter platform and the current working method.

Process and Waste Chart: PaWC							
Chart Number 1 Plan 1 Construction-Installation Station : CYP 8539A Chaiyaphum				Project: Civil Upgress 1800MHZ900MHZ Process: Construction and installation of mobile device transmitter platform			
Recorded by: Project Engineer Date 1/03/2016 Team work (Engineer) : 3 man				Working Method: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Future			
Work Breakdown Structure							
Activities	Quantity	Team work (man)	Distance (Km.)	Time (Minute)		Identified wastes	
1. Transporting equipment to the site by six-wheelstruck.		1	100	120		T	
2. Sorting steel parts	120 pieces	3		480		P	
3. Checking	120 pieces	3		30			
4. Assembling main legs of platform. Install piece by piece at the level of 3 meters by workers.	120 pieces	3		60		P	
5. Setting the level of main legs of platform to the original structure.		3		40		None	
6. Installing equipment, protecting rail and grating of the platform	1 set	3		120		None	
7. Moving the main distribution board	1 cabinet	3		60		None	
8. Installing ground system	1 set	3		60		None	
Total			100	970			3 activities

Step 3. Checking and analyzing data using 5W1H technique and brainstorming. In 3

activities that have been identified, the wastes can be detected.

1.Objective (What)

Question: What to do?

Answer: Transport the equipment to construct and install the mobile device transmitter platform.

(Indicate waste: T )

Answer: Sorting steel parts to separate each piece according to the plan (Indicate waste: P )

Answer: Assembling main legs of the platform in order to mount the protecting rails and grating (Indicate waste: P )

Question: Why doing this? (Why)

Answer: To install Civil Upgress, renovate the construction, and upgrade the telephone system according to the contract.

Question: Is there any other way to do?

Answer: No.

2. Location (where)

Question: Where is the location?

Answer: Chaiphum, CYP 8539A, the original pillar structure of telephone system.

Question: Why operating at that location? (Why)

Answer: It is a location and installation point according to the standard, and has been designed specifically for this structure.

Question: Can it be other location?

Answer: No. Because it is operated according to the contract.

3. Work priority (When)

Question: When to start the work?

Answer: Transportation of equipment start when the previous station completed its work. (Indicate: T )

Answer: Sorting steel parts after transportation of equipment (Indicate: P )

Answer: Assembling main legs of the platform after checking (Indicate: P )

Question: Why starting the work at that time? (Why)

Answer: It is the time according to the plan.

Question: Can it start at later time?

Answer: No because the time sequence of activities have already been planned.

Question: Can the time of activities be exchanged?

Answer: No because the team have already planned the sequence of construction process to finish the work within the duration of the project.

4. Who operate this work? (Who)

Question: Who is the operator?

Answer: Dedicated installation team.

Question: Why choosing this operator? (Why)

Answer: The operating team was hired on the contract and this team also had experience in this type of work.

Question: Is there any other team that is more suitable?

Answer: No.

Question: What kind of employee is suitable for this work?

Answer: Experienced team that understand the process and working method.

5. Working method (How)

Question: What is the working method? And, what is needed for this working method.

Answer: Transportation by six-wheels trucks.

Answer: Sorting steel parts for beam, main legs, protecting rail, and floor gratings, then separated them to each position. These parts are prepared to be installed by the team as set in the plan.

Answer: Assembling main legs of the platform, and bring up the parts piece by piece to install by the team at the 3 meters level of the pillar structure.

Question: Why using this method? (Why)

Answer: Because there is only a six-wheel truck used for transportation in the company.

Answer: Because steel sorting is the current working method that the team perform by using the same experience.

Answer: Because assembling the structure of main legs of platform is the current working method that the team perform by using the same experience.

Question: Can it be performed by using another method that is convenient, quick?

Answer: Yes, if the transportation is adjusted so that it become convenient and fast.

Answer: Yes, if the order of activities are adjusted by combining the steps for sorting, checking, and assembling steels into 1 activity.

Answer: Yes, if the method for assembling the structure of main legs of the platform is adjusted.

Question: How should the working method be adjusted?

Answer: Adjust transportation method from six-wheels truck to four-wheels truck. This can increase the speed of transportation and also reduce time.

Answer: Adjust the method by combining the steps of sorting, checking, and assembling steels into the same activity, then continuously perform piece by piece.

Answer: Adjust the method by assembling the whole structure of main legs of the platform at the ground level, then using a lifting tool (1 ton manual Chain Hoist) to facilitate the installation process at the 3 meters level of the pillar structure instead of using the original method that depend on workers to install the parts piece by piece at the high level. This help facilitate the working process, and also reduce installation time.

Step 4. Develop the new working method. From the examination of current working method above. Researchers and the team have analyzed the data, studied and developed the working method for constructing the mobile device transmitter platform. The development details are as follow: changing the size of a truck used for transportation, adjusting the method in the activity of steel sorting and checking so that they

are performed at the same time, adjusting the method in the activity of assembling the structure of main legs of the platform at the ground level and use a lifting tool (1 ton manual Chain Hoist) to facilitate the installation process, preparing a

chart that schedules the future activities, going to the area of operations in order to experiment and record the actual working time of each activity into the PaWC that is shown in Table 3.

Table 3. Process and Waste Chart (PaWC) shows the construction and installation of mobile device transmitter platform and the future working method

Process and Waste Chart (PaWC)						
Chart Number 1 Plan 2 Construction-Installation Station : CYP 8539A Chaiyaphum			Project: Civil Upgress 1800MHZ900MHZ Process: Construction and installation of mobile device transmitter platform			
Recorded by: Project Engineer Date 25/03/2016 Team work (Engineer) : 3 man			Working Method: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Future			
Work Breakdown Structure						
Activities	Quantity	Team work (man)	Distance (KM.)	Time (Minute)		Indicate wastes
1. Transporting equipment to the site by 4-wheels truck.		1	100	60		None
2. Sorting steel parts, checking, and Assembling the whole set of main legs of platform piece by piece at the ground level.	120 pieces	3		240		None
3. Use the lifting tool to facilitate the installation. (1 ton manual Chain Hoist)	1 unit	3		30		None
4. Setting the level of main legs of platform to the original structure.		3		40		None
5. Installing equipment, protecting rail and grating of the platform.	1 set	3		120		None
6. Moving the main distribution board	1 cabinet	3		60		None
7. Installing ground system	1 set	3		60		None
Total			100	610		None

After experimenting and recording the data of new working time, the team has compared the process charts of the original working method

and the new working method that are used for constructing the mobile device transmitter platform. It is found that the new method has

faster transportation, and can reduce fuel costs in transportation activities by changing the size of the truck. The transportation time is also reduced by 60 minutes. In the steps of sorting, checking, and assembling steel parts, when combining all three steps into 1 activity, assigning 1 worker in the team to sort steel parts, and assigning another 2 workers in the team to concurrently check and assemble the steel parts piece by piece, it can help enable the smooth operation, and facilitate the workflow (One-piece Flow) of the process. In addition, the step of assembling the main legs of platform piece by piece is adjusted to be performed at the ground level from originally performed at the 3-meters level. This is because the quality checking at the ground level can be more thorough than quality checking at the high level, and can reduce the installation time by approximately 270 minutes. Furthermore, the activity for installation by using the lifting tool (1 ton manual Chain Hoist) can be more convenient than using workers, and can reduce the working time by approximately 30 minutes.

Step 5. Apply the new working method into practice. Before applying the new working method that have been developed. The team has explained the importance and benefits of developing new working methods to the manager in order to get an approval and a support beforehand since the resources or budget for

operation may be required. Once approved, the new working method will be explained to the team, then a 4-wheels truck and lifting tools (1 ton manual Chain Hoist) will also be prepared for the installation and assembly of the mobile device transmitter platform. Then the experiment will be implemented by constructing and installing another trial platform using the new working method under close supervision.

Step 6. Follow up and evaluate .Initially, there is a few trouble for complying with the new working method since the team may have to adapt and get used to the new ways of working. Therefore, the team are given the opportunity to learn and practice new ways of working until becoming skillful prior to the evaluation. After that, the team will continuously follow up and evaluate the performance of all activities in order to find defects and errors such that the efficiency improvement can be achieved.

From the results of experiment of new working method, it is found that transportation by reducing the size of the truck, combining the activities of sorting, checking, and assembling together, and adjusting the method for installation by assembling the whole set at the ground level and using the lifting tool (1 ton manual Chain Hoist) to facilitate the installation, can bring into real practice and help reduce the operating time. If the new working method is applied to all new

stations in the process of constructing and installing the mobile device transmitter platform of Civil Upgress 1800MHZ900MHZ Project, it can result in reduction of total operating time of the project.

4. Conclusion

Determination of working method for constructing and installing the mobile device transmitter platform, Civil Upgress 1800MHG 900MHG Project, uses the techniques of Method Study to record the data of the current working process and displays the data in a symbolic form that represents operation, movement, checking, waiting, and storing which are the sequence of the process as well as the way to apply 'The 7 Wastes in Lean Manufacturing ' as an indicator to identify wastes and the current states of the PaWC. This can help set the guidelines to eliminate wastes more easily by analyzing the

details and examining the working method systematically by using the 5W1H technique, and help find ways to develop the new suitable working method by combining activities in the process, using tools to facilitate the operation, bringing the data obtained from the analysis to create the PaWC for future state, and then going to the area of operations, making an experiment, and recording actual working time.

After applying the new working method to the construction and installation process of the mobile device transmitter platform, Civil Upgress 1800MHG 900MHG Project, it can help reduce 1 activity and shorten the transportation time by changing the size of the truck. By assembling the parts at the ground level and using the lifting tool to facilitate the installation, the total operating time can be reduced by about 360 minutes/station. The comparison between the current and future performances is shown in Table 4.

Table 4. Comparison of the current and future performances.

Activities	Current	Future	Distance (Kilometers)	Current working time (Minutes)	Future working time (Minutes)	Working time reduced by (Minutes)
Operation 	6	6	-	820	550	270
Movement 	1	1	100	120	60	60
Checking 	1	-	-	30	-	30
Waiting 	-	-	-	-	-	-
Storing 	-	-	-	-	-	-
Total	8	7	100	970	610	360

Therefore, determination of working method that suit the construction is one method that can increase productivity and also helpful in planning the working process. Furthermore, it can also determine the new working method that is the basis for improving the standards consistently and leading to the development of efficient working processes that reduce delays in construction.

5. Discussion

From the study of working processes that are performed in a repetitive manner and have high-value in contract, their data can be used for creating the PaWC that is used to obtain the overview of the working processes, search for wastes, analyze, reduce wastes in the process, and develop new suitable working method.

However, process chart is the chart that includes all manufacturing procedures on a single sheet, and used for presenting details of the process in a micro level. For this reason, the details of process chart are not enough for improving the process in a macro-level. Each chart is designed for different purposes

Sometimes, it can be adapted to the work in other forms, but may not be as effective as the chart that is specifically designed. So users should understand the advantages and

limitations of each type of chart in order to use them correctly.

The results of this study are consistent with the problems encountered in the current working method. This indicates the improper determination of construction method and lacks of Method Study. As a result, the productivity is low and the yield does not meet the expectation such that it affects the time and cost. If the production and transportation process has better management according to the determined working method, it can reduce the cost of preparation, cost of worker camp, cost of electricity, other indirect costs, and hidden costs in management. However, the reduction of operating time also depends on working environment of each station such as weather during operation, transportation routes, and etc.

When comparing with recent studies that use the techniques of Method Study to develop working methods such as Reports from Proctor and Gamble [6], and DuPont Company [19], including a survey of Victor Sanvido [20]. It is found that, by using the Method Study to find the cause of the problem, each activity can reduce the operating time and cost complying with this research which apply the techniques of Method Study to determine the working method for constructing and installing the platform supported on main legs of the mobile device

transmitter For this reason, it can results in higher productivity, and achieves intended cost of production.

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