

Improving Production Efficiency for Precast Concrete Slabs

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Abstract

This research aims to study the production process and improve the production efficiency of a precast concrete floor company in Pathum Thani province, Thailand. The research seeks to help the company improve and enhance its production efficiency by using Pareto charts to identify problems and employing a Why-Why analysis to determine the root causes. The ECRS principle is then applied to address the identified issues and facilitate process improvement. Based on the current research, the main problems identified are as follows: production efficiency is not reaching its full potential with an average production rate of 26,460.22 square meters, employee health is affected by work fatigue due to long working hours, averaging 10.95 hours per day, and labor costs amount to an average of 231,841.90 baht per month. After implementing the ECRS and modifying the work procedures, the research indicates that the production efficiency has improved, with an average monthly production rate of 29,973.82 square meters. Additionally, the average daily working hours have decreased by 7.78 hours, and labor costs have been reduced to 199,825.50 baht per month. The percentages are as follows: 1) Production efficiency increased by 10.88%, 2) Working time decreased by 19.67%, and 3) labor cost decreased by 13.80%.

Keywords

Precast concrete slabs, the Pareto chart, ECRS: Eliminate, Combine, Rearrange and Simplify the Fishbone diagram.

1. Introduction

Risks are anticipated in the construction sector in 2022 due to the sharp increase in transportation and building material costs. The Russo-Ukrainian War, which led to higher prices for necessary building supplies, including steel and cement, and increasing oil prices, was responsible for these elevated expenses. In the years 2023 and 2024, the construction industry is expected to expand in step with the expected rise in the value of total construction investments, which is predicted to rise by an average of 4.5 to 5.5% annually.

The precast concrete floors come in 3 varieties: solid, three-legged, and hollow. Due to their affordability and flexibility in terms of length options, clients highly seek these sorts. As a result, manufacturing must accommodate different project allocations and client needs, which might wear down workers during production. This makes it difficult to manage production cycle durations and reach production goals, which has detrimental effects, including incomplete production and lost commercial chances. The company and the experts agree that increasing productivity in the precast concrete slab production process is crucial, given the relevance of this issue. Thus, this case study aimed to address these issues and boost production effectiveness.

1.1 Objectives of the Research

- 1.1. To study the production process of precast concrete slabs
- 1.2. To improve and increase the efficiency of the production process for precast concrete slabs
- 1.3. To reduce production costs

1.2 Theory and Related Research

From this chapter, principles and theories are discussed. Related to the application with various tools. used to improve production The researcher has studied the theory. various research works Related To be able to understand the concept and how to apply it. To improve the production process and solve problems in the production process. The contents have been compiled in the following order:

Pareto chart theory:

Pareto Chart Theory It consists of bar graphs that are aligned next to each other. There is a cumulative frequency line. that shows the quantification of the cause from the greatest to the least quantitative in each cause It helps to select the cause or problem that has the highest volume. to be edited from the bar graph and the cumulative frequency line There must also be a relationship of principles. This theory will lead to Identify the essence of each problem. in order to analyze what the problem is solved from can be fixed Then it will compare the importance of the volume of the bar graph. which cause should be corrected before and after by following up on the results of the research to find out what In most cases, the Pareto theory is used in industrial production to eliminate the root cause of the problem. in order to produce more quality.

1.2.2. Fishbone diagram

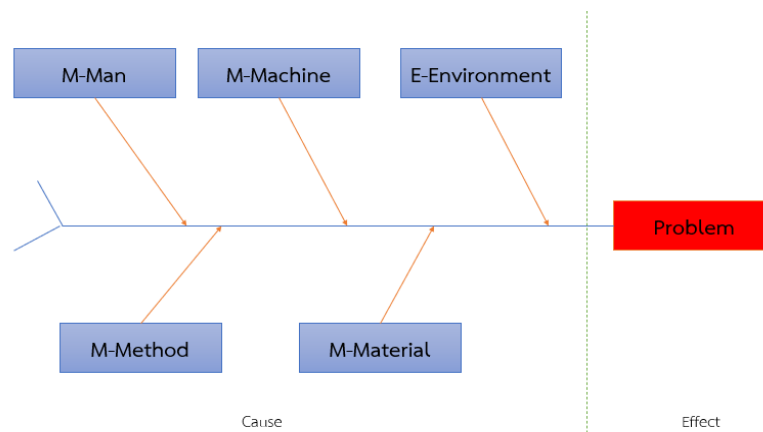


Figure 1. Fishbone Diagram

The fishbone diagram is the overall theory of all parties. to ascertain the cause of the problem In each of the relevant sections, this theory has two names, one is "Ishikawa Diagram" and the other is "Ichikawa Diagram". The "fishbone diagram" due to its tip-like appearance consists of the tip, skeleton, core, and fishbone, with the fish head being the main problem in ascertaining. And then all parties will investigate the sub-problems as arrows towards the core. and why it is gathered with other units and then send it to the head of the fish for analysis and correction in the next step The relevant cause can be traced through the 4M+1E principle.

M-Man

Means workers or employees or personnel both inside and outside, which is the main factor that is most important. and the most difficult to control Is the inspection according to the required standards or not, responsible or not? have expertise or not Have you been looking for a job that matches your ability or not?

M-Machine

Refers to machinery and equipment used in the production process. facility equipment inspection Consistent with the ability of the production process or not. Does the machine crash often? Is there a proper placement? and is it ready to use or not.

M-Material

Refers to raw materials or materials used in production. which is an important factor in many matters such as how the control is managed The loss of raw materials or materials is the least with the best quality. and most effective.

M-Method

Refers to methods, procedures, or processes for work or production. Checking if the standards of work are sufficient or not. Is it safe? Is it an effective way? Is the sequence of work steps appropriate? New methods are always being developed. To save time, reduce steps and can be easily checked.

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Why-Why analysis theory

“Why-Why analysis” is another method of investigating the cause of a problem. By constantly asking the question “why” until the problem can be completely identified. Most of them are used to find the root cause of the problem and fix it one by one. to reduce recurring problems If using this theory the problem recurs. It might be because the question was asked in the wrong direction. We will have to come back and analyze the cause again. This is a very useful tool. If the analyst has an understanding and expertise in the current work Will find various causes, which can use techniques and 10 requirements that must be considered as follows

1. Find clarity on the problem.
2. See actual behavior
3. Be aware of unreasonable origins.
4. The problem must be considered in all aspects.
5. Avoid mental causes
6. Define the root causes as problem measures to avoid recurrence.
7. It is not popular to use problem-solving measures to determine the root cause.
8. Integrity must be checked.
9. Determine which cause should be the ultimate source.
10. Keep in mind the key goals of the analysis.

That's why "Why-Why analysis" is an analysis that finds the root cause of the problem. which if we can find the origin of the problem and get rid of it That problem doesn't repeat itself anymore. If the problem is still unable to be eliminated This indicates that our analysis may be wrong. Therefore, it is necessary to re-analyze it.

ECRS theory

Essentially, ECRS consists of elimination, consolidation, rearrangement and simplification. which is a simple method Used in the production process to increase the efficiency of the work process.

- Rooting

The elimination can start from studying the current work and then elimination with 7 wastes to reduce or eliminate all irrelevant steps.

- integration

due to elimination After considering the work, we will find that the workflow in each section. Then we analyze Sub-steps to combine tasks will result in a faster workflow.

- rearrangement

The new arrangement will be a new work plan by analyzing the smoothness of work in each step. To reduce irrelevant work, reduce time, reduce steps.

- Simplification

It is an easier and more convenient workflow. by creating a new way of working to reduce steps, reduce time, for example Creation of devices that help hold the workpiece to make it more convenient to work and more accurate, etc., which can reduce irrelevant work or reduce waste during the production process. A number of studies have been conducted using the ECRS principle to improve workflow efficiency and reduce work waste. It can also be widely applied in education. resulting in a combination with other principles to improve performance even further to improve efficiency even further, for example, to study the production process. To improve the production process by creating a standard time of each work process. Then analyze the relationship between man and machine in accordance with the work. There are many researches using the ECRS principle to improve efficiency and reduce waste in production lines.

Related research

This chapter explores several hypotheses relating to various technologies intended to increase output. To fully comprehend the theories' concepts and valuable applications, the researcher thoroughly researched them and related studies. ECRS, which stands for Eliminate, Combine, Rearrange, and Simplify, is one of the methodologies mentioned. These straightforward yet efficient techniques are used in production to boost productivity and deal with emerging issues.

Pawinee Arjpruu (2008) From the example, you will see a way to reduce time and wastage in the breaker production line. By trying to eliminate and reduce the time that does not cause added value to the work piece, such as wasted due to waiting excessive movement wastage due to lost work or work that needs to be reworked, etc. As a result of improvements in the production line, it was found that the losses mentioned above tended to decrease from 41 percent to 28 percent. The 1-Pole version of the product increased from 122 pieces per person to 159 pieces per person, and the 2,3-Pole version increased from 89 pieces per person to 116 pieces per person. increased from 79% to 85%

Phawinee Uisrikoon (2014) This research is a company producing assembly parts for electronic components. to increase the efficiency of the production process to get ahead of market competitors Therefore, the goal is to improve the production process by focusing on reducing Lean wastage from the article, we have studied the standard time in every sub-step, collecting data and analyzing it. It can be seen that before improving the production process, there are 3 wastes occurring: more than necessary 2.waste due to transportation because there are more steps than necessary and 3. wasted due to waiting that cause the production to lack continuity Therefore, the researcher has applied the principles of ECRS to improve the production process by integrating the production process and rearranging the production structure. The continuity of work is based on the relationship between employees and machines. and has made a new balance of production by reducing the amount of workpieces during production Thus causing a continuous production flow. After the improvement, it was found that the workpiece volume decreased during production from 486 pieces per hour to 89 pieces per hour. And found that the production process is more efficient around the production time. can be reduced from the original 189.8 seconds to 178.6 seconds, which is 5.9 percent of the production cycle time.

Paitoon Pakaraphang (2012), who conducted research on Production process optimization with LEAN technique of brick or concrete block production process The research results are There is a problem of unbalanced production processes. Due to the gaps within the production process at the extrusion stage and the lack of skill of the workforce. causing the production process to not be smooth and making it impossible to increase productivity from the production process.

Sornsiri Rueanglok (2017) is a study on improving efficiency in the production process. About balancing each step and reducing waste in the production process for a case study company that produces electronic components. Starting from recording the standard time of each work step. Therefore, the work of employees and machines was analyzed using man-machine charts. Before the improvement, it was found that there was an imbalance at the production line causing the production line efficiency to be low. Then the production line was improved using the ECRS principle and the production balance was re-balanced. After the improvement, it was found that the number of employees could be reduced from 13 people to 12 people and the efficiency of the production line increased from 64.14% to 87.80% in reducing waste in the production process. Before the improvement, it was found that the value of waste in the production process exceeded the target set by the company at less than 500 baht per month. Then, the cause of waste was analyzed using a fishbone chart. After that, improvements were made to reduce waste. After the renovation, it was found that waste value could be reduced from 1,387 baht per month to 487 baht per month.

Sirawit Buakruen (2021) Study on production process efficiency improvement by production sequencing method. of a sample medical device factory Found that the tendency of increasing customer demand as a result, the efficiency in the current production process cannot be produced as needed. At present, machines have been used in the production process to replace a large number of human labor. When bringing machines into the production process, what should be considered is the production sequence to bring about production efficiency under various conditions and requirements of the organization, so the goal of the production sequence results in wasted time. of the machine was reduced for 98 minutes and the power rate of the machine was increased by an average of 22%

1.3. Research methods

This research aims to optimize the production process of precast concrete slabs by obtaining valuable information and enhancing the existing process. The study is divided into three distinct research periods, which are outlined as follows:

1.3.1 Study the essential information in the production process of the case study factory.

1.3.1.1 The Case Study Factory, founded in 2004, is located in the Pathum Thani Province's Nong Suea District. Precast concrete goods are its area of expertise, and it produces and distributes them to a wide range of domestic and foreign customers, including those from Laos, Cambodia, Myanmar, and other nations.



Figure 2 . Precast concrete slabs

1.3.1.2 Basic information about the production process

1.3.2 Data were gathered for the study by timing the production process. It was noted that the monthly production was not functioning at total capacity by referring to the precast concrete slab production plan in . A daily average of 1102.51 square meters, or 87.50 percent of the production capacity, were produced. The typical daily workday lasted 10.95 hours or almost 11 hours. These numbers allow us to estimate the production speed, or Takt time, at about 35.91 seconds per square millimeter. This calculation example does an excellent job of illuminating the manufacturing pace.

$$\begin{aligned}
 \text{Production speed value} &= \frac{\text{Net normal working time in one day} \left(\frac{s}{\text{day}} \right)}{\text{Number of square meters needed per day} \left(\frac{m^2}{\text{day}} \right)} \\
 &= \frac{39600 \left(\frac{s}{\text{day}} \right)}{1102.51 \left(\frac{m^2}{\text{day}} \right)} \\
 &= 35.91 \frac{s}{m^2}
 \end{aligned}$$

1.3.3 Study improvements and increase efficiency by machines.

Analyze the cause from the Pareto chart.

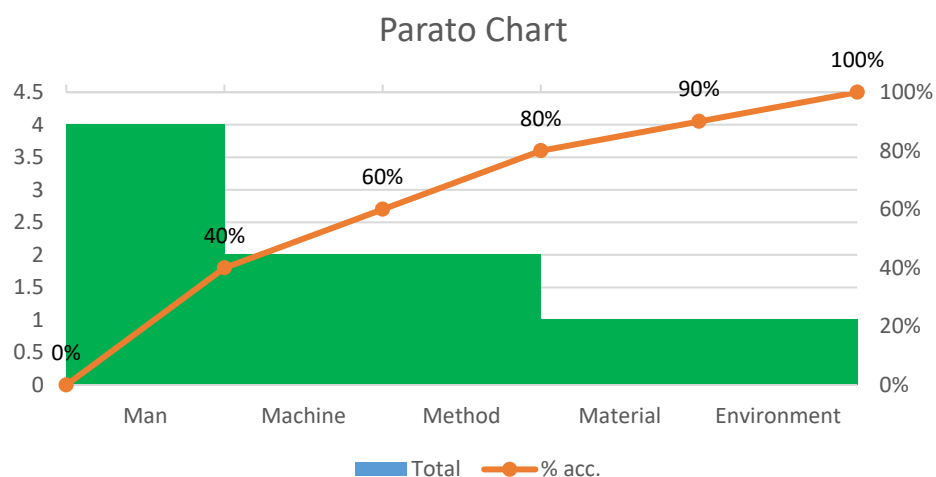


Figure 3. Analysis of Pareto Chart

By analyzing the Pareto chart (Figure 3.), it becomes evident that there is a variation in production quantities, leading to an imbalance in production efficiency. Consequently, identifying the root cause of this issue becomes crucial for addressing it in subsequent orders.

Analyze the cause from the fishbone diagram.

To determine the underlying causes of issues, the analysis uses the 4M+1E framework, which stands for Man, Machine, Material, Method, and Environment. The goal of this all-encompassing strategy is to increase production and effectiveness. A fishbone diagram graphically shows the cause-and-effect relationships, clearly describing the elements causing the current problems.

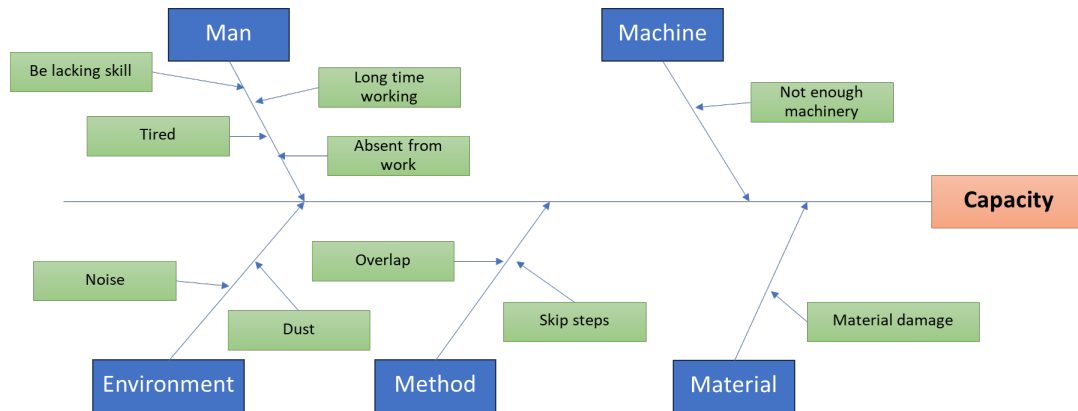


Figure 4. Analysis of the fishbone diagram

Upon analyzing the fishbone diagram (Figure 4), it became evident that the primary cause of most problems was the workforce, as the production of concrete slabs required skilled labor. The business realized this and recognized an opportunity to save costs in the coming stages.



Figure 5. Crane

As a result, the researcher asked for funding to buy and set up labor-saving equipment on the assembly line. This included placing an order for a 5-ton crane, which cost 265,000 Baht, because the 3-ton crane already in place could not raise the cement buckets, causing delays.



Figure 6. Plastering machine

In addition, a 360,000 baht plastering machine was ordered to replace the previous unit's sluggish operation. Working time was maximized due to installing these labor-saving devices, which decreased the need for manual labor.

1.4 Conclusion

The results of improving production efficiency for precast concrete slabs can be summarized as follows:

1. The production line workflows have been eagerly anticipated, but unfortunately, they have resulted in high cycle times and significant production wastage.
2. One strategy for enhancing the production process is modifying each team's attendance time, dramatically shortening wait times. To maintain consistent production efficiency, this modification presents a problem regarding job fatigue.
3. To enhance production, one strategy is to invest in additional capital machinery. This investment can reduce time and decrease the number of employees required, from 21 individuals to 16. Consequently, the wage difference can be allocated towards accounting for the machine's payback period.

1.5 Discussion

The popularity and high demand for concrete slabs, the research company's best-selling product, led to the start of this study. Internal company conversations were held to investigate how better to address consumer expectations in response to this market demand. The researcher, therefore, concentrated on increasing manufacturing effectiveness, resulting in an astounding output of about 29,973.82 square meters. The company's ability to better manage production parameters and, as a result, better satisfy consumer demand increases due to this greater efficiency. Additionally, the company's competitive position is strengthened by this greater efficiency, which boosts revenue generation.

Suggestion

1. All the recorded data in this study have been collected from actual operations, allowing for more accurate and insightful analysis.
2. The ability of the workers to satisfy the production capacity means that the production process still depends on their talents. Their knowledge and skill are essential for the production process to run well.
3. Further research can be conducted to explore the possibility of reducing the number of employees by leveraging additional capital machinery in other processes. The business can increase production efficiency and possibly lessen its dependency on manual labor by finding areas where automation or mechanization can be used. This line of inquiry has the potential to raise output, reduce costs, and boost operational efficiency. **he percentages are as follows.**

Details	Before improvement	After improvement	Percentage
Production efficiency	87.50 %	98.38 %	More 10.88 %
Working time	10.95 hours/day	8.73 hours/day	Reduce 19.67 %
Labor cost reduction	231,841.93	199,825.48	Reduce 13.80 %

From the conclusions shown in above table, the researchers and the administrators There is a tendency to continually improve efficiency. It will take up the work process. In this research further and continuously record the results for consideration in future improvements All work is a new approach. which may take time to collect additional information After that, the company will continue to operate.

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