Global Academy of Multidisciplinary Studies (GAMS)
Vol 1, No 4, 2025, 275-294 https://doi.org/10.35912/gams.v1i4.3564

Solutions for the concrete readymix supply shortage on projects in the New Capital (IKN) of Indonesia

Pandit Purnajuara[1], Mursyid Hasan Basri[2]
Institut Teknologi Bandung, Indonesia[1-2]
purnajuara@gmail.com

Article History
Received on 1 April 2025
1st Revised on 16 April 2025
2nd Revised on 26 May 2025
Accepted on 29 May 2025

Abstract
Purpose: This study aimed to develop a comprehensive conceptual framework representing all aspects of the Readymix Concrete Supply Chain, including Environment, Product, Method, Supply Chain, Time, and Finance. It seeks to identify the main probable causes of operational issues using the Kepner-Tregoe analysis to support effective decision-making.
Methodology: The Kepner-Tregoe analysis was applied to evaluate the situation and identify the root causes. SWOT analysis was then used to analyze the internal and external factors affecting company performance and generate strategic alternatives. Subject Matter Experts (SMEs) conducted pairwise comparisons based on five solution criteria: Cost, Flexibility & Adaptability, Schedule, Product Quality, and Supply Chain Reliability. The Analytical Hierarchy Process (AHP) was used to prioritize three alternative solutions for PT.
Results: Findings indicate that constructing a new batching plant ranks as the top alternative, with a priority score of 50.3%, aligning strongly with the five key criteria and demonstrating high feasibility for implementation.
Conclusion: The decision to establish a new batching plant can improve supply chain performance, provided that risk mitigation, budget planning, and site mapping are completed before the execution.
Limitations: The study is limited by its reliance on expert judgment and single-company analysis, which may restrict generalizability.
Contribution: This research offers a practical decision-making framework that integrates the Kepner-Tregoe, SWOT, and AHP methods to optimize operational efficiency and strategic planning in the concrete supply chain sector.

Keywords: *Analytical Hierarchy Process, Kepner-Tregoe Problem Analysis, Readymix Concrete Supply, SWOT Analysis*

How to Cite: Purnajuara, P., & Basri, M. H. (2025). Solutions for the concrete readymix supply shortage on projects in the New Capital (IKN) of Indonesia. *Global Academy of Multidisciplinary Studies,* 1(4), 275-294.

1. Introduction

Ibu Kota Nusantara (IKN) is the official name of the new capital city of Indonesia, which will replace Jakarta as the capital. Officially, IKN will be a unique provincial-level regional government unit, as its territory will be the capital city of the Republic of Indonesia (Anirwan, Aljurida, & Baharuddin, 2024). Administratively, the IKN area is located in two existing regencies, namely North Penajam Paser Regency and Kutai Kartanegara Regency, as shown in the relocation of the Capital City (IKN), which is carried out as one of the strategies to realize Indonesia's 2045 economic target with more inclusive and equitable economic growth through accelerating the development of Eastern Indonesia (Effendi & Siallagan, 2025). Moving the National Capital City from Java Island to Kalimantan Island is one of the

effortss to encourage regional equityand reduce thee gap between the Eastern andWestern Regionsn of Indonesia, especially between the Java Region and outside the Java Region. In addition, the development of IKN is designed to make it a sustainable city in the world, a symbol of national identity, and a driving force for the Indonesian economy in the future. Therefore, the development of IKN must include the following five norms.
(1) An effective and efficient government.
(2) Livable cities
(3) Smart infrastructure and connectivity
(4) Priority sectors for the future; and
(5) Collaboration among the three cities, Samarinda, Balikpapan, and IKN. To meet this target, the government prepared a development plan in a master plan for the development of the national capital.

To support these strategic projects, adequate building materials are required. Especially in support of readymix concrete material as the main and major base material in construction, the contractor must be able to provide the need for this material for the smooth implementation of the project. Readymix is a term for concrete that is ready for use without further processing in the field. Ready-mixed concrete is increasingly used for the structural components of buildings in Indonesian construction projects. This is mainly due to its controllable quality and relatively high productivity compared to traditional concrete batching and mixing practices (Pottonen, 2023). Ready-mix concrete is the primary material used to support production work in the field. There are at least six ongoing projects in IKN that require Concrete Material (Readymix Concrete being one of them) supply for each of its completion. Currently, PT XYZ is responsible for supplying an estimated 119.045 m^3 of concrete. Hence, the reliability of the supply of adequate amounts is severely required.

The projects have only relied on two local batching plant vendors, namely, PT. SAB and PT. RB. These vendors also serve IKN projects carried out by other contractors, so the production supply capacity cannot be maximized. In addition, the natural materials that form ready-mix concrete, such as sand, split, and cement, will also be increasingly difficult to obtain. Apart from the large demand, some materials must also be imported from outside Kalimantan, such as from Palu, Sulawesi. This also makes the existing costs more expensive and requires planning in the procurement process to adjust the existing target schedule (Nson, 2024). To fulfil the target in ongoing projects and ensure the sustainability of the company's business development, decision-making is required to determine the best solutions to solve the shortage of concrete readymix supply (Bazyar & Abbasi, 2025). This research highlights the following questions for further investigation and recommendations for concrete readymix supply shortages in PT. ABC projects in IKN.

1. What is the root cause of the concrete readymix supply shortage issue at PT. XYZ projects in IKN?
2. What are the proposed alternative solutions to solve the concrete readymix supply shortage issue at PT. XYZ projects in IKN?
3. What is the best solution to solve the concrete readymix supply shortage issue at PT. XYZ projects in IKN?

This study aims to provide options and solutions for the supply of ready-mix concrete to meet the following objectives:

1. To identify the root cause of the concrete readymix supply shortage at PT. XYZ projects in IKN.
2. To propose alternative solutions to solve the concrete readymix supply shortage on PT. XYZ projects in IKN.
3. To select the best solution to solve the concrete readymix supply shortage at PT. XYZ projects in IKN.

2. Literature review

2.1 Theoretical Foundation

2.1.1 Kepner-Tregoe Problem Analysis

Kepner-Tregoe (KT) (Kepner & Tregoe, 1997) Problem Analysis is a structured problem-solving method developed by Charles H. Kepner and Benjamin B. Tregoe. These two social scientists conducted

research on breakdowns in decision-making at the Strategic Air Command in the late 1950s. Kepner-Tregoe developed four basic Rational Processes for using and sharing information about organizational concerns. It is a systematic approach to analyzing and resolving complex problems. The four basic Rational Processes are as follows (Kepner & Tregoe, 1997):

1. Situational Aprraisal
   The Situational Appraisal step in KT problem solving aims to provide a comprehensive understanding of the problem's current state and its underlying causes. By conducting a systematic analysis of the situation, individuals or teams can gain insights into the factors contributing to the problem and lay a foundation for developing effective alternative solutions.
2. Problem Analysis
   In this step, the problem is further analyzed to identify its root cause. Various analytical techniques, such as cause-and-effect analysis, are used to determine the underlying factors contributing to the problem.
3. Decision Analysis
   Once the root causes are identified, decision analysis is performed to evaluate different alternatives and select the most appropriate solution. This step involves assessing the potential impact of each alternative, considering the associated risks and benefits, and making an informed decision.
4. Potential Problem (Opportunity) Analysis
   After implementing the chosen solution, it is crucial to anticipate any potential problems or side effects that may arise. This step involves evaluating potential risks and developing contingency plans to mitigate them.

In this study, we will analyze the case focusing on problem and decision analysis. By analyzing the problems with this process, we will be able to identify situations and find the core of the problem so that we can provide insight to find the right solution. Kepner Tregoe describes the analytical method in several stages as follows (Kepner & Tregoe, 1997):

1. State the Problem
   In this step, we must identify the problem statement or name of the problem. It is important to name the problem precisely because all the work follows. Subsequently, we can describe, analyze, and explain a problem. In this study, the name of the problem is the object of concrete readymix.
   One of the methods to specify the object problem is to use the 5H-1H method. Six basic questions were used to specify the problem.
   a. What : the identity of the deviation/problem we are trying to explain
   b. Where : the location of the deviation/problem
   c. When : the timing of the deviation/problem
   d. Who : the stakeholder that related to the deviation/problem
   e. Why : the reason that make the deviation/problem significant impact to us
   f. How : the magnitude of the deviation
2. Specify the Problem
   At this stage, we attempt to answer the previous 5 W-1H question method with the is and is not methods. As shown in Table 1**,** which refers to Kepner and Tregoe (1997), we attempt to explain what the problem IS and what the problem IS NOT for each aspect of the problem.

Table 1. KT Problem Analysis – Spesify the Problem

		Is	**Is Not**
What	**Identify**	What is The Problem?	What is **Not** The Problem?
Where	**Locate**	Where is The Problem Found?	Where is The Problem **Not** Found?
When	**Timing**	When Does The Problem Occur?	When Does The Problem **Not** Occur?
		When was it first observed?	When was it last observed?

Extent	**Magnitude**	How Far does the problem extent?	How localized is the problem?
		How many units are affected?	How many units are not affected?
		How much of any one unit is affected?	How much of any one unit is **Not** affected?

Source : Kepner and Tregoe (1997)

3. Develop possible causes based on knowledge and experience, or distinctions and changes.

At this stage, we must identify the causes of each question that we have elaborated on to determine the problem at the previous stage. In addition, we must also try to see gaps or differences in the results of the analysis of what is a problem and what is not a problem. The description can be seen in Table 2, the KT Problem Analysis worksheet, with the addition of two columns on the right, which refers to Kepner and Tregoe (1997).

Table 2. KT Problem Analysis - Develop Possible Cause

		Is	**Is Not**	**Distinction**	**Cause**
What	**Identify**	What is The Problem?	What is **Not** The Problem?	What is the distinction between the is and the *is not*	What is a possible cause?
Where	**Locate**	Where is The Problem Found?	Where is The Problem **Not** Found?	What is the distinctive about the different locations?	What is a possible cause?
When	**Timing**	When Does The Problem Occur?	When Does The Problem **Not** Occur?	What is the distinctive about the different in timing?	What is a possible cause?
		When was it first observed?	When was it last observed?	What is the distinctions between these observation?	What is a possible cause?
Extent	**Magnitude**	How Far does the problem extent?	How localized is the problem?	What is the distinction?	What is a possible cause?
		How many units are affected?	How many units are not affected?	What is the distinction?	What is a possible cause?
		How much of any one unit is affected?	How much of any one unit is **Not** affected?	What is the distinction?	What is a possible cause?

Source : Kepner & Tregoe (1997)

2.2 SWOT Analysis

SWOT analysis is an effective framework for analyzing the Strengths, Weaknesses, Opportunities, and Threats of an organization (or a project) that helps to address the effectiveness of project planning and implementation. Strengths are defined as any internal assets that help meet demands and fight threats. Weaknesses describe internal deficits that hinder an organization from meeting its demands. Opportunities are external circumstances or trends that favor the demand for an organization's specific competence. Threats are any external circumstances or trends that unfavorably influence the demand for an organization's competence (Sabbaghi & Vaidyanathan, 2004). Table 3 shows the key questions that can guide the analysis and typical answers. These four factors can be analyzed using a matrix, as

shown in the worksheet. From the results of the analysis, positive and negative responses should be obtained in terms of internal and external factors.

Table 3. SWOT Key Questions and Typical Answers

		Key Questions:	Typical answers
Internal	Strengths	What are our advantages? What do we do well?, How are we doing competitively? What are our resources? Are there any internal assets (know-how, motivation, technology, finance, business links) which will help to meet demands and to fight off threats?	Well-trained man-power , well established knowledge base, good contact to target group, technology, etc.
	Weaknesses	What could be improved? What is done badly? What should be avoided? Are there any Internal deficits hindering the organization in meeting demands?	Lack of motivation, lack of transport facilities, problems in distribution of services or products, low reputation (the lack of a particular strength)
External	Opportunities	What are the good tasks? What are the interesting trends? What changes do we expect to see in the market over the next few years? Are are any external circumstances or trends that favors the demand for an organization's specific competence?	Changes in technology and market that favor your products or services, changes in government policy related to your industry, changes in social patterns, population profiles, lifestyle, etc., local, national, & international events increasing purchasing power.
	Threats	What is our competition doing? What are the obstacles? What future changes will affect our organization? Is changing technology threatening our position? Do we have management support? Sufficient resources? Are we using the right tools, software, and platform? Are there any external circumstances or trends which will unfavorably influence demand for an organization's competence?	Establishment of strong competitors, lack of cash at household level, governmental regulations that limit free distribution of our product.

2.2.1 Analytic Hierarchy Process

AHP is one of the most useful methods for selecting projects and is becoming increasingly important. This method was developed by Dr. Thomas Saaty in 1980 as a tool to help solve technical and managerial problems. It aims to measure the relative priority of a givenn set of alternatives on a ratio scale, based on the judgment of the decision maker, and emphasizes the importance of the intuitive judgment of the decision maker as well as the consistency of the comparison of alternatives in the decision-making process. The AHP method is especially suitable for fields where the risk of intuition, rationality, and irrationality with respect to and movement can be found (Palcic & Lalic, 2009). The AHP algorithm is composed of two steps: (1) determine the relative weights of the decision criteria and (2) determine the relative rankings (priority) of alternatives. Both qualitative and quantitative information can be compared using informed judgment to derive weights and priorities. The steps are as follows:

Make a structure hierarchy of Criteria and Decision Alternative

In the first step, we must define the problem and make a tree of criteria and alternatives that can be chosen. The criteria can be chosen based on what we want to achieve. Subsequently, we must identify the alternative decision, as shown in Figure II.3.

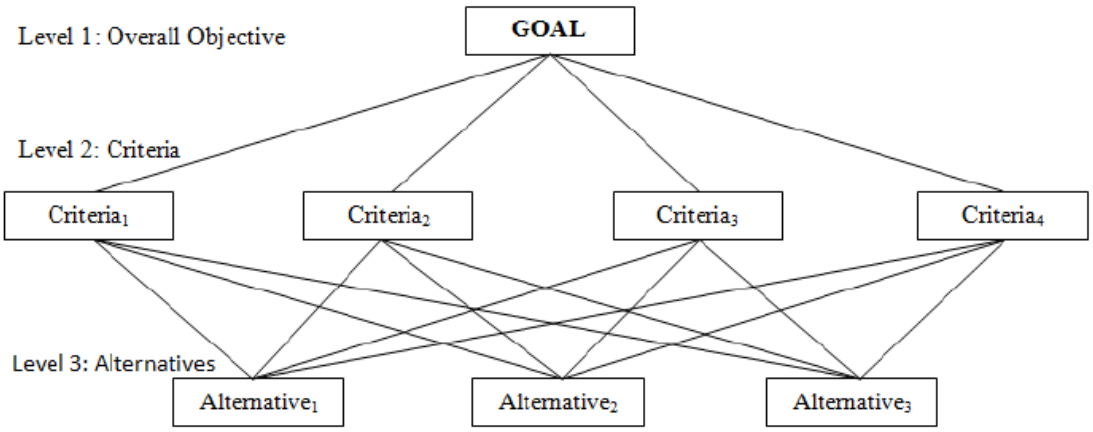

Figure 1. Illustration of AHP Structure Hierarchy

Check the Consistency

An important consideration in terms of the quality of the ultimate decision relates to the consistency of the judgments that the decision-maker demonstrated during the series of pairwise comparisons. To handle the consistency question, the AHP provides a method for measuring the degree of consistency among the pairwise judgments provided by the decision-maker. The ratio is designed such that values exceeding 0.10 are indicative of inconsistent judgments. Although the exact mathematical computation of the consistency ratio is beyond the scope of this study, an approximation of the ratio can be obtained.

The steps to estimate the Consistency Ratio are as follows:

1. Each value in the first column of the pairwise comparison matrix is multiplied by the relative priority of the first item considered. The same procedures were followed for the other items.
2. The elements of the vector of weighted sums obtained in Step 1 are divided by the corresponding priority value.
3. The average of the values computed in Step 2 is computed. This average is denoted as λ_{max}
4. The consistency index (CI) was computed, where n is the number of items being compared. The formula is :

$$CI = \frac{\lambda_{max} - n}{n - 1}$$

5. The consistency ratio (CR) is computed as CR = (CI/RI), Where RI is the random index, which is the consistency index of a randomly generated pairwise comparison matrix.
6. Development the Priority Ranking
   The overall priority for each decision alternative is obtained by summing the product of the criterion priority and the priority of the decision alternative with respect to that criterion. By ranking these priority values, we obtain the AHP ranking of the decision alternatives.

2.3 Conceptual Framework

Conceptual frameworks are tools that guide empirical research, offering critical structure and direction (Hussain, 2024). Ravitch and Riggan (2016) implied that they are “an argument about why the topic one wishes to study matters, and why the means proposed to study it are appropriate and rigorous.” The conceptual Framework should be able to define the concurrent problem and seek answers to questions based on the problem (Luft, Jeong, Idsardi, & Gardner, 2022).

Several factors contribute to the general Supply Chain Process of PT XYZ. The aspects of environment, time, economic situation, capital power, and pricing should play a significant part in the PT XYZ Readymix Concrete process. These factors are elaborated as follows:

1. Environment Aspects
   As concrete workability is a major part of Readymix Concrete Structure, it should be sufficient to be poured without voids and create a solid bond between materials. Concrete normally settles and

starts to harden in a relatively short amount of time, approximately 90 min (Mahgoub, Hussein, & Mousa, 2024). Hence, speed and distance should play a significant role in concrete delivery. Legal procedures and permits should also play a significant role in production, as they should adhere to regulations, specifically at the production site.

2. Product
   Product Quality and Quantity should be supervised in detail, as they are the major part of a concrete structure (Nurokhman, Suharyanto, & Rochmawati, 2021). Product Quality and Quantity should adhere to construction specifications, as is also related to the aspect of Quality, Safety, Health, and Environment.
3. Method
   Donald, David, M Bixby, and John (2020) initially implied that Supply Chain Management is a multifirm relationship management. Effective tools of communication and technology allow the subjects of the supply chain to communicate and create value among each other. The structure of production should add value to productivity by reducing the amount of production time, process cost, and identifying issues that should improve the production process (Quesada, Gazo, & Sanchez, 2012).
4. Supply Chain
   Supply Chain performance is defined as operational excellence in delivering a leading customer experience (Simchi-Levi, Kaminsky, & Simchi-Levi, 2004). Responsiveness also changes, and service/technical support is a major component of Supplier Performance (Steward, Wu, & Hartley, 2010).
5. Time
   Time management is the process of controlling and recording the time taken by projects. Bad time and scheduling add cost overruns, disputes, or even abandonment of the projects (Westland, 2006). Hence, time management in terms of delivery schedule and time is important.
6. Finance
   Implementing adequate Financial Control could prevent fraud, as it can ensure Supply Chain Stability and resilience. Fluctuations in material prices and sourcing ability may also affect the supply chain process (Stemmler, 2002). Hence, strong equity power and good economic conditions are the major aspects of supply chain resilience.

Based on all the previous aspects that have been mentioned, it can be compiled into a conceptual framework to constitute a complete and solid principal of the RMC supply conceptual framework. Figure 1 shows the general illustration of the factors that play a part in the Readymix Concrete Supply.

3. Research methodology

This chapter discusses the research methodology, including the research design, data collection methods, and data analysis methods. The research design discusses the framework of the research methods. The data collection method will discuss how the selected sources and methods are appropriate to the contextual problem by specifying what kind of data will be collected. The data obtained will be discussed in relation to the method or how to analyze the data in the subchapter of the data analysis method.

3.1 Research Design

Kepner-Tregoe analysis was applied from the beginning stage, as described in Chapter I, to determine the problem. This problem may occur as the implications of the concurring root cause, which should be determined prior to the implementation of alternative solutions. The main root cause should then be verified by brainstorming to generate ideas and additional information and verify the assumption. To determine the solution, SWOT analysis and brainstorming process are required based on the category mentioned based on Kepner-Tregoe Analysis to determine the company situation and what shall be the applicable solution for the concurrent situation. In the decision-making step, the Analytical Hierarchy Process was used to quantify the priority order of the decisions to solve the main problem. The decision should be assessed comprehensively through proper risk, budget, and spot/location analyses.

3.2 Data Collection Method

The researcher used several data collection methods to support the research. In this study, quantitative data collection will be conducted from reports that have been running. Likewise, a qualitative analysis will be carried out on related stakeholders as well as the point of view of experts in each section to conduct a qualitative analysis based on observation and brainstorming.

3.2.1 Data Quantitative

This quantitative data will help analyze the initial identification of problems that exist in the initial ready-mix production process in the projects being studied. These data were obtained from the primary report production data using ready-mix concrete material compared to the daily procurement plan targeted by the sample project. The data were sourced from the project's internal data, which were reported in the project's weekly report. In the step to define the root cause, we also needed to identify the 5W1H questions to describe the core of the problem we faced. To support this, we must obtain the related data to answer each question to guide us in finding the root cause. In addition, when we attempt to analyze using AHP to choose the best solution, we need to obtain the data of project progress and cost contained in each solution option for consideration. All data can be obtained by using observation and reports over a period of time.

3.2.2 Data Qualitative

Qualitative data are also required to analyze the research process, such as defining root causes and determining solution stages. This qualitative data can add information to deepen the consideration of answering and making decision solutions. This qualitative data was obtained through brainstorming and direct discussions with relevant stakeholders. Qualitative data are also required in the solution determination stage of the AHP process. At this stage, considerations and views from experts in the field (Subject Matter Expert) are needed to address the problems faced in this study. A summary of the data collection method is presented in Table III.1.

3.3 Data Analysis Method

In this research, data analysis methods will be carried out in the form of quantitative and qualitative data methods.

1. Quantitative method analysis data
   Quantitative method analysis data is a systematic approach to examine numerical data to extract meaningful insights, identify patterns, and make informed decisions. In this study, a descriptive statistical analysis was used. Descriptive statistics consist of methods for organizing, displaying, and describing data using tables, graphs, and summary measures. (Mann & Lane, 1995)
2. Qualitative Data Analysis Method
   Qualitative analysis aims to help us understand the underlying meanings, interpretations, and experiences of individuals or groups. In this study, framework analysis was used. Framework analysis involves developing a thematic framework or matrix to organize and analyze the data. Researchers use this matrix to systematically compare and contrast data across different cases and themes.

4. Results and discussions

4.1 Possible Cause Analysis

Upon determining the root cause, this research directly involves Three Subject Matter Experts (SME) as correspondents, as it should provide important information regarding the required information and problem resolutions (Khanam, 2023). The selected SME's are the persons who are directly in charge of the working site as project owners, and some of the others serve as persons in charge of the RMC production at this current Batching Plant.

Table 4. List of Qualified Subject Matter Expert

SUBJECT	EXPERTISE/OCCUPATION/ROLE
SUBJECT MATTER EXPERT 1	Site Operations Manager of PT ABC
SUBJECT MATTER EXPERT 2	Site Contract Administration Manager of PT ABC
SUBJECT MATTER EXPERT 3	Site Procurement, Logistic, Equipment Manager of PT ABC

Various questions were asked of the correspondent (see Appendix A) that correlated with the information and qualitative data needed to support this research. After the interview process was completed, the research continued to the advanced steps, which consisted of the following approaches:

1. Kepner-Tregoe Analysis
   The Kepner-Tregoe Analysis (KT Analysis) has been used since the beginning of the research. Upon determining the problem, KT Analysis determine the distinction of the situation, what seems to be different than the ideal situation.In chapter I we obtain an issue which is Shortage of Readymix Concrete Supply which is possibly caused by several reason.

The analysis proceeds to the next step, and particular reasons are implied depending on the analyst's judgement and standpoint (Kristamuljana, 1998). Thus, these are the possible reasons based on the results of the conducted interview and analysis:

a. Production Machine/Unit Insufficiency
b. Low Batching Plant Productivity
c. High difficulty in material hauling
d. Difficulties in Raw Material Supply
e. Insufficient amount of manpower/labour

2. Root Cause Analysis

To define the root cause, brainstorming was used to determine the main probable cause. The idea of using brainstorming is to verify the assumed most probable cause and confirm the issue that likely caused the concurrent issue (Kurnia et al., 2020). To provide systematic thinking to find the main cause of the problem, root cause analysis is necessary before proceeding to remedial action planning and execution (Groot, 2021).

4.2 Determining Problem Resolutions

The next step After the root cause determination process is completed, the research proceeds to the steps of defining problem resolutions, which include several methods, such as:

1. SWOT Analysis

To obtain the optimal resolution to the problem, the SWOT analysis method was utilized to gather all the general situations and assess the four main points of current conditions, including Strengths, Weaknesses, Opportunities, and Threats in advance, prior to the solutions process, as strengths and weaknesses mainly as the result of the company's own performance, and Opportunities and Threats might be derived from external factors (Gurl, 2017). According to Table 1, PT XYZ possesses several key factors as its strengths and opportunities as the major point to start on problem resolutions, while also suffering from its weaknesses and being imposed on upcoming threats as potential obstacles upon resolving the current situation/problem. Subject Matter Expert (SME) Opinions and Recommendations As Subject Matter Expert (SME)s Opinions and Recommendations are also posing significant roles on this research, another list of targeted Subject Matter Experts also provides some alternative solutions towards the problem. Previously, SMEs were listed to define the main problem caused by the problem. The next step involved selecting several SMEs as audiences to gather the necessary information. The qualified SMEs are listed in Table 5. However, several alternative solutions were proposed based on interviews and brainstorming with the involved correspondences, as shown in Table 5.

Table 5. List of Subject Matter Expert

EXPERTISE/OCCUPATION/ROLE	Expertise/Job Description
Vice President – *Konstruksi dan Instalasi* of PT XYZ	Responsible for Maintaining the Supply Chain Reliability and Process of PT XYZ
Project Manager of PT ABC	Responsible for whole project operations of PT ABC
Project Manager of PT XYZ	Responsible for whole productions of concrete readymix supply
Site Contract Administration Manage of PT XYZ	Responsible for Budget Controlling
Site Engineering and Standardization Manager PT XYZ	Responsible for design and quality controlling
Project Manager of PT XYZ	Responsible for whole productions of concrete readymix supply
Site Procurement, Logistics, and Equipment Manager of PT ABC	Responsible for project work, equipment, and materials procurement, logistics management, and warehouse management.

The interview results provided several alternative solutions to the probable main causes, as the alternative solutions also consider the SWOT analysis shown in Table 6. As previously mentioned, SWOT analysis represents the company's general situation. Based on the conducted interview along with the qualified SME, as listed in Table 5, the provided solutions are narrowed into three best alternative solutions, as the solutions might be feasible and applicable, as those should be able to address the main probable cause. Hence, three Alternative Solutions are provided by the Qualified SME:

1. Purchase new production machine and expanding current batching plant
2. Outsource Readymix Concrete Supply from External Vendors with long term strategic partnership
3. Build new Batching Plant with new production equipment and bigger production volume

Table 6. Root Cause Problem with Alternative Solutions

Main Problem	Alternative Solutions
Shortage on Readymix Concrete Material Supply caused by Low Batching Plant Productiviy and Difficulties on Delivery Process.	1. Purchase new production machine and expanding current batching plant 2. Outsource Readymix Concrete Supply from External Vendors with long term strategic partnership 3. Build new Batching Plant with new production equipment and bigger production volume

To support the decision-making process, alternative solutions also consider the aspect of implementation cost, as outsourcing ready concrete supply might include the production cost, which should be the responsibility of the potential strategic partner. Thus, the estimated implementation costs are presented in Table 7.

Table 7. Estimated Cost for Solutions Implementation

No.	Alternative Solutions	Estimated Cost
1	Purchase new production machine and expanding current batching plant	**± Rp 310.000.000.000**
2	Outsource Readymix Concrete Supply from External Vendors with long term strategic partnership	**± 20.000.000.000,-***
3	Build new Batching Plant with new production equipment and bigger production volume	**± Rp 429.000.000.000,-**

Based on Table 7, three key solutions are proposed to address the primary probable cause. Each of these solutions has its own advantages and disadvantages, as shown in Table 8, and requires further justification to quantify the decision-making process to establish the most effective and efficient solutions. One thing that should be considered is that while outsourcing readymix concrete may appear lower in terms of issue resolving price, the material orders might be higher than the actual cost as there should be margins or profit for the 3rd party vendor, that part must be considered in advance.

In Addition, Alternative solutions are measured by five key aspects that would complement the decision-making process. Five key factors must be considered to choose the fittest decision for the concurring problem, each representing its own description and criteria. The five key criterias and its descriptions are shown in Table 8.

Table 8. Five Key Criteria on Alternative Solutions

CRITERIA	DESCRIPTION
Cost	Cost required for solution implementation, including project cost, maintentance cost, operational cost, and procurement cost
Flexibility & Adaptability	The ability to adapt to the required amount of production, change of specification required, and fluctuation in market price
Schedule	Estimated Time for Solution Implementation and Project Completion
Product Quality	Product Quality according to required specifications based on the standard of the construction process; this played significant aspect of product acceptability and construction safety when the construction process is finished
Supply Chain Reliability	The consistent ability of a Supply Chain to deliver products according to demanded quantities, matched quality levels, and resistant on disturbances and disruption

All the aspects from Table 8 are required to consider the Product Quality Aspect as it is the most prominent aspect among all the five criteria, as Product Quality is directly correlated with Product Acceptability and Safety Aspects of the finished construction according to the required construction specifications and requirement.

4.3 Decision Making Process

Advancing to the Decision Making, in this research used Analytical Hierarchy Process (AHP). As Saaty and Vargas (2012) implied, prior to the decision-making process, it is necessary to consider which factors to include in the process. This consists of identifying the issues, determining the probable causess and the main probable cause,and alternative solutions. Few steps are needed to determine the correlations between the two aspects.

1. Construction of Hierarchy Structure
   The three alternative solutions mentioned based on Table IV.6 should be complemented by criteria based on Table IV.9, which are the fundamental aspects of determining the possible solutions that directly consider the five key aspects. The Hierarchy Structure is shown in Figure IV.4.
2. Pairwise Comparison of Analytical Hierarchy Process
   Saaty and Vargas (2012) implied that Pairwise Comparison is meant to quantify preferences between criteria and alternative solutions. SME are required to answer and choose between criteria and their correlated alternative solutions, which are also called fundamental scales. The numbers are meant to quantify the significance or preference of the criteria. The higher the number, which is nine (9), the higher the preference towards the desired criteria, and vice versa for the undesired criteria. A detailed explanation of the number signification on quantifying the preference in Pairwise Comparison is shown in Figure IV.5. An example of the pairwise comparison table is shown in Figures IV.6 and IV.7.

Intensity of importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
2	Weak	
3	Moderate importance	Experience and judgment slightly favor one activity over another
4	Moderate plus	
5	Strong importance	Experience and judgment strongly favor one activity over another
6	Strong plus	
7	Very strong or demonstrated importance	An activity is favored very strongly over another; its dominance demonstrated in practice
8	Very, very strong	
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation
Reciprocals of above	If activity *i* has one of the above nonzero numbers assigned to it when compared with activity *j*, then *j* has the reciprocal value when compared with *i*	A reasonable assumption
Rationals	Ratios arising from the scale	If consistency were to be forced by obtaining *n* numerical values to span the matrix

The generic responses collected from the interview along with the qualified correspondents are listed in Table IV.10, and the detailed responses are attached in the Appendix Section for each of Pairwise Comparison Tables. The detailed responses that can be processed are presented in a table, in which each criterion represents the average value of the correspondence criteria solutions.

The pairwise comparison of Alternative Solutions for each criteria solution is listed in Table IV.11. The Table would then be processed along with the criteria solutions from Table IV.10, and analysis can start to finish with the AHP Method to determine the decision to solve for the main probable cause.

Table 9. Pairwise Comparison of Criteria Solutions for Problem Cause

CRITERIA	AVERAGE SCORE	CRITERIA	AVERAGE SCORE
Cost	0,54	Schedule	1,86
Cost	2,29	Flexibility & Adaptability	0,44
Cost	0,15	Product Quality	6,57
Cost	0,58	Supply Chain Reliability	1,71
Schedule	2,71	Flexibility & Adaptability	0,37
Schedule	0,18	Product Quality	5,71
Schedule	2,57	Supply Chain Reliability	0,39
Flexibility & Adaptability	0,16	Product Quality	6,14

Flexibility & Adaptability	1,86	Supply Chain Reliability	0,54
Product Quality	6,14	Supply Chain Reliability	0,16

Analysis for Decision Making Process based on Pairwise Comparison
The analysis was conducted to determine the Main Goal (As Drawn on Figure IV. 5). The Level 2 – Criteria might be the main criteria to be considered for each alternative solution as the level-3 of the matrix hierarchy. Herewith the analytical hierarchy process computation as the advancing step after the responses are collected:

1) Upon the pairwise comparison of criteria solutions, the data should be summed to obtain the total score for each criteria solution. The summed quantified responses of each Subject Matter Experts are presented in Table 10.

Table 10. Total Column of Each Criteria Solutions

CRITERIA	Cost	Schedule	Flexibility & Adaptability	Product Quality	Supply Chain Reliability
Cost	1	0,54	2,29	0,15	0,58
Schedule	1,86	1	2,71	0,18	2,57
Flexibility & Adaptability	0,44	0,37	1	0,16	1,86
Product Quality	6,57	5,71	6,14	1	6,14
Supply Chain Reliability	1,71	0,39	0,54	0,16	1
Column Total	11,58	8,01	12,68	1,65	12,15

2) Each row is divided by the column total to determine the average of each row. The average of each row should be used for further calculations in the matrix calculation. The result of each row divided by the Column Total is on Table IV.13

Table 11. Row Average for Each Criteria Solution

CRITERIA	Cost	Schedule	Flexibility & Adaptability	Product Quality	Supply Chain Reliability	Row Average
Cost	0,09	0,07	0,18	0,09	0,05	0,09
Schedule	0,16	0,12	0,21	0,11	0,21	0,16
Flexibility & Adaptability	0,04	0,05	0,08	0,10	0,15	0,08
Product Quality	0,57	0,71	0,48	0,61	0,51	0,58
Supply Chain Reliability	0,15	0,05	0,04	0,10	0,08	0,08
Column Total	1	1	1	1	1	1

Hence, based on Table 11 the eigen vector found is as shown in Table 12. As the table represent the matrix or vector of solution criteria which would be needed to determine the decision in the later

Table 12 Priority Vector of Criteria Solution

SOLUTION CRITERIA	PRIORITY VECTOR
Cost	0,09
Schedule	0,16
Flexibility & Adaptability	0,08
Product Quality	0,58
Supply Chain Reliability	0,08

3) To determine the matrix of alternative solutions, a similar method is applied, in which each solution criterion must be quantified through pairwise comparison. Each solution criterion, which was previously mentioned, is now paired with the alternative solution, as illustrated in **Figures IV.6** and **IV.7**. The detailed process of the analysis is available in the Appendix section. **Table IV.15** presents a compilation of each priority vector of the alternative solutions for each criterion solution.

Table 13. Priority Vector of Alternative Solutions based on Each Criteria Solution

Alternative Solutions	Cost	Schedule	Flexibility & Adaptability	Product Quality	Supply Chain Reliability
Purchase New Equipment	0,23	0,15	0,33	0,31	0,28
Strategic Partnership with Suppliers	0,69	0,60	0,07	0,08	0,08
Build New Batching Plant	0,08	0,25	0,60	0,61	0,64

4) To define the priority ranking based on the Priority Vector of Solution Criteria and Alternative solution of each solution criterion, a weighted sum is applied to quantify the priority ranking. Prior to the calculation step, the quantification of each criteria and alternative solutions is shown in Figure 2.

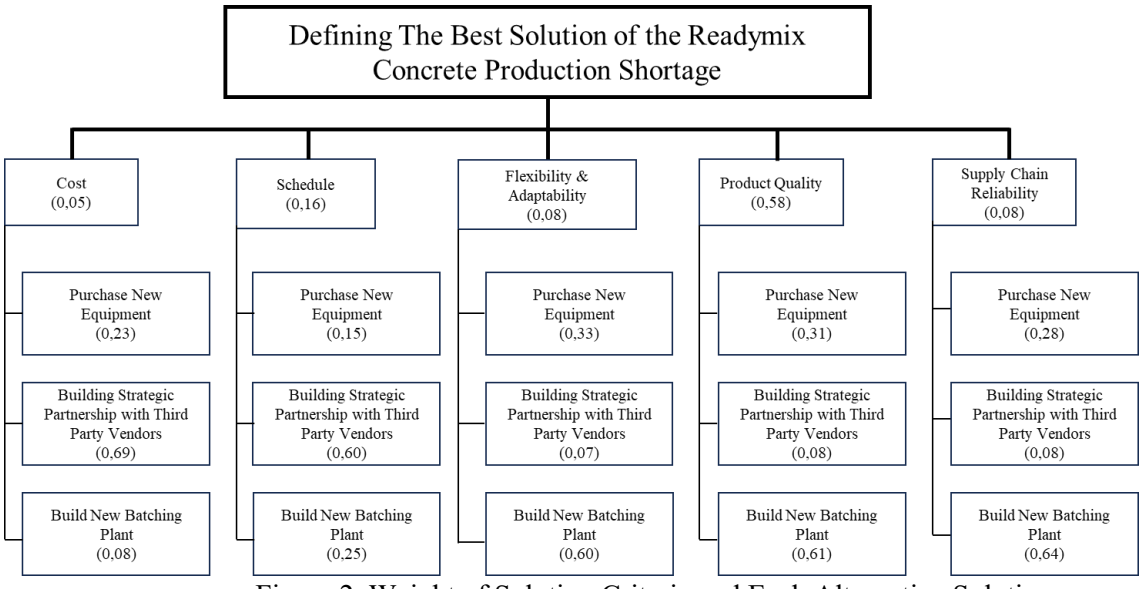

Figure 2. Weight of Solution Criteria and Each Alternative Solution

The criteria Solution with the aspect of Product Quality played a very significant role in decision-making, as it was mandatory for every production. Failure to achieve the required quality structure can cause significant profit loss or even mortality. These implications can cause a domino effect on the entire company's welfare. Product Quality is also a mandatory requirement for a structure to be accepted, as it should be paid after the project/progress is completed and meets the required quality.

However, all the aspects of Criteria Solution are important, as Schedule and Supply Chain Reliability are also the second and third highest weighted priorities, respectively, as the schedule might be impacted on the duration based on the duration of the procurement contract, which any latency in delivery and completion would cause an immediate punishment such as a fine or the worst is contract termination. Moreover, Cost and Flexibility & Adaptability are the fourth and fifth priorities, respectively.

5) Advanced to the decision-making process, AHP utilizes matrix computation to quantify the most effective decision regarding the weight of the criteria solution (level-1) and the weight of the alternative solution (Level-2). The calculation process for determining the decision is as follows:

Alternative Ranking = Priority Vector (Level -1) x Priority Vector (Level-2)

$$\text{Alternative Ranking} = \begin{pmatrix} 0{,}23 & 0{,}15 & 0{,}33 & 0{,}31 & 0{,}28 \\ 0{,}69 & 0{,}60 & 0{,}07 & 0{,}08 & 0{,}08 \\ 0{,}08 & 0{,}25 & 0{,}60 & 0{,}61 & 0{,}64 \end{pmatrix} \text{x} \begin{pmatrix} 0{,}09 \\ 0{,}16 \\ 0{,}08 \\ 0{,}58 \\ 0{,}08 \end{pmatrix}$$

$$\text{Alternative Ranking} = \begin{pmatrix} 0{,}274 \\ 0{,}223 \\ 0{,}503 \end{pmatrix}$$

As the calculation was completed, it was defined that the third alternative solution of "Build New Batching Plant" stands as the best alternative solution towards the main problem, which would address the problem and also consider the five important aspects. As the table of decision ranking is as seen on Table 13.

Table 13. Priority Ranking of Alternative Solutions

Alternative Solution	Score	Alternative Rank
Purchase New Equipment	27,4 %	Second
Strategic Partnership with Suppliers	22,3 %	Third
Build New Batching Plant	**50,3 %**	**First**

1. As the decision is made, it is required to check the Constency Index and Consistency Ratio as every Crieria Level-1 and Level-2 have to be acceptable based on the Consistency Ratio below 0,1 or 10% indicates a consistent judgement which is acceptable:
   1) The weight of every aspect of the solution criteria, which is listed in Table 13, is determined based on each criterias on Table 13. The method for determining the Consistency Index is to define the value of $\lambda_{max,}$ and we can immediately determine the Consistency Index (CI).
   2) Then, after obtaining the Consistency Index (CI), it is mandatory to understand that this research considers five criteria solutions, which are correlated with n to define the Random Consistency Index (RI) based on Table 14.

Table 14. Random Consistency Index (RI)

n	1	2	3	4	5	6	7	8	9	10
RI	0.00	0.00	0,58	0,90	1,12	1,24	1,32	1,41	1,45	1,49

Source : Padmowati (2009)

3) The alternative solutions of each criterion are also required to be verified, though with different indices of the Random Consistency Index (RI) as a similar method might be applied. All criteria must meet the required Consistency Ratio, as mentioned above, which is 0,1.

Detailed calculations and Consistency Ratio Checking are attached in the Appendix section. Hence, after the calculation was completed, the compilations are as shown in Tables IV.19 and IV.20.

Table 15. Consistency Ratio of Criteria Solutions

Criteria Solutions	Row Average	Weighted Sum	Average Value	λmax	Consistency Index (CI)	Consistency Ratio (CR)
Cost	0,09	0,51	5,36			
Schedule	0,16	0,88	5,39			
Flexibility & Adaptability	0,08	0,43	5,24	5,36	0,09	0,081
Product Quality	0,58	3,16	5,49			
Supply Chain Reliability	0,08	0,45	5,34			

As a result of the decision-making process completed using the AHP Method, the main root cause was addressed, which was "Shortage on Readymix Concrete Material Supply caused by Low Batching Plant Productiviy and Difficulties on Delivery Process." is "Build New Batching Plant" as the answer held the highest alternative rank (50,3%) as mentioned in Table IV.17, as the decision appeared to be consistent for each criteria solution. Hence the Hierarchy Tree for Proposed Alternative Solutions for each criteria Solutions is on Figure 3.

b. Business Implementation Plan

The implementation plan consists of the process of executing the decision made, which is to Build New Batching Plant," which was previously obtained through the AHP method with concurrent circumstances. The Plan consists of risk analysis, estimating construction bill of quantities, cost and benefit analysis, production analysis, and positioning analysis of the New Batching Plan. Here are the steps to execute the "Implementation Plan":

1. SWOT Analysis

   Comprehensive Risk Analysis is a mandatory process before proceeding to the next step, as SWOT analysis is meant to determine the current condition of the company. The SWOT analysis, which is based on Table IV.4, is still applicable considering that all of the aspects are literal factors that represent the whole company's current welfare. Several points can be added to adhere to the current specific situation. In addition, PT XYZ is not a candidate for the consortium of PT Karya Logistik Nusantara, which plays a significant role in Concrete Manufacturing, especially for the acceleration program for IKN development. Moreover, the current company liquidation process imposes a difficult situation.

2. Budget Analysis

   Based on past sales, it is assumed that PT XYZ can achieve 17,5% of the total demand, as the project owner is presumed to purchase ready-mix concrete from several vendors. Moreover, it is estimated that in the next two years, the demand for concrete readymix that is specific to PT XYZ 305.689 m^2. Budget analysis consists of estimating the operations cost, which is the Cost of Goods Manufactured, General & Administrative Expenses, Cost of Goods Sold, and Revenue. The Goods Manufactured is a detailed bill of quantities of estimated work based on the demand from the project owner, as the Cost of Goods Sold have the same quantities, but the adjusted price to generate margin or profit. On the other hand, general and administrative expenses are estimated at 1% of the Cost of Goods Manufactured (COGM).

3. Spot Analysis

The last step before executing the plan is that the location of the new batching plant should not be too distant from the projects to eliminate any possibility of difficulty during the hauling process. In addition to addressing roadway difficulties, the setting time for ready-mix concrete is considerably long. A new batching plant should withstand at least two to five years. Several locations are available in a few options, and Simpang IKN appears to be the most effective and efficient spot to build a new batching plant. Simpang IKN, or the IKN main intersection, is central to potential and ongoing projects, which means it should be able to address the previously mentioned issue. The illustration of the proposed location is shown on Figure 3.

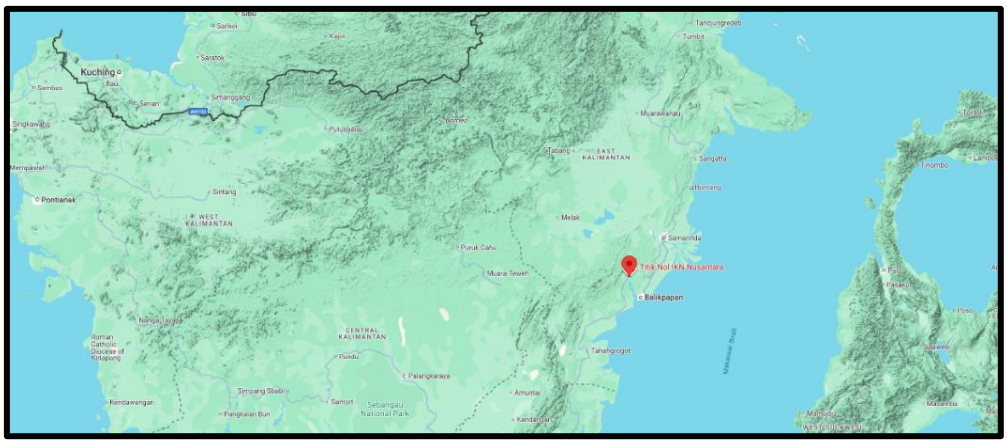

Figure 3. Map of New Batching Plant

4. Risk Analysis

Risk analysis is mandatory to analyze the possible threats and risks during the implementation process. Risk analysis should identify all vital aspects of the company, including financial, production, supply chain management, human resource, and legal risks. Risk analysis should be accompanied by immediate mitigation, as it should not occur; therefore, the implementation process is applicable. The risk Analysis is shown in Table 16.

Table 16. Risk Analysis of Implementation Plan

No.	Risk	Main Cause	Mitigations
1	**Financial Risk** – Difficulties on achieving desired market shares	• Current Product Price is Higher compared to PT XYZ competitors	• Evalue current purchasing method, COGM, and COGM • Identify and construct a strategic partnership with third party raw material supplier
2	**Production Risk** – underachieveing production rate	• Bad Weather Condition • Bad Quality Control • Limited Workforce Available • Uncertainty of Raw Material Supply	• Increasing the effectiveness of the quality control • Reassuring the production equipment have to be in good condition • Recruit more high capability workforce • Construct a better third party vendors, especially high achieving supplier with lowest price
3	**Supply Chain Management Risk** –	• Limited Available Supplier	• Reassuring outline agreement towards available

No.	Risk	Main Cause	Mitigations
	Uncertainty in Price and Latency in Product and Raw Material Supply	• Difficulties in Access • Communication Problem	vendors to lock uncertainty in market price • Better Delivery Access by selecting the most efficient way • Make sure that outstanding payment is not too long
4	**Human Resource Risk** – Low Skilled Workforce	• Slow Speed in terms of increasing Workforce Skills • Low retaining rate for Current High Skilled Workforce	• Improving training speed with more efficient method • Reassuring that the incentive would adhere the needs of the Workforce
5	**Legal Risk** – Illegal Production Process	• Low Legal Awareness • Limited Time for Production Permits	• Reasurring All Required Administrative Document is ready • Create document monitoring and build better commniucation with legal division to control the process

5. Conclusion

After the situation appraisal to obtain information regarding the current situation, followed by the problem-solving process, this research and several implications may be applied as problem resolutions.

5.1 Conclusion

This study finally addressed the root cause of the issue, followed by problem resolution and the decision-making process to choose the best option. The conclusions of this study are as follows:

1. What is the root cause of the concrete readymix supply shortage issue at PT.XYZ projects in IKN? Through the Kepner-Tregoe Analysis and verified through brainstorming with correspondences`, several issues that cause the shortage of ready-mix concrete supply were identified.

a. Production Machine/Unit Insufficiency
b. Low Batching Plant Productivity
c. High difficulty in material hauling
d. Difficulties in Raw Material Supply
e. Insufficient amount of manpower/labour

Hence, the main root cause of the problem is the shortage of ready-mix concrete material supply caused by low batching plant productivity and difficulties in the delivery process.

2. What are the proposed alternative solutions to solve the concrete readymix supply shortage issue at PT. XYZ projects in IKN? To solve this concurrent issue, this study involves SMEs to address the main root cause. SMEs offered alternative resolutions as those solutions were assumed to be effective enough to address the main root cause of the problem, which are as follows:

a. Purchase a new production machine and expand the current batching plant.
b. Outsource Readymix Concrete Supply from External Vendors with long-term strategic partnerships.
c. Build a new Batching Plant with new production equipment and a larger production volume.

3. What is the best solution to solve the concrete readymix supply shortage issue at PT. XYZ projects in IKN?

Through the Analytical Hierarchy Process (AHP), by considering five important aspects, including Cost, Schedule, Flexibility & Adaptability, and Supply Chain Reliability, the most effective solution

appeared to be “Build a new Batching Plant with new production equipment and a larger production volume.” According to the alternative ranking, building a new batching plant pose 50,3% in terms of scoring as the highest score compared to the other two problem solutions.

5.2 Recommendation

An implementation plan to solve the main root cause should be developed under strict supervision, considering possible threats that may affect the implementation process, including progress monitoring and evaluation, and risk mitigation should be strictly under control, as it should save the company from upcoming threats. A batching plant should be built after it is legally permitted and under safe conditions, as new problems may arise and impose the company’s current welfare. It is better to consider other factors before proceeding to the next step by completing another study and other considerations.

However, the research can be improved in many ways, such as increasing the number of correspondents, since the current condition author is limited. The justification and decision-making may differ in other cases because other situations may differ from this research subject based on the main root cause, alternative solutions, or any other considerations.

References

Anirwan, A., Aljurida, A., & Baharuddin, T. (2024). Developing a New Capital City (IKN) In Indonesia: A Thematic Analysis. *Policy & Governance Review, 8*, 1-18. doi:https://doi.org/10.30589/pgr.v8i1.863

Bazyar, A., & Abbasi, M. (2025). Multi-objective planning for a multi-echelon supply chain using parameter-tuned meta-heuristics. *Annals of Management and Organization Research, 7*(1), 45-65. doi:https://doi.org/10.35912/amor.v7i1.2542

Donald, J. B., David, J. C., M Bixby, C., & John, C. B. (2020). *Supply chain logistics management*: McGraw-Hill Education.

Effendi, Y. M., & Siallagan, M. P. S. (2025). Prioritizing the product development roadmap of Zains SAAS using Analytical Hierarchy Process (AHP). *International Journal of Accounting and Management Information Systems, 1*(2), 121-141. doi:https://doi.org/10.35912/ijamis.v1i2.3042

Groot, W. (2021). Root cause analysis–what do we know? *Maandblad voor accountancy en bedrijfseconomie, 95*(1/2), 87-93. doi:https://doi.org/10.5117/mab.95.60778

Gurl, E. (2017). SWOT analysis: A theoretical review.

Hussain, A. (2024). *The Tale of Technology: A Guide to Understanding Technology Business in the 21st Century*: Notion Press.

Kepner, C. H., & Tregoe, B. B. (1997). *The New Rational Manager* Princeton Research Press.

Khanam, M. (2023). *Subject Matter Expert (SME) Management Strategy for Multi-Criteria Decision Making (MCDM): A Case Study of Hierarchical Decision Model (HDM).* Paper presented at the 2023 Portland International Conference on Management of Engineering and Technology (PICMET).

Kristamuljana, S. (1998). *Landasan Teori Metode Kasus untuk Pengembangan Manajer yang Rasional.* Paper presented at the Forum Manajemen.

Kurnia, G., Johanes, H., Hidayat, D., Rozha, A., Zahvira, M., & Sukarno, I. (2020). Improving Airport On-Time Performance Using Kepner-Tregoe Problem-Solving Approaches. *Jurnal Teknologia, 3*(1), 493086.

Luft, J. A., Jeong, S., Idsardi, R., & Gardner, G. (2022). Literature reviews, theoretical frameworks, and conceptual frameworks: An introduction for new biology education researchers. *CBE—Life Sciences Education, 21*(3), rm33. doi:https://doi.org/10.1187/cbe.21-05-0134

Mahgoub, M., Hussein, M., & Mousa, A. (2024). Extended discharge time of ready-mixed concrete: Myth or necessity? *Construction and Building Materials, 437*, 136913. doi:https://doi.org/10.1016/j.conbuildmat.2024.136913

Mann, W. C., & Lane, J., P. (1995). Technology and Disability. *4*(2).

Nson, Y. D. (2024). Management by walking about in achieving organizational excellence: The role of total quality management. *Annals of Human Resource Management Research, 4*(2), 111-126. doi:https://doi.org/10.35912/ahrmr.v4i2.2408

Nurokhman, N., Suharyanto, I., & Rochmawati, U. (2021). Evaluasi Mutu Beton Dari Berbagai Ready Mix Pada Gedung Parkir Yogyakarta International Airport. *CivETech, 3*(2), 55-65. doi:https://doi.org/10.47200/civetech.v3i2.1058

Padmowati, R. d. L. E. (2009). *Pengukuran index konsistensi dalam proses pengambilan keputusan menggunakan metode AHP*. Paper presented at the Seminar Nasional Informatika (SEMNASIF).

Palcic, I., & Lalic, B. (2009). Analytical Hierarchy Process as a tool for selecting and evaluating projects. *International Journal of Simulation Modelling (IJSIMM), 8*(1). doi:https://doi.org/10.2507/IJSIMM08(1)2.112

Pottonen, J. (2023). Utilization of The 8d Quality Tool in Solving The Quality Problems in John Crane Nordic Units.

Quesada, H., Gazo, R., & Sanchez, S. (2012). Critical factors affecting supply chain management: A case study in the US pallet industry. *Pathways to supply chain excellence*, 33-56.

Ravitch, S. M., & Riggan, M. (2016). *Reason & rigor: How conceptual frameworks guide research*: Sage publications.

Saaty, T. L., & Vargas, L. G. (2012). *Models, methods, concepts & applications of the analytic hierarchy process* (Vol. 175): Springer Science & Business Media.

Sabbaghi, A., & Vaidyanathan, G. (2004). SWOT analysis and theory of constraint in information technology projects. *Information systems education journal, 2*(23), 1-19.

Simchi-Levi, D., Kaminsky, P., & Simchi-Levi, E. (2004). *Managing the supply chain: the definitive guide for the business professional*: McGraw-Hill.

Stemmler, L. (2002). *The role of finance in supply chain management.* Paper presented at the Cost management in supply chains.

Steward, M. D., Wu, Z., & Hartley, J. L. (2010). Exploring supply managers' intrapreneurial ability and relationship quality. *Journal of Business-to-Business Marketing, 17*(2), 127-148. doi:https://doi.org/10.1080/10517120903407857

Westland, J. (2006). *The project management life cycle: a complete step-by-step methodology for initiating, planning, executing & closing a project successfully*: Kogan Page Limited.