Innovation Product for Spun Pile Products at Precast Construction Company in Indonesia with a Risk Approach and ISO 56002 Innovation Process to Increase Competitiveness

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Innovation Product for Spun Pile Products in Indonesia Using a Risk Management and ISO 56002 Innovation Process to Increase Competitiveness

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Abstract. The demand for precast concrete is increasing rapidly along with the development of construction technology, where almost all building elements use precast concrete. This can be seen in the production capacity, which is increasing yearly, making it possible for similar products from abroad to enter the country. Therefore increasing the superiority of precast concrete products is necessary to increase companies' competitiveness to compete in the industry. This research focuses on the product with the highest demand in Company X, spun pile. This study aims to identify what factors must be considered in product innovation as well as existing risk factors to increase competitiveness. This study uses Qualitative analysis methods by validating research results in product innovation and risk factors on experts who were analyzed using the Delphi method and the ISO 56002 innovation process as a reference for the research flow. Based on the research results, three factors with a total of twelve indicators need to be considered in product innovation. There are a total of twenty-eight identified risks based on the goals and objectives of each indicator. This study resulted in product innovation recommendations in the form of preventive and corrective actions for any high risks in spun pile products to increase competitiveness.
Keywords: Precast Concrete, Innovation Product, Risk, Competitiveness, ISO 56002.

1. Introduction

The demand for precast concrete needs in construction projects in Indonesia is excellent due to the increasing infrastructure development in Indonesia, which has triggered a high demand for the construction industry [1]. Based on data from the Ministry of PUPR, the national demand for precast concrete is increasing rapidly [2]. Along with the development of technology, innovations in the use of precast concrete products, which have continued to develop to this day, can be used in the construction of houses, bridges, station platforms, and electricity poles. Based on this, the production capacity of precast concrete has grown from 2015 of 25.45 million tons to 41.28 million tons in 2019 [1].

According to the SNI National Standardization Agency [22], precast concrete, which is often referred to as precast concrete, is a construction whose component components go through a fabrication or moulding process. This process can be carried out directly on production land and in the field, forming a construction or building. The use of precast concrete has several advantages, including saving time because the whole precast concrete is produced in the factory so that it can be directly installed on the section needed. It also makes efficient concrete because precast concrete is made according to factory standards which are also carried out quality control to produce concrete as designed, and also the use of precast concrete dramatically minimizes man-hours, thereby lowering labour costs as no on-site casting is required [20]. Precast concrete products continue to grow every year, where currently there are many types of products, some of which are Box Girder, U Girder, Façade, Box Culvert, Planter Box, U Ditch, Tetra Pod, Arch Girder, Spun Pile, Square Pile, I Girders, and Sheet Piles

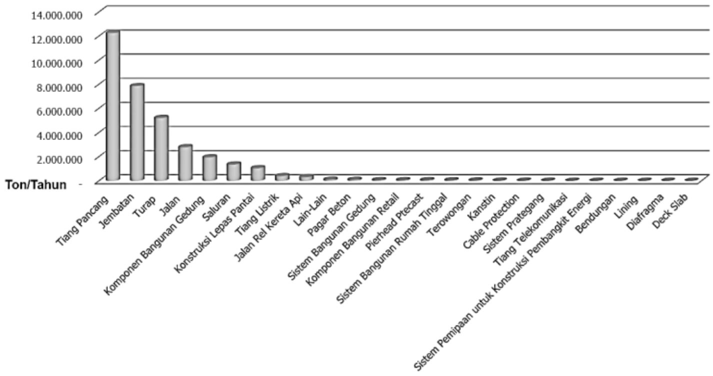

Figure 1. Precast Concrete Production Capacity

Source: AP3I, 2020 [3]

Based on Fig.1, precast concrete production capacity data, the product with the highest production volume is the spun pile product. In this research, the case study used is Company X, a precast concrete company established in 2002 and focusing on a ready mix and precast concrete business. Based on data from Company X spun pile product is one of the superior products where production is carried out daily. Therefore this research focuses on one product, namely spun pile. For the last 5 (five) years, the demand for precast concrete at Company X from 2018 at 33,505,071 has increased by 1.06x to 2019.

However, the precast industry's development needs to be improved by several obstacles. Namely, the current production capacity is still very limited, while demand continues to increase five times above the production capacity of the precast concrete industry [4]. Then the enactment of the ASEAN Economic Community (AEC) and the ASEAN China Free Trade Area (ACFTA) also increased competition in the precast concrete industry due to policies that allow similar products to enter Indonesia without import duty fees [5]. Based on this, the competitiveness of companies is severely tested. Only companies with high capability in innovating the right products can survive. To keep precast concrete in a stable competitive position, several innovative considerations include the escess supply capacity, regarding the rapid increase of the product's present national demand [26]. If companies cannot compete, they will go bankrupt and leave the market [21].

However, in carrying out product innovation, several causes affect competitiveness, failing to increase competitiveness, and achieving product superiority, such as product uniqueness, quality, price, product difference, and product standardization [6]. Have not attained the desired product quality, such as performance, features, reliability, and suitability [7]. In addition, product innovation does not offer new designs that are unique or misjudge the competition, product innovations that are carried out produce designs with product efficiency that is much lower than initially estimated and calculated. [8].

One of the solutions to increase the company's Competitiveness is to innovate precast concrete products by accurately analyzing all the risks that may occur in carrying out product innovations.This development was carried out through product excellence, uniques, packaging, and cost efficiency to increase competitiveness [26].

2. Materials and Methods

2.1. Concept of Product Innovation

Innovation is the implementation of new or significantly improved products or processes, new marketing methods, or new organizational methods in business practices, workplace organizations or external relations [9]. In addition, companies can also make innovations first in product innovation, such as goods, services, ideas and places. Secondly, in management innovation, such as work processes, production processes, marketing finance etc., innovation is crucial for a company to maintain a competitive advantage [7].

So it can be concluded that product innovation is an effort made by companies or business actors to improve, develop, or create new products that meet market needs with excellence, quality, and competitive prices, to provide added value compared to similar products and increase sales.

2.2. Competitiveness

A company's competitiveness depends on its ability to produce products with ever-increasing quality, reduce costs, and fast time-to-market [10]. According to Porter (1990), a competitive advantage is the ability of a company to gain economic benefits above the profits that competitors can achieve in the same industry.

Based on studies conducted by Porter, several ways to gain competitive advantage include offering products or services at a minimum price (cost leadership), offering products or services that are unique compared to competitors (differentiation), or focusing on a particular segment (focus) [7].

So it can be concluded that competitiveness is the ability of a company or an industry to increase productivity with excellence, quality, and competitive prices for better products and always increase to achieve high and sustainable growth.

2.3. Product Excellence, Quality, and Cost

Product excellence is everything that makes the product has advantages and value in customers' eyes to encourage buyers to buy [11]. Product quality is the physical condition, function, and product characteristics of goods and services based on the expected quality level [12]. Costs are funds or capital that the company must issue to process raw materials in producing a product that will later be marketed or sold [13].

2.4. Risk Management

Risk management aims to identify, analyze and control risks in all company activities to achieve greater effectiveness and efficiency. Risk relates to the possibility of unwanted or unanticipated consequences or losses. In other words, there is likely uncertainty, a condition that increases the risk [14].

As defined in ISO31000:2018 [15], risk is the impact of uncertainty on objectives. Where uncertainty is defined by the inability to understand a state or event that is generally related to the future, the impact is defined as a deviation from what is expected and the process that creates or generates opportunities and risks.

Risk management is needed to manage risk in innovation rather than making risk an obstacle by considering the main features of innovation that will always face risk. In improving the organizational ability to manage risk, a risk management approach is used in product innovation [16].

Based on PMBOK [18], the risk management process generally consists of several processes, including:

1) Plan Risk Management, defining how risk management is carried out in a project.
2) Risk Identification, the process of determining which risks will impact the project and documenting their characteristics.
3) Qualitative Risk Analysis, prioritizing risks for further analysis or action by assessing and combining the probabilities of events and their impacts.
4) Quantitative Risk Analysis, the process of numerically analyzing the effects of identified risks on the entire project.
5) Risk Responses Plan, a process for developing action options that can be taken to minimize threats to project achievement.
6) Control Risk, implementing a risk response plan, tracking risks, monitoring risks, identifying new risks, and evaluating the effectiveness of the risk process throughout the project.

2.5. Delphi Method

The Delphi method is a systematic way to get consensus from a group of experts [23]. The Delphi method is a systematic method of collecting opinions from a group of experts through a questionnaire. The feedback mechanism is through rounds of questions at each stage of the analysis to ensure the anonymity of the respondent's responses. The Delphi method is a modification of brainwriting and survey techniques. In this method, panels are used in communication with the help of a questionnaire instrument. The Delphi technique was developed to obtain expert opinions [24].

In this study, Delphi is a method of verifying the analysis results carried out by researchers to know the opinions and preferences of expert experiences.

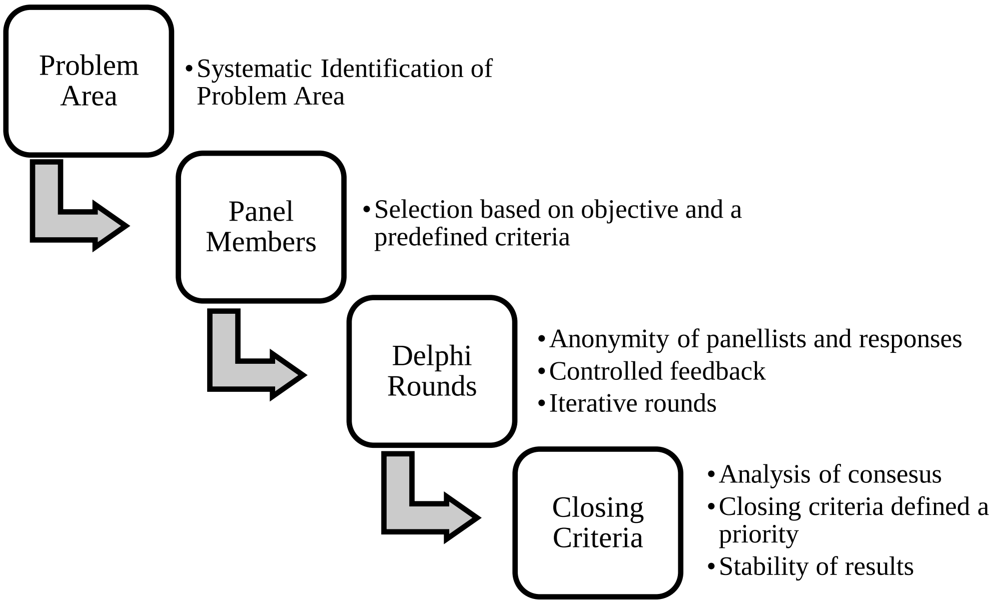

Figure 2. Stepwise Quality Assessment of Delphi Studies.

Source: Nasa, et al [25]

Based on Figure 2, the following are the steps used in the Delphi method in this study.

1) Identify the problem and conduct a literature study
2) Choose experts with work experience or in the same field for at least 20 years with a minimum Master's degree for director positions and 15 years experience with a minimum bachelor's degree education for division head positions.
3) Designing a first stage questionnaire instrument containing data from literature studies and interviews.
4) Distributing questionnaires and analyzing the first stage of the questionnaire to obtain validation and suggestions/input from experts obtained through interviews.
5) Designing the second stage of the questionnaire instrument, which contains additional data obtained from several experts, to be validated again to get a perfect final result.
6) Repeat step five if there is still feedback or suggestions and disagreement from experts until consensus is reached
7) Make conclusions on the final results of the validation to be then given to experts as information

2.6. Innovation Process Based on ISO 56002

Based on ISO 56002 [17], five process stages must be passed to carry out innovation, including identifying opportunities, creating, validating, developing, and deploying solutions.

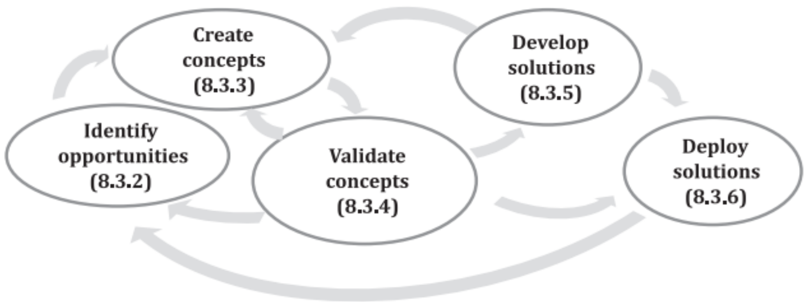

Figure 3. Innovation Process
Source: ISO 56002 [17]

The following is the innovation process based on Figure 3, with input, process, and output carried out in this study.

Table 1. Product Innovation Process

ISO 56002 Innovation Process	Description	Product		
		Input	**Process**	**Output**
Identify Opportunities	Searching for GAP analysis and opportunities	• Product innovation factors • Risk factors • Research process • Information on the latest product innovations	• Searching from literature studies • Validation of findings to experts	• Factors that have been validated • Risks that have been validated • Innovation process • Input current product developments
Create Concepts	Attempts to fill the analysis GAP and take advantage of opportunities	Output identify opportunities	• Analysis of validated factors that have been validated • Risk analysis	Innovation recommendations related to corrective and preventive actions of high risks
Validate Concepts	Validate ideas and innovation concepts created	Output create concepts	Presentation and FGD related to the results of the recommended innovation	Additional insight and revision to the product innovation recommendations presented
Develop Solutions	Development of ideas and validated innovation concepts	Output validate concepts	Refinement and completion of innovation recommendations resulting from FGD	Recommendations that have been corrected and adapted to the results of the FGD
Deploy Solutions	Realization of the value of innovative ideas to be realized	Output develop solutions	Submission of making a Decision Letter to implement the innovation (Performed by the company)	• Implementation of innovation recommendations • Monitoring the implementation

2.7. Frameworks

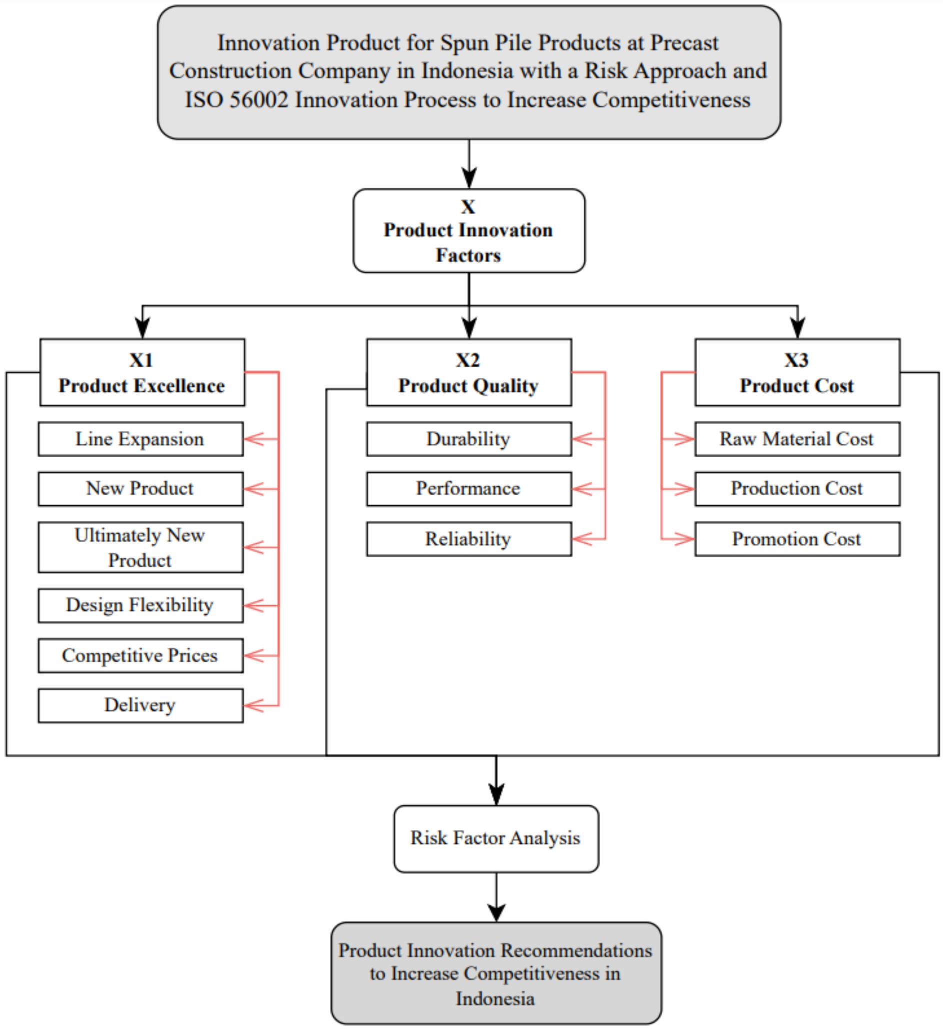

Figure 4. Research Framework

This study used three sub-variables: product excellence, quality, and cost. These sub-variables are based on literature studies from books and journals. In the X1 product excellence sub-variable, six indicators will be used: line expansion, new product, ultimately new product, design flexibility, competitive prices, and delivery. Then for the X2 product quality sub-variable, three indicators will be used: durability, performance, and reliability. Then, for the X3 product cost sub-variable, three indicators will be used: raw material costs, production costs, and promotion costs. Based on the sub-variables and indicators that have been identified, the risk of each indicator that will produce high risk will then be analyzed, which will then determine preventive and corrective actions for the high risk.

3. Results and Discussions

3.1. Product Innovation Indicators

Based on the results of a literature study, the data will be validated by several experts through interviews using a questionnaire instrument which also known as the Delphi Method. The results of the several experts are combined, which will then be re-validated for the second time. The following are three factors and twelve indicators of product innovation in Table 2.

Table 2. Product Innovation Factors and Indicators

Sub Variable	Indicator Code	Indicators
X1 Product Excellence	X1.1	Line Expansion
	X1.2	New Product
	X1.3	Ultimately New Product
	X1.4	Design Flexibility
	X1.5	Competitive Prices
	X1.6	Delivery
X2 Product Quality	X2.1	Durability
	X2.2	Performance
	X2.3	Reliability
X3 Product Cost	X3.1	Raw Material Costs
	X3.2	Production Cost
	X3.3	Promotion Cost

3.2. Product Innovation Risks

Based on the results of the risk identification carried out, then validation is carried out by experts regarding several risks that have been identified, which are divided based on the factors / sub-variables. In Table 3, there are ten identified risks in the X1 Sub Product Excellence sub-variable as follows.

Table 3. Product Excellence (X1) Risks

Indicator Code	Indicators	Risk ID	Risk Description
X1.1	Line Expansion	R1	There are limited ideas in the product R&D process
		R2	The mindset is still conventional
X1.2	New Product	R3	The superiority of competitor products in product development
X1.3	Ultimately New Product	R4	Innovative products are not in accordance with consumer desires.
		R5	Low quantity and quality of ideas produced
		R6	There are financial limitations in the product R&D process
X1.4	Design Flexibility	R7	The company cannot fulfil market/ consumer demand.
X1.5	Competitive Prices	R8	The price of the resulting product is still relatively high
X1.6	Delivery	R9	The product is defective during delivery
		R10	There was a delay in product delivery

Followed by sub-variable X2 Product Quality, there are eleven identified risks in Table 4 as follows.

Table 4. Product Quality (X2) Risks

Indicator Code	Indicators	Risk ID	Risk Description
X2.1	Durability	R11	The product does not pass the compressive strength test
		R12	Inspection or test performed is not optimal
		R13	The product is damaged before the warranty period expires
X2.2	Performance	R14	Product performance does not match design calculations
		R15	The product cracks or breaks when used / when given a load
X2.3	Reliability	R16	Cracked defective product
		R17	Porous defective product
		R18	Skin sticky defect product
		R19	Product alignment defects
		R20	There is sedimentation in the spun pile cavity
		R21	The thickness of the concrete does not meet the standards

Then in sub-variable X3 Product Cost, there are seven identified risks in Table 5 as follows .

Table 5. Product Cost (X3) Risks

Indicator Code	Indicators	Risk ID	Risk Description
X3.1	Raw Material Costs	R22	Insufficient material supply
		R23	Increase in costs for raw materials
		R24	The quality of the material obtained is not the same as the primary material
		R25	The quality of raw materials changes
X3.2	Production Cost	R26	Unexpected additional costs
X3.3	Promotion Cost	R27	The media used is not on target
		R28	Uncontrollable promotional costs

3.3. High-Risk Analysis

Based on the twenty-eight risks identified above, each risk was analyzed through respondents' assessment of the frequency and impact of each risk referring to Figure.4. Where in the questionnaire the matrix is translated into: Probability (1 = Very Low, 2 = Low, 3 = Medium, 4 = High, 5 = Very High), and Impact (1 = Very Low, 2 = Low, 3 = Moderate, 4 = High, 5 = Very High).

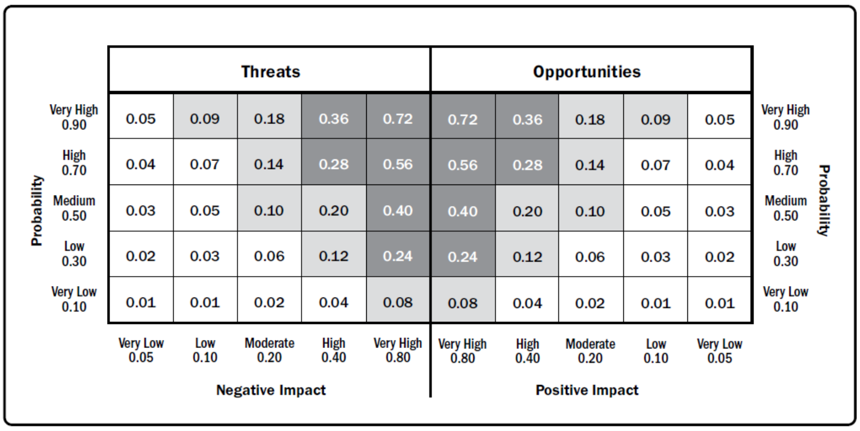

Figure 5. Probability and Impact Matrix
Source: PMBOK 6th Edition [18]

The value of the results of filling out the probability and impact of the respondents will be averaged and then multiplied to produce a risk weight value. The division of categories of risk levels based on risk weights are divided into three, namely: Low (W ≤ 0.07), Moderate (0.08 ≤ W ≤ 0.20), and High (W ≥ 0.21). Table 6 shows an example of calculating the risk weight in R5 and R6, where each risk has a risk weight of more than 0.21, so R5 and R6 are included in the high-risk category.

Table 6. Example of Risk Weight Calculation

Code	Indicator	Objective	Risk ID	Risk	Cause ID	Causes	Average		
							P	I	Weight
X1.3	Ultimately New Product	Creating New Product	R5	Low quantity and quality of ideas produced	C5	Lack of competence Human resources	0,54	0,44	0,24
			R6	There are financial limitations in the product R&D process	C6	Declining product sales	0,66	0,50	0,33

A total of four high risks were obtained which can be seen in Table 7. These risks are then analyzed based on the causes and impacts that will be given preventive and corrective actions to minimize the risks. Each of the following preventive and corrective actions was obtained through benchmarking, which experts corrected and validated. After combining the data, FGDs are conducted with experts to get the final validation. The result is as follows.

Table 7. High-Risk Analysis with Preventive and Corrective Actions

Risk ID	Risk Description	Cause ID	Cause	Preventive Action	Impact	Corrective Action
R5	Low quantity and quality of ideas produced	C5	Lack of competence human resources	Recruit human resources who are experienced in the field of R&D and are competent	The company has no competitiveness	Conducted training related to the R&D process and looking for good and reliable partners
R6	There are financial limitations in the product R&D process	C6	Declining product sales	Perform cost reduction on fixed overhead costs	The product R&D process is hampered/ stalled	The work program is carried out in the form of a written concept
R16	Cracked defective product	C18	Improper mix composition	Perform analysis using the Taguchi method with simulated control factors and noise factors	The product will be easily damaged/ failed	Using the concrete injection method on cracked substantial parts
R23	Increase in costs for raw materials	C25	There is inflation and rising prices	Buy raw materials before inflation occurs	Additional costs outside the RAB are needed in the production process	Take into account the inflation factor in contracts with clients

4. Conclusion

The results of this study indicate that three factors can influence product innovation, namely product excellence, product quality, and cost, where each factor has a total of twelve indicators. Then twenty-eight risks were identified, with four dominant risks. Namely, the low quantity and quality of ideas produced, financial limitations in the product R&D process, cracked defective products, and increased raw material costs.

Innovative recommendations that can be given are in the form of preventive and corrective actions for each dominant risk. One of the innovations is preventive action at C18 for R16 at the risk of cracked defective products using the Taguchi Method analysis. Taguchi Method is a quality improvement method with the principle of minimizing the consequences of variations without eliminating the causes by simulating control factors (S/A ratio, admixture content, rotation speed, and rotation duration) and noise factors (sand gradation).

For further research, it can be developed by adding other control and noise factors and then rearranging the intervals of factor levels. Then conduct research using different types of research objects in precast concrete products to improve and provide innovation to increase company competitiveness.

5. Acknowledgement

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