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Qualitative Risk Analysis of Production Precast Spun Pile at Company-X

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Abstract— Precast concrete is a building process where concrete structural components are made off-site, at a designated location. Occasionally, these parts are assembled in advance of being delivered to the installation location. The precast concrete plant's production capacity is a major factor in the industry's sustainability. The maximum amount of output that may be produced during production activities in a given amount of time is referred to as production capacity. The creation of a risk-based guideline to optimize the manufacturing performance of circular spun pile foundations at Company X is the main objective of this study.

Keywords— Precast, Spun pile, Risk.

I. INTRODUCTION

One of the essential materials in infrastructure and construction projects is precast concrete. This industry has been in existence since the 1970s and has evolved over time, showcasing various innovations and becoming a more efficient construction sector compared to conventional systems. Currently, the precast industry stands as a backbone in constructing various infrastructure facilities, residential buildings, and other construction works. Precast concrete is a construction technology involving the fabrication of concrete structure components at a specialized location (off-site fabrication). Sometimes, these components are pre-assembled before being transported to the site for installation.

The precast concrete system differs from monolithic construction, particularly in the planning aspect, which depends on or is determined by the method of fabrication, assembly, and installation. Additionally, it is also determined by the technical behavior of the precast system, specifically in terms of how components are joined together. Some principles believed to provide added benefits from this precast concrete technology include aspects related to time, cost, quality, predictability, reliability, productivity, health, safety, environment, coordination, innovation, reusability, as well as relocatability.

Indonesia, alongside its partner countries, committed to participating in global or free market globalization by 2020. Since 2013, the government has taken massive steps to prepare infrastructure and enhance the national construction industry to actively and optimally participate in this era. The manufacturing-based precast industry is expected to become a cornerstone of the national construction industry. In support of this government program, all parties, both government entities and private enterprises, need to contribute to the development of the precast concrete business. One of these contributions involves establishing precast plants or factories.

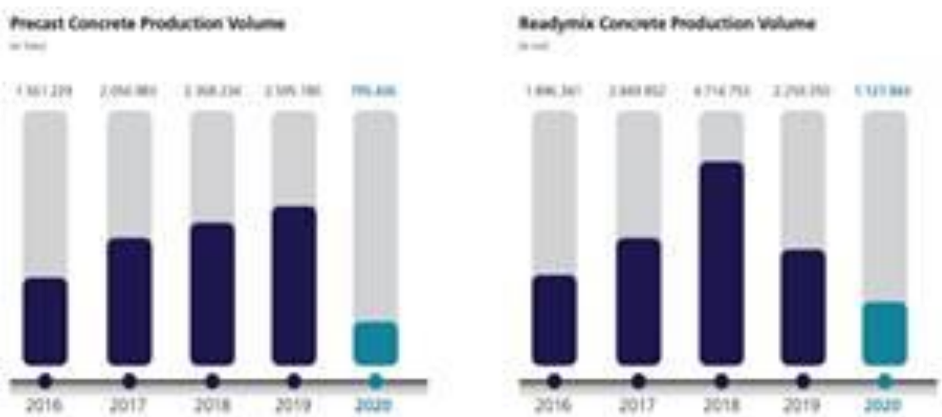

Figure 1: *Capacity and Production Data of Company-X's Precast Division*

Industries reliant on precast concrete, or precast concrete plants, heavily rely on production capacity. Production capacity refers to the maximum output achievable within a specified timeframe during production activities. Therefore, higher production capacity signifies better performance. Achieving maximum capacity requires improvements in the implementation of tasks within precast concrete plants. One of the improvements under discussion in this research involves developing a risk-based guideline strategy to enhance the production performance of circular spun pile foundations at Company X.

The author is inclined to investigate the underlying causes of productivity concerns in precast production at Company X, given the suboptimal utility issues and the production gap. The goal is to improve overall production performance and allow the company to reach its maximum production capacity. This study tries to discover significant variables and factors affecting productivity by building on previous studies.

The goal of this research is to identify the key factors affecting the productivity of precast production. These factors will then be used as standards or recommendations in the production process, allowing the business to maximize production productivity.

Therefore, the purpose of this research is to not only identify production productivity concerns but also to offer remedies based on significant variables, enabling the organization to significantly improve production performance.

II. RESEARCH METHOD

A. Review Stage

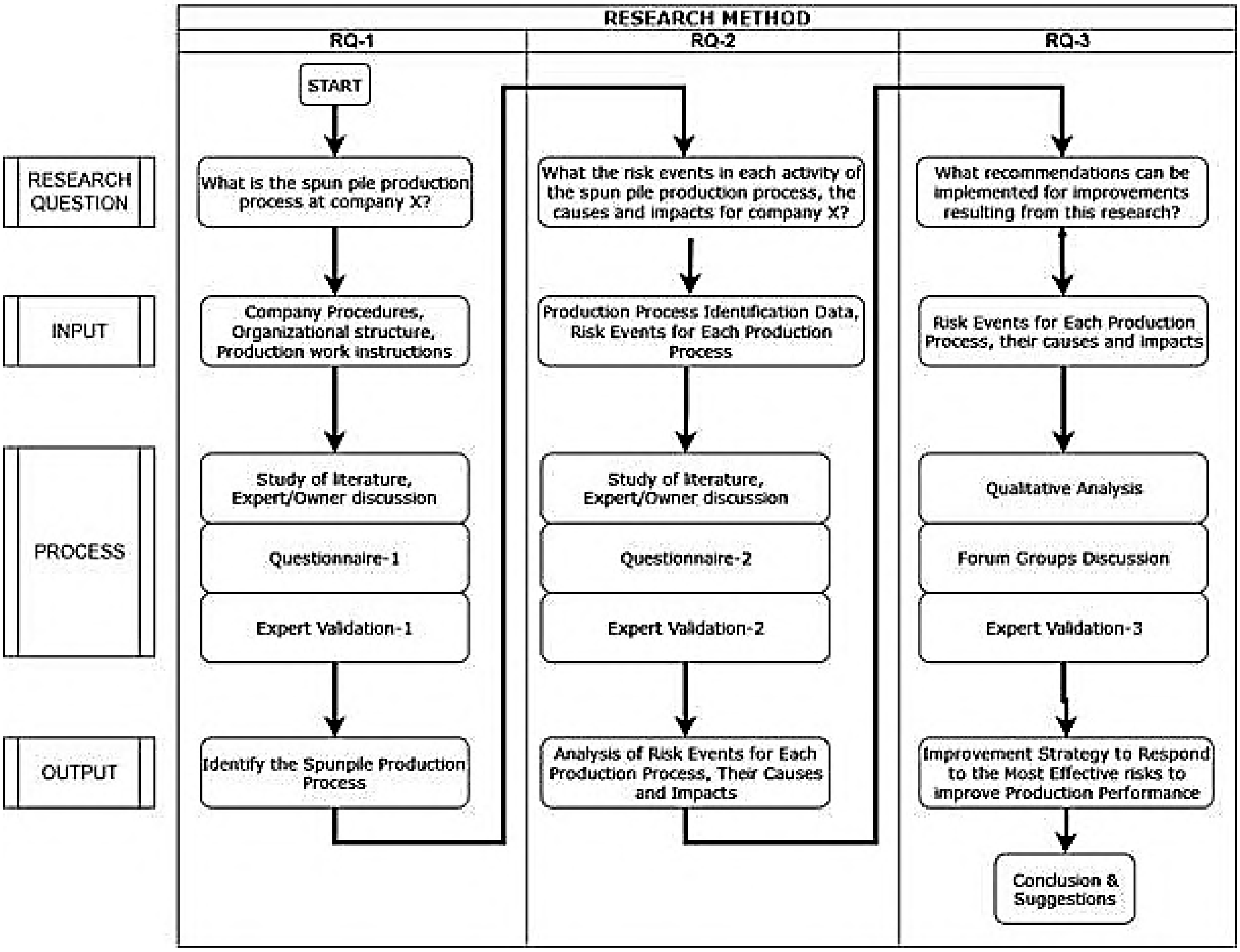

Figure 2: *Research Flowchart*

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In order to accomplish the research objectives, the study will examine the research design and methods. It will cover the following topics: research variables, research instruments, research questions, research strategy, research process, data gathering method, and analytic technique.

The research will utilize an analytical methodology, utilizing risk analysis to design a production strategy for spun piles. This entails determining the hazards that affect production performance within each production activity. The objective is to lay the groundwork for creating production norms that reduce these risks, either by taking preventative measures or making corrections for each major risk. This research is qualitative and descriptive in nature.

Descriptive research aims to understand the value of independent variables, whether one or more, without making comparisons or linking them to other variables (Sugiyono, 2009). Meanwhile, qualitative research is utilized to examine natural conditions where the researcher acts as the key instrument. Understanding the nature of the research will guide the data collection methods and the development of appropriate research instruments.

Table 1: *Probability and Impact Matrix Risiko*

Probability		Impact: Low	Impact: Medium	Impact: High	Impact: Very High	Legend
	Very High	4	8	12	16	Low Risk
	High	3	6	9	12	Medium Risk
	Medium	2	4	6	8	High Risk
	Low	1	2	3	4	Very High Risk

The Measurement Scale

There are four categories of measurement for observational data (Steven, 1946): Likert Scale: Used to measure an individual's attitudes or perceptions regarding social phenomena. Guttman Scale: Presents measurement in a clear-cut manner. Semantic Differential Scale: Measures opinions represented along a line. Rating Scale: Measures something in terms of opinion ratings expressed as numerical values.

Based on the explanation above, the data measurement used in this research is the Likert scale.

The Likert scale is employed to gauge respondents' opinions regarding the extent of the causes and impacts of each risk factor using a scale from 1 to 4. A score of 4 indicates a very high frequency and a significant impact. For the independent variables, a risk influence assessment scale is used, as shown in the following tables:

Frequency Measurement Scale

Table 2. *Assessment of Risk Frequency and, Impact Measurement Scale*

Parameter	Probability	Frequency
Low	**≤ 10%**	Can occur within a period of more than 1 year
Medium	**> 10% - ≤ 50%**	Can occur within a period of 6 months - 1 year
High	**> 50% - ≤ 70%**	Can occur within 3 months - 6 months
Very High	**> 70%**	Can occur within 3 months

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Table 3. *Assessment of Risk Impact*

Parameter	Deviation from production targets	Information
Low	≤ 10%	Can have an impact on reducing production output; minus 0% - 10%
Medium	> 10% - ≤ 20%	Can have an impact on reducing production output; minus 11% - 20%
High	> 20% - ≤ 30%	Can have an impact on reducing production output; minus 21% - 30%
Very High	> 30%	Can have an impact on reducing production output; minus more than 30%

Data Collection

This research employs both primary and secondary data. Primary data refers to information gathered firsthand from the actual source (Sekaran, 2006). According to Sugiyono (2012, p. 308), primary sources are those that directly provide data to the data collector. In this study, primary data is obtained through interviews with experts and specialists to gather responses regarding the variables and questionnaires that will be administered to respondents. According to Sekaran (2006, p.77), secondary data refers to information obtained by researchers from existing sources through various intermediary channels (gathered and recorded by other parties). In this research, secondary data utilized includes books, magazines, journals, theses, and dissertations.

III. RESULT & DISCUSSION

The Result of the Research in the literature review proposed as a production activity yielded activities in spun pile production, including:

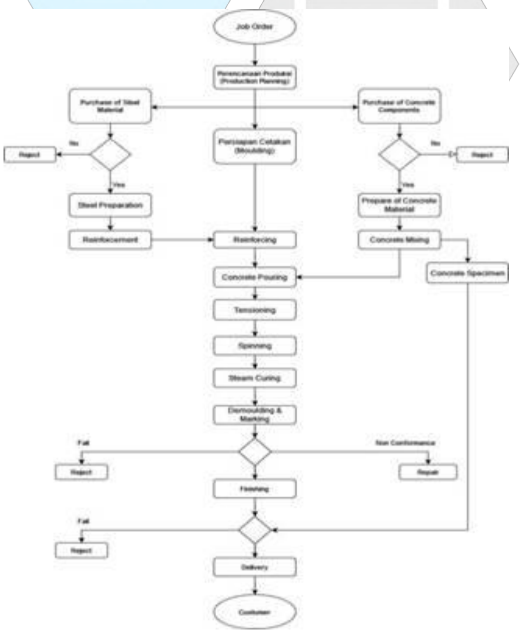

Figure 3: *Spun Pile Production Flowchart*

1. **Production Planning:** Experts suggest that planning is essential for the implementation of the spun pile production process. Planning is crucial as it involves the necessary materials and equipment. Risks can arise if production planning is inadequate, resulting in material shortages. Hence, planning needs to align with production targets or demands. Planning can be perceived as the initial step in designing the requirements and actions for activities. It involves decision-making that can be carried out individually or collaboratively in groups (Rusniati and Haq, 2014). Production planning encompasses all the needs concerning production to create a product by designing and organizing the necessary activities before production commences. Organizational production planning is crucial to ensure clear objectives and adherence to the initial production plan by the organization. Production planning is essential to achieve organizational goals (Devani, 2013).
2. **Moulding Preparation:** Mould preparation involves necessary stages in spun pile production to ensure technical readiness for use. This process must be technically managed to avoid operator negligence. Supervision is crucial to ensure that the mould operates according to its technical specifications. Operators must also implement occupational health and safety practices and environmental protection (K3L) to ensure personal and collective safety.
3. **Reinforcing:** Reinforcing is performed to create a framework for casting, ensuring strength and safety in line with planned procedures. Typically, protective gear is used during reinforcing, and it is advised for individual and collective safety. Risks, including fatal accidents, can occur during reinforcing work. Adhering to proper occupational health and safety measures is crucial, including using personal protective equipment. Project preparation needs to ensure the necessary work elements, including tools, materials, and workforce,

are in place before project production work can commence (Dewi, Rafie, and Indrayadi, 2022). Additionally, Binamarga explains that preparatory work involves planning, preparation, and production implementation (Binamarga, 2021).

4. **Concrete Pouring:** Concrete pouring is a core activity in spun pile production. It must adhere to standard procedures because the accuracy of material mixing is crucial to produce high-quality products. This activity is conducted while applying personal protective equipment, following material mixing standard procedures, and ensuring supervision (Pariri and Buyung, 2022).
5. **Tensioning:** Tensioning involves applying pre-stressing force using a stressing machine as per the planned or specified design. This activity is conducted during reinforcing. Operators need to ensure the safe operation of the stressing machine and maintain cooperation among themselves without playful behavior. Often, the pre-tension system is utilized to control and enhance the quality of the concrete (Suseno et al., 2016).
6. **Spinning/Centrifugal Force:** Spinning is performed to compact the concrete within the specified timeframe. Operators need to follow specific procedures, and supervision is essential. The pouring is carried out using cylindrical molds to produce cylindrical cast products by rotating the mold. Due to the centrifugal force, the casting material is thrown towards the mold's walls until it's compact, followed by curing to enhance its perfection (Jitro in Suseno et al., 2016).
7. **Steam Curing:** This activity is carried out to expedite the drying time and facilitate the demolding process. The method involves steam and water vapor with appropriate temperature and time in a steam chamber. It's conducted following the standard operational procedures.
8. **Demoulding & Marking:** The removal of spun pile products from the curing process and assigning codes to the spun pile products. The molds can be reused in the spun pile production process. This should be performed cautiously and following proper procedures.
9. **Product Finishing:** Finished products, released from the molds, are labeled or coded, tidied, and undergo a quality check. The goal is to match the initial design or planned specifications according to the requirements while using personal protective equipment.
10. **Delivery:** Products meeting the requirements are delivered, marking the final stage. However, hazards need to be continuously considered. Risks may arise during product arrangement in the truck bed. Ensure the safety of others is not compromised.

The series of actions listed above makes up the spinning pile producing activities that this study's findings are based on. manufacturing planning, mold preparation, reinforcement, concrete pouring, tensioning, spinning/centrifugal force, steam curing, de-moulding and marking, product finishing, and delivery are some of the tasks involved in the manufacturing of spun piles.

Experts in the field of spinning pile production procedures at PT. X are involved in the study as information sources or responders, setting these as assessed research features. All of the activities are in line with the original design found in the literature, according to the data gathered. There are ten categories for the spun pile activities.

Risk occurrences in production activities can be categorized into several risk activities. These activity sequences can be grouped according to the spun pile production process, including a total of 88 risk activities from each activity. The following are the validated findings obtained.

***Table 4:** Spun Pile Production Risks per Activitys*

Code	Activity	Risk Event	Reference
X1.1	Planning	Inaccurate material requirement calculations leading to production halts	J.U.D. Hatmoko, M. A. Wibowo , M. D. Astuty , 2019
X1.2	Planning	Changes in production demand affecting material priorities	J.U.D. Hatmoko, M. A. Wibowo , M. D. Astuty , 2019
X1.3	Planning	Delayed arrival of production materials	J.U.D. Hatmoko, M. A. Wibowo , M. D. Astuty , 2019
X1.4	Planning	Limited personnel disrupting production cycles	J.U.D. Hatmoko, M. A. Wibowo , M. D. Astuty , 2019

X1.5	Planning	Production cost plans exceeding budgets, requiring adjustments in factory activities	J.U.D. Hatmoko, M. A. Wibowo , M. D. Astuty , 2019
X1.6	Planning	Sudden changes in production priorities affecting start/stop production	J.U.D. Hatmoko, M. A. Wibowo , M. D. Astuty , 2019
X1.7	Planning	Limited skilled human resources for specialized spunpile production	Manlian Simanjuntak , Bernadus Kusumadanu , (2021)
X1.8	Planning	Delayed or inaccurate payment of wages, incentives, or bonuses affecting work progress	Novika Candra Fertiliaa , Raden Yudityo Afri Adjib, (2020)
X1.9	Planning	Insufficient management commitment to resolving production issues	Novika Candra Fertiliaa , Raden Yudityo Afri Adjib, (2020)
X2.1	Planning	Lack of mold feasibility assessments	Andika Okayana, (2023)
X2.2	Mold Preparation	Lack of inspections at workstations	Siti Nurlina, Syarif Hidayat, (2013)
X2.3	Mold Preparation	Molds not aligning with drawings, needing field adjustments	Author's Observation
X2.4	Mold Preparation	Damage to equipment during production	Andika Okayana, (2023)
X3.1	Mold Preparation	Workers' insufficient capability to meet production targets	J.U.D. Hatmoko, M. A. Wibowo , M. D. Astuty , 2019
X3.2	Reinforcement	Excessive safety induction at workplaces with potential hazards	Wahyu Dian Sekar Rini, (2019)
X3.3	Reinforcement	Lack of prior notification regarding potential work hazards and safety signage	Wahyu Dian Sekar Rini, (2019)
X3.4	Reinforcement	Workers' delays in spiral/reinforcement activities leading to decreased productivity	Alvin J.L , Leonard F.A, (2013)
X3.5	Reinforcement	Discontinuous filling of PC bars and iron wire affecting production cycles	Andika Okayana, (2023)
X3.6	Reinforcement	Machinery operating at suboptimal conditions	Andika Okayana, (2023)
X3.7	Reinforcement	Limited personnel trained to operate machinery	Andika Okayana, (2023)
X3.8	Reinforcement	PC bar lengths not meeting quality plans due to cutting equipment issues	Andika Okayana, (2023)
X3.9	Reinforcement	Raw material preparation in iron roll form hindering production, needing additional work for straightening	Siti Nurlina, Syarif Hidayat, (2013)
X3.10	Reinforcement	Additional work to rectify straightening of iron roll causing delays	Siti Nurlina, Syarif Hidayat, (2013)
X3.11	Reinforcement	Excessive inspections at each workstation	Siti Nurlina, Syarif Hidayat, (2013)
X3.12	Reinforcement	Distant movement of joint plates and reinforcement assembly causing delays	Siti Nurlina, Syarif Hidayat, (2013)
X3.13	Reinforcement	Damage to equipment during production	Andika Okayana, (2023)
X3.14	Reinforcement	PC Bar heading results not aligning with quality plans due to heading equipment issues	Andika Okayana, (2023)
X3.15	Reinforcement	High turnover of workers and inappropriate break times	Author's Observation
X4.1	Reinforcement	Workers' inadequate capability in meeting production targets	J.U.D. Hatmoko, M. A. Wibowo , M. D. Astuty , 2019
X4.2	Pouring	Excessive safety induction at workplaces with potential hazards	Wahyu Dian Sekar Rini, (2019)

X4.3	Pouring	Lack of prior notification regarding potential work hazards and safety signage	Wahyu Dian Sekar Rini, (2019)
X4.4	Pouring	Frequent breakdowns and slow movement of trolleys	Andika Okayana, (2023)
X4.5	Pouring	Inadequate personnel for backup work (highly congested area)	Andika Okayana, (2023)
X4.6	Pouring	Excessive inspections at each workstation	Siti Nurlina, Syarif Hidayat, (2013)
X4.7	Pouring	Imperfect closure of spunpile molds after assembly	Siti Nurlina, Syarif Hidayat, (2013)
X4.8	Pouring	Pouring concrete with mixer trucks at spunpile casting site (not using concrete hoppers)	Siti Nurlina, Syarif Hidayat, (2013)
X4.9	Pouring	Issues with ready-mix concrete (slump value & workability) at the casting area	Siti Nurlina, Syarif Hidayat, (2013)
X4.10	Pouring	Improper installation/setting of mold joints compared to Quality plans occurring in the field	Author's Observation
X4.11	Pouring	Damage to equipment during production	Andika Okayana, (2023)
X4.12	Pouring	Additional work due to material usage adjustments (cement/silica fume/additional additives)	Author's Observation
X4.13	Pouring	High turnover of workers and inappropriate break times	Author's Observation
X4.14	Pouring	Communication between workers and batching plant operators being manual (distant signals)	Andika Okayana, (2023)
X5.2	Pouring	Excessive safety induction at workplaces with potential hazards	Wahyu Dian Sekar Rini, (2019)
X5.3	Tensioning	Lack of prior notification regarding potential work hazards and safety signage	Wahyu Dian Sekar Rini, (2019)
X5.4	Tensioning	Inspeksi yang berlebihan dilakukan di tiap pos pekerjaan	Siti Nurlina, Syarif Hidayat, (2013)
X5.5	Tensioning	Damage to equipment during production	Andika Okayana, (2023)
X5.6	Tensioning	Pull failures causing material damage	Author's Observation
X5.7	Tensioning	High turnover of workers and inappropriate break times	Author's Observation
X6.1	Tensioning	Workers' insufficient capability to meet production targets	J.U.D. Hatmoko, M. A. Wibowo , M. D. Astuty , 2019
X6.2	Spinning	Excessive safety induction at workplaces with potential hazards	Wahyu Dian Sekar Rini, (2019)
X6.3	Spinning	Lack of prior notification regarding potential work hazards and safety signage	Wahyu Dian Sekar Rini, (2019)
X6.4	Spinning	Detachment of pillow block covers and damaged blower bearing pads indicating spinning machine failure (steaming)	Iqlima Trysti Aulia, (2018)
X6.5	Spinning	Overhead crane equipment damage (remote) rendering them unusable	Iqlima Trysti Aulia, (2018)
X6.6	Spinning	Overhead crane equipment damage (gearbox) rendering them unusable	Iqlima Trysti Aulia, (2018)
X6.7	Spinning	Overhead crane equipment damage (reswitch-carbon brush) rendering them unusable	Iqlima Trysti Aulia, (2018)
X6.8	Spinning	Excessive inspections at each workstation	Siti Nurlina, Syarif Hidayat, (2013)
X6.9	Spinning	Additional work for liquid waste removal after spinning area	Siti Nurlina, Syarif Hidayat, (2013)

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X6.10	Spinning	Spinning RPM not meeting calculations, exceeding target duration	Author's Observation
X6.11	Spinning	High turnover of workers and inappropriate break times	Author's Observation
X7.1	Steaming	Excessive safety induction at workplaces with potential hazards	Wahyu Dian Sekar Rini, (2019)
X7.2	Steaming	Lack of prior notification regarding potential work hazards and safety signage	Wahyu Dian Sekar Rini, (2019)
X7.3	Steaming	Detachment of pillow block covers and damaged blower bearing pads indicating spinning machine failure (steaming)	Iqlima Trysti Aulia, (2018)
X7.4	Steaming	Overhead crane equipment damage (remote) rendering them unusable	Iqlima Trysti Aulia, (2018)
X7.5	Steaming	Overhead crane equipment damage (gearbox) rendering them unusable	Iqlima Trysti Aulia, (2018)
X7.6	Steaming	Overhead crane equipment damage (reswitch-carbon brush) rendering them unusable	Iqlima Trysti Aulia, (2018)
X7.7	Steaming	Excessive inspections at each workstation	Siti Nurlina, Syarif Hidayat, (2013)
X7.8	Steaming	High turnover of workers and inappropriate break times	Author's Observation
X7.9	Steaming	Boiler-generated heat not meeting calculated/target temperatures for required heat	Author's Observation
X8.1	Demolding	Workers' insufficient capability to meet production targets	J.U.D. Hatmoko, M. A. Wibowo , M. D. Astuty , 2019
X8.2	Demolding	Product quality not meeting standards	J.U.D. Hatmoko, M. A. Wibowo , M. D. Astuty , 2019
X8.3	Demolding	Excessive safety induction at workplaces with potential hazards	Wahyu Dian Sekar Rini, (2019)
X8.4	Demolding	Lack of prior notification regarding potential work hazards and safety signage	Wahyu Dian Sekar Rini, (2019)
X8.5	Demolding	Workers' inadequate capability in the demolding stage	Andika Okayana, (2023)
X8.6	Demolding	Excessive inspections at each workstation	Siti Nurlina, Syarif Hidayat, (2013)
X8.7	Demolding	Damage to equipment during production	Andika Okayana, (2023)
X8.8	Demolding	High turnover of workers and inappropriate break times	Author's Observation
X9.1	Finishing	Workers' insufficient capability to meet production targets	J.U.D. Hatmoko, M. A. Wibowo , M. D. Astuty , 2019
X9.2	Finishing	Lack of prior notification regarding potential work hazards and safety signage	Wahyu Dian Sekar Rini, (2019)
X9.3	Finishing	Excessive inspections at each workstation	Siti Nurlina, Syarif Hidayat, (2013)
X9.4	Finishing	Need for extensive space and blockage of raw material storage access to the production area	Siti Nurlina, Syarif Hidayat, (2013)
X9.5	Finishing	Damage to equipment during production	Andika Okayana, (2023)
X9.6	Finishing	High turnover of workers and inappropriate break times	Author's Observation
X10.1	Delivery	Excessive safety induction at workplaces with potential hazards	Wahyu Dian Sekar Rini, (2019)
X10.2	Delivery	Lack of prior notification regarding potential work hazards and safety signage	Wahyu Dian Sekar Rini, (2019)
X10.3	Delivery	Excessive inspections at each workstation	Siti Nurlina, Syarif Hidayat, (2013)

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Risk assessments were based on primary and secondary data, gathered through interviews, questionnaires, and direct field observations concerning the risks occurring in spun pile production. After the data collection phase was completed, the obtained data from questionnaires and interviews were processed through data processing stages. Risks were formulated as a function of the likelihood and negative impact, represented by the risk index = Likelihood Probability X Impact. Potential risks are those needing attention due to their high likelihood of occurrence and significant negative consequences. The assessment results were validated by experts who understood the significance of reliability for each potential risky activity. The confirmed count after validation by experts amounted to 16 high-risk activities in spun pile production, validated through a probability-impact matrix. The outcomes showed a range from Negligible (can be ignored) to Undesirable (not expected). Hence, this research suggests recommendations for improvement, namely corrective actions.

Table 5: *Risk Assessment Results*

Probability	Low	Medium	High	Very High
Very High	4	8	12	16
High	3	3 Risks 6	10 Risks 9	5 Risks 12
Medium	2	34 Risks 4	34 Risks 6	1 Risks 8
Low	1	2	3	4
	Impact			

Table 6: *High Risks in Spun Pile Production Work*

Code	Activity	Risk Event	Risk
X3.13	Reinforcement	Damage to equipment during production	High Risk
X5.5	Tensioning	Damage to equipment during production	High Risk
X1.3	Planning	Delayed arrival of production materials	High Risk
X2.4	Mold Preparation	Damage to equipment during production	High Risk
X1.6	Planning	Sudden changes in production priorities affecting start/stop production	High Risk
X5.6	Tensioning	Pull failures causing material damage	High Risk
X3.6	Reinforcement	Machinery operating at suboptimal conditions	High Risk
X4.11	Pouring	Damage to equipment during production	High Risk
X4.4	Pouring	Frequent breakdowns and slow movement of trolleys	High Risk
X6.5	Spinning	Overhead crane equipment damage (remote) rendering them unusable	High Risk
X6.7	Spinning	Overhead crane equipment damage (reswitch-carbon brush) rendering them unusable	High Risk
X1.5	Planning	Production cost plans exceeding budgets, requiring adjustments in factory activities	High Risk
X6.6	Spinning	Overhead crane equipment damage (gearbox) rendering them unusable	High Risk
X2.1	Planning	Lack of mold feasibility assessments	High Risk
X3.7	Reinforcement	Limited personnel trained to operate machinery	High Risk
X1.7	Planning	Limited skilled human resources for specialized spunpile production	High Risk

The research findings indicate that the main risks in spun pile production are associated with machine failures at critical stages (X3.13/X5.5/X2.4) and planning activities (X1.3/X1.6), both of which have a negative impact on production outputs. The entire manufacturing schedule is immediately impacted by these mishaps. Our results are consistent with earlier studies showing that production machinery poses a risk in the process of producing spun piles. (Andika Okayana, 2023) states that equipment production falling short of intended capacity is the primary cause of the issue, with equipment quality being one of the contributing elements.

According to (J.U.D. Hatmoko, 2019), there are considerable risks associated with planning activities, including material delays and adjustments to production priorities. It is important to realize that outside variables affect the demand for concrete products. The company's internal management cannot completely control the risks connected with this demand, even though they can be estimated.

It is important to note that Company-X's internal data is the only data used in this analysis. Although they were not given much thought in this study, other factors like raw material variability or weather conditions may also have an impact on production risks.

IV. CONCLUSION

Risks in production work can be managed appropriately before and during task execution. This research concludes:

1. The process of spun pile production involves 10 activities: Production Planning; Moulding Preparation; Reinforcing; Concrete Pouring; Tensioning; Spinning; Steam Curing; Demoulding & Marking; Product Finishing; and Delivery.
2. Risk occurrences in each activity of the spun pile production process, considering their causes and impacts, after validation by experts, resulted in 16 top risks out of 85 risk occurrences before validation.

REFERENCES

[1] Adri, Yuli. (2016). Analisis Tingkat Produktivitas Tiang Pancang dengan Metode Marvin Emundel pada Pt. Multiguna Precast Mandiri. Universitas Islam Negeri Sultan Syarif Kasim Riau.

[2] Alvin J.L, Leonard F.A, Sentosa Limanto, Jonathan H.K (2016). PRODUKTIVITAS DAN KETERLAMBATAN PRODUKSI TIANG PANCANG DAN TIANG LISTRIK PADA PERUSAHAAN “X” DENGAN MPDM. Surabaya: Program Studi Teknik Sipil Universitas Kristen Petra.

[3] Andika Okayana, (2023). Evaluation on Production Flow Using Line Balancing Method to Increase the Production Capacity of Spun Pile at PT. Adhi Persada Beton Plant Mojokerto - East Java

[4] Atfal Murodif (2016). PENGUKURAN PRODUKTIVITAS DAN FAKTOR-FAKTOR YANG MEMPENGARUHI DALAM PEMBANGUNAN GEDUNG MENARA SENTRAYA JAKARTA. Bogor: Program Studi Teknik Sipil dan Lingkungan, Institut Pertanian Bogor.

[5] Asiyanto. (2005). Manajemen Produksi Untuk Jasa Konstruksi. Jakarta: Pradnya Paramita.

[6] Asosiasi Perusahaan Pracetak dan Prategang Indonesia (AP3I),(2020) PERAN PEMASOK DALAM RANTAI PASOK KONSTRUKSI PRODUK PRACETAK DAN PRATEGANG

[7] Bernadus, Kusumadanu (2020). ANALISIS MODEL PRODUKTIVITAS SPUN PILE PADA PERUSAHAAN PRECAST XYZ DALAM MENINGKATKAN KINERJA KONSTRUKSI (STUDI KASUS: PERUSAHAAN PRECAST DI PULAU JAWA)

[8] Binamarga (2021) Spesifikasi Khusus, https://binamarga.pu.go.id/. Tersedia pada: https://binamarga.pu.go.id/uploads/files/1826/spesifikasi-khusus-paket-toll-road-development-of-semarang-demak-1a.pdf (Diakses: 10 Desember 2022).

[9] Bougie, R., & Sekaran, U. (2019). Research Methods For Business: A Skill Building Approach, 8th Edition. Wiley Publisher.

[10] Iqlima Trysti Aulia, (2023). Analisis Risiko Kegagalan Mesin Produksi Spunpile Dengan Metode FMEA dan FTA Pada PT. Adhi Persada Beton

[11] Jati Utomo Dwi Hatmoko, Mochamad Agung Wibowo , Marita Dewi Astuty , Desy Ratna Arthaningtyas , Moh Nur Sholeh, (2019). Managing risks of precast concrete supply chain: a case study

[12] Litasari Kusuma Putri, I Wayan Suletra, (2017). Analisis Risiko K3 di Proses Produksi Tiang Pancang dengan Metode JSA dan Risk Matrix: Studi Kasus di PT X

[13] Siti Nurlina, Syarif Hidayat, (2023). APPLICATION OF LEAN MANUFACTURING IN THE PRODUCTION PROCESS SPUN PILE USING WASTE ASSESMENT MODEL (WAM) AND VALUE STREAM ANALYSTS TOOLS (VALSAT)

[14] Wahyu Dian Sekar Rini, (2020). EVALUASI PENERAPAN SARANA PENGENDALIAN RISIKO DI BAGIAN PRODUKSI TIANG PANCANG BULAT PT.TB.PBB WIJAYA KARYA BETON BOYOLALI

[15] W.R Satyadharma, (2022). Optimalisasi Proses Produksi Tiang Pancang (Spun Pile) Menggunakan Connector Ring Pada Cetakan