INTERNATIONAL JOURNAL OF INDUSTRIAL MANAGEMENT
ISSN: 2289-9286 E-ISSN: 0127-564X
VOLUME 19, NO. 4, 2025, 210 – 220
DOI: https://doi.org/10.15282/ijim.19.4.2025.13591

RESEARCH ARTICLE

# Risk Analysis Using the House of Risk Method on Inbound Activities in the Raw Material Warehouse of a Cup Noodle Manufacturing Plant, Semarang, Indonesia

**Mega Eulina Natalia Br Tarigan, Stacia Reviany Mege***

Logistics Management and Administration Study Program, Vocational College, Diponegoro University, Semarang, Central Java, 50275 Indonesia

**ABSTRACT -** The cup noodle manufacturing plant in Semarang, Indonesia, renowned for its "Cup Noodle" brand, faces significant challenges in its inbound logistics process, including inconsistencies in delivered quantities, delays in arrivals, and work-related accidents. This study addresses these issues through the application of the House of Risk (HOR) methodology to systematically identify, analyse, and prioritise risks associated with the inbound logistics of raw materials. Employing a qualitative research approach, the study integrates semi-structured interviews with key personnel from the raw material and beads warehouse departments, non-participatory observations of the inbound process, and the analysis of relevant documentation, such as annual reports, monthly logs, and operational photographs. The HOR methodology was implemented in two phases: Phase 1 focused on the identification and ranking of risk events and risk agents, while Phase 2 concentrated on the formulation and evaluation of mitigation strategies based on their Effectiveness to Difficulty Ratio (ETDk). The research identified several critical risk agents and recommended three principal mitigation strategies: enhancing communication procedures, establishing pertinent Key Performance Indicators (KPIs), and adopting an integrated Enterprise Resource Planning (ERP) system. These strategies are expected to mitigate logistical discrepancies and delays, thereby improving inventory accuracy and reducing operational disruptions. The findings provide actionable recommendations aimed at enhancing the efficiency and reliability of inbound logistics, ultimately contributing to overall operational improvements and reduced disruptions at the manufacturing plant.

**ARTICLE HISTORY**

| | | |
|---|---|---|
| Received | : | 20-04-2025 |
| Revised | : | 29-07-2025 |
| Accepted | : | 30-11-2025 |
| Published | : | 05-12-2025 |

**KEYWORDS**

*House of Risk (HOR)*
*Qualitative study*
*Enterprise Resource Planning (ERP)*
*Noodle manufacturing*

## 1. INTRODUCTION

The food processing industry holds a vital role in fulfilling human basic needs and fostering economic progress in Indonesia. Specifically, the cup noodle industry is an essential part of Indonesia's food processing sector, which not only satisfies domestic consumer needs but also boosts export income. Effective logistics are vital for preserving product quality and addressing market demands. A growing economy offers opportunities for this industry to add value to its products and enter international markets, making food products a significant source of foreign exchange for the country. Logistics, particularly warehousing, is crucial in industrial business operations. Warehouses are designed to store and handle goods or materials, whether raw, semi-finished, or finished (Ruswanto, 2022). The quality of raw materials supplied can significantly impact the final product quality (Kristiawan & Husada, 2014).

As an integral part of a company's logistics system, warehouses ensure smooth production and distribution. Key warehouse management activities include receiving, storage, picking, and shipping (Adawiyah, 2022). Efficient warehouse operations enhance a company's overall efficiency and effectiveness. Logistics encompasses inbound and outbound processes. Inbound logistics involves managing goods entering the company, including purchasing, storing, and ensuring timely production inputs (Danusantoso, 2023). Effective inbound logistics management significantly influences production performance (Kristiawan & Husada, 2014).

This study focuses on a cup noodle manufacturing plant in Semarang, Indonesia, known for its popular "Cup Noodle" brand since 1987. The company operates two warehouses: one for raw materials and another for finished goods. This research centres on the raw material warehouse, which stores imported beads to manufacture Expandable Polystyrene (EPS) cups. It seeks to identify and rank the risks associated with the inbound logistics of raw materials at a cup noodle manufacturing facility and employ the House of Risk (HOR) method to formulate effective mitigation strategies. The inbound logistics for raw material beads is critical in the supply chain of ready-to-eat food products like cup noodles. Irregular bead arrival schedules, especially during high market demand periods, pose significant challenges. These beads are imported based on market demand and require efficient handling and storage to ensure smooth production. In Indonesia, these challenges are worsened by frequent issues with infrastructure and logistics. Poor transportation facilities and unreliable services can make it even harder to ensure timely deliveries and maintain quality control.

***CORRESPONDING AUTHOR | S.R. Mege** | ✉ staciareviany@live.undip.ac.id

Table 1. Raw material stock receipt log (January – June 2023)

| Post Date | Description | Quantity (Sack) |
|---|---|---|
| 18 January 2023 | EPS HJ 808 C | 40 |
| 01 February 2023 | EPS HJ 808 C | 40 |
| 07 February 2023 | EPS HJ 808 C | 40 |
| 15 March 2023 | EPS HJ 808 C | 40 |
| 04 April 2023 | EPS HJ 808 C | 40 |
| 04 May 2023 | EPS HJ 808 C | 40 |
| 09 May 2023 | EPS HJ 808 C | 40 |
| 22 May 2023 | EPS HJ 808 C | 40 |
| 05 June 2023 | EPS HJ 808 C | 40 |

During the inbound process, the effort exerted by workers does not match the heavy load of the raw materials. Workers are advised to be cautious to prevent beads from falling and causing injuries or losses to the company. Several common issues in the inbound process at the bead warehouse include discrepancies in delivered quantities, delayed arrivals, supplier inability to meet orders, damaged packaging, work accidents, delayed production processes, exceeding storage capacity, and unloading beyond cut-off times. These issues disrupt the smooth inbound process, hence necessitating better handling and efficiency.

In Indonesia, these logistical issues are made worse by inconsistent supplier performance, occasional regulatory challenges, and limitations in digital infrastructure, which make it difficult to monitor and document logistics activities effectively. The manual material handling equipment used in the inbound process includes a hand pallet, a forklift, and two workers. The limited equipment, such as the manual hand pallet, slows down the unloading process and reduces its effectiveness. This not only decreases the entire inbound process but also increases the risk of raw material damage. Improper and rushed handling can lead to physical damage or quality changes in the beads and affect the final product quality. In 2022, several work accidents occurred during the inbound process at the bead and EPS warehouses. Beads with heavy loads fell from pallets during unloading, causing packaging damage and scattering beads on the ground. Some beads also fell on workers, causing severe burns or bruises that required medical attention. Loose beads can also cause quality changes due to gas emissions from the raw material. Accidents also occurred within the bead warehouse, where beads fell due to improper stacking, causing leaks and prioritising their use in production. This can lead to additional costs, such as damage costs, and production delays.

Several factors affecting the smooth inbound process in the bead warehouse include worker negligence, poor communication, uneven stacking, lack of digitalisation and documentation, inefficient management, limited workforce, inadequate occupational safety knowledge, lack of personal protective equipment, insufficient work tools, simultaneous arrival of goods, SAP system downtime, and the considerable distance from unloading to storage. In Indonesia, these challenges are further complicated by regional differences in resource availability and varying standards of safety and operations among facilities. Addressing these factors is crucial for more effective inbound activities.

This study employed qualitative methods for data collection, including interviews, observations, documentation, and the House of Risk (HOR) method. The HOR method is used to analyse and measure potential risks in inbound activities at the raw material warehouse. This method prioritises risks based on severity and likelihood, aiding in effective resource allocation to address critical risks first. The structured approach ensures comprehensive risk management that improves operational efficiency and reliability in the warehouse, ultimately contributing to the company's success.

## 2. LITERATURE REVIEW

### *2.1 Inbound Logistics*

Inbound logistics refers to the process of managing the flow of goods and materials from external sources into a company. It is a crucial component of logistics, which involves coordinating the flow of business operations to ensure efficiency. In the context of material management, inbound logistics encompasses the procurement of components, storage of raw materials, and their subsequent use in production. The primary goal of material management is to ensure that production has the necessary inputs at the right time and place (Kristiawan & Husada, 2014). Additionally, inbound logistics plays a critical role in ensuring that raw material supplies, and inventory levels are adaptable (Bowersox, 2010).

Three key factors influence production performance from the perspective of inbound logistics: cost, speed, and consistency of delivery (Bowersox, 2010). Several indicators are essential to consider in the inbound process, including delivery accuracy, raw material quality, inventory availability, handling and receiving efficiency, quality control, documentation and reporting availability, supplier stability and relationships, and regulatory compliance and standards. Ensuring timely and accurate delivery of materials is vital for maintaining smooth production processes. Any delays or inaccuracies can disrupt production, leading to inefficiencies and increased costs. The quality of raw materials directly impacts the final product, making strict quality control measures necessary to ensure that only high-quality inputs are used, thereby maintaining product standards. Maintaining adequate stock levels is essential to prevent production delays and effective inventory management systems are crucial for accurately tracking and managing these levels. Efficient processes for handling and receiving goods ensure that materials are quickly moved to their required locations, thus reducing downtime and enhancing productivity.

Furthermore, robust quality control measures ensure that materials meet the required standards, which will reduce waste and promote product consistency. Comprehensive documentation and accurate reporting facilitate better tracking and management of materials, ensuring transparency and accountability in the supply chain. Strong, stable relationships with suppliers are crucial for reliable supply chains. Effective communication and long-term partnerships with suppliers help mitigate risks and ensure a steady flow of materials. Adherence to regulatory requirements and industry standards is essential for operational legality and maintaining customer trust, ensuring that all processes meet necessary legal and quality benchmarks.

### *2.2 Risk Analysis*

Risk is generally defined as a systematic process for identifying, analysing, controlling, and mitigating factors that can disrupt business objectives. Eddie Cade (2022) suggests that the definition of risk varies depending on its purpose, but it generally involves exposure to uncertainty and the potential for negative outcomes. Risk encompasses two key aspects: the probability of an event occurring and the potential loss or impact it may cause. In the context of management, risk refers to any condition or event that can influence the success or failure of a process, project, or organisation. Key characteristics of risk include uncertainty, potential for loss, likelihood of occurrence, and the ability to manage it. Uncertainty refers to the unpredictable nature of events, while the potential for loss indicates a negative impact on financial, operational, reputational, or other areas. The likelihood of occurrence measures the probability of an event happening and risk management involves identifying, analysing, evaluating, and implementing strategies to mitigate or control these risks.

The definition of risk can vary across different contexts to reflect the specific nature of the environment or industry. For example, in manufacturing, risks might relate to machine failures or supply chain disruptions, whereas in health and safety contexts, risks are more focused on potential accidents and employee hazards. The primary goal of risk management is to identify potential risks, assess their impact, and develop plans to address or mitigate them. Risk management involves several critical steps: Risk Identification, which entails identifying various types of risks that might occur in a specific context; Risk Assessment, which involves evaluating the likelihood and impact of these risks on desired outcomes; Risk Evaluation, where identified and assessed risks are compared to determine their priority for action; Risk Control, which includes developing and implementing strategies to reduce the probability or impact of risks; and Monitoring and Review, which involves regularly monitoring risks, the effectiveness of control strategies, and making adjustments as needed.

Effective risk management helps organisations prepare for uncertainties and minimise negative impacts that could disrupt their objectives. It encompasses all risks faced by society, such as property loss, financial risks, and business risks. Organisations implement risk management policies and procedures to manage, monitor, and control these risks. According to Arta and Satriawan (2021), the goals of risk analysis include recognising various risks faced by a company, developing strategies to reduce or control their impact, protecting company assets, ensuring compliance with relevant laws and standards, improving operational performance by reducing disruptions, building stakeholder confidence, providing relevant information for better decision-making, reducing costs associated with risks, and ensuring employee safety and well-being.

Risk measurement involves identifying and studying the characteristics of risks, measuring their impact on business performance, and prioritising risks for mitigation. Techniques for measuring different types of risks include Value at Risk (VaR) for market risk, stress testing, credit ratings for credit risk, duration methods for interest rate risk, and various metrics and models for operational risk, such as the House of Risk (HOR). These methods help quantify risks and understand their impact on a company's performance, aiding in effective risk management and prioritisation.

### *2.3 House of Risk Method*

The House of Risk (HOR) method is a structured approach to risk management that integrates the principles of Failure Mode and Effects Analysis (FMEA) and the Quality Function Deployment (QFD) approach. It focuses on identifying, analysing, and prioritising risks to develop effective mitigation strategies. The HOR method has gained significant attention in various industries due to its systematic and comprehensive approach to risk management (Pujawan & Geraldin, 2009).

The HOR method was developed to address the limitations of traditional risk management techniques, which often treat risks in isolation and fail to consider their interdependencies. It emphasises the relationship between potential risk events and their causes, providing a holistic view of the risk landscape (Pujawan & Geraldin, 2009). The method comprises two main phases: risk identification and analysis (HOR1) and risk mitigation and management (HOR2). HOR1 focuses on identifying potential risk events and their associated risk agents (causes). It involves identifying potential risk events that could negatively impact the organisation's objectives, determining the causes or sources of these risk events, developing a matrix to illustrate the relationships between risk events and risk agents, and calculating the Risk Priority Number (RPN) for each risk agent by multiplying the severity, occurrence, and detection ratings. This calculation helps in prioritising risk agents based on their potential impact on the organisation (Pujawan & Geraldin, 2009). Meanwhile, HOR2 focuses on developing and implementing strategies to mitigate prioritised risks. This phase includes identifying possible actions or strategies to mitigate the prioritised risk agents identified in HOR1, evaluating the effectiveness of each mitigation action in reducing the occurrence or impact of risk agents, assessing the cost and benefits of implementing each mitigation action to ensure that the selected strategies are economically feasible, developing a detailed plan for implementing the selected mitigation actions, and continuously monitoring the effectiveness of these actions while reviewing the risk management process to ensure continuous improvement (Pujawan & Geraldin, 2009).

The HOR method has been applied in various industries, including manufacturing, supply chain management, healthcare, and project management. In manufacturing, the HOR method helps in identifying and mitigating risks related to production processes, equipment failures, and supply chain disruptions. In supply chain management, it is used to manage risks associated with supplier reliability, logistics, and inventory management, ensuring smooth and efficient operations. In healthcare, the HOR method aids in managing risks related to patient safety, medical errors, and operational inefficiencies. In project management, the method helps project managers identify and mitigate risks that could impact project timelines, budgets, and deliverables (Pujawan & Geraldin, 2009; Kurniati et al., 2017).

The benefits of the HOR method include providing a detailed and structured approach to risk identification and analysis while considering the interdependencies between risk events and their causes. By calculating RPNs, the HOR method helps organisations prioritise risks based on their potential impact, allowing for focused and effective risk mitigation. It also facilitates the development of targeted mitigation strategies, ensuring that resources are allocated effectively to address the most critical risks. Furthermore, the monitoring and review process ensures that risk management practices are continuously improved while adapting to changing risk landscapes and organisational needs (Pujawan & Geraldin, 2009; Kurniati et al., 2017).

### *2.4 Analytical Features of a Literature Review*

The HOR method provides a structured approach to risk management, building upon traditional risk management techniques like Failure Mode and Effects Analysis (FMEA) and Quality Function Deployment (QFD). By integrating these principles, the HOR method offers a more holistic view of risk management that considers the interdependencies between risk events and their causes (Pujawan & Geraldin, 2009). Recent studies have expanded on this foundation by applying the HOR method across various industries, including manufacturing, supply chain management, healthcare, and project management. For instance, Sholihah (2023) applied the HOR method to the inbound logistics process at PT XYZ, resulting in the identification of 20 risk events and 18 risk factors and proposing mitigation strategies to address these risks. This study adds new insights to the existing body of knowledge by demonstrating the applicability of the HOR method to specific operational contexts and highlighting the need for tailored mitigation strategies.

The intellectual progression of risk management using the HOR method can be traced through its application in various industries. Early studies focused on the foundational aspects of the HOR method, such as its development and initial application in supply chain management (Pujawan & Geraldin, 2009). Subsequent research has expanded its use, highlighting the method's versatility and effectiveness. Reynoldus and Gumabo (2022) study on PT Bandar Trisula utilised the HOR method alongside the Supply Chain Operations Reference (SCOR) model and FMEA to identify and prioritise risks in the supply chain. This study emphasises the debate on integrating multiple risk management frameworks to enhance the robustness of risk analysis. The ongoing discourse in the field revolves around the need for comprehensive approaches that combine different risk assessment techniques to address complex risk landscapes effectively.

Furthermore, studies by Ardiansyah (2022) and Maulana (2020) demonstrate HOR’s application in identifying and mitigating supply chain risks in manufacturing and CV. Tunas Karya, respectively. These findings highlight the importance of combining the SCOR model with the HOR method to map supply chain activities and identify critical risk agents. Mulyaningtyas (2023) further underscores the relevance of the HOR method in production processes by identifying 18 risk agents and 19 risk events in wire rope sling production. These sources provide valuable insights into the practical application of the HOR method and emphasise the importance of using a structured approach to prioritise and mitigate risks effectively.

## 3. RESEARCH DESIGN

This research used a qualitative approach to examine risk management in the inbound logistics of a cup noodle manufacturing plant. The researcher gathered detailed information on warehouse operations and associated risks through interviews, observations, and documentation. Interviews were conducted with key staff from the raw material warehouse and the beads warehouse departments. These staff members were chosen for their extensive experience and direct involvement in inbound logistics. The interviews were semi-structured, allowing the researcher to delve deeply into topics such as risk identification, mitigation strategies, and operational issues. Observations took place directly in the beads warehouse, where the researcher tracked how materials moved from receipt to storage and noted any problems. This method was non-participatory, meaning that the researcher observed without getting involved in the activities, ensuring a clear and accurate record of the process.

The researcher also reviewed various documents related to the inbound process, including annual reports, monthly logs, and photographs. These records provided additional context and evidence regarding the frequency of risks and the effectiveness of mitigation strategies. By comparing this documentary evidence with the data from interviews and observations, the researcher was able to create a well-rounded analysis of risk management practices. Combining these methods with the House of Risk (HOR) methodology enabled the development of actionable recommendations for improving warehouse operations.

## 4. RESULTS AND DISCUSSION

The results of this study yield valuable output regarding the risks that occur in the inbound process activities in the beads warehouse, as well as the priority of suitable mitigation action strategies in handling the occurring risks. Stages 1 and 2 of the HOR method began with identifying risk events and risk agents to determine the priority of mitigation actions.

### *4.1 Mapping Inbound Process Activities*

Table 2 shows the inbound process activities in the beads or raw material warehouse:

Table 2. Inbound Process Activities

| Activity | Sub Activity |
|---|---|
| Procurement | a. Issuing Purchase Requisition Beads via SAP<br>b. Issuing and sending Purchase Order CPE to suppliers and the PPIC Department at the Semarang branch<br>c. Scheduling the arrival of goods<br>d. Receiving goods from suppliers<br>e. Purchase Order Closing |
| Transportation | a. Arrival of beads container to the Company<br>b. Driver reports to security<br>c. Registering at the raw material counter<br>d. Weighing the container with all the beads it carries<br>e. Truck inspection by security<br>f. Inspection of COA and waybill<br>g. Unloading goods<br>h. Weighing the container only after the beads are removed<br>i. Issuing good receipt<br>j. Handover of SPB |
| Storage | a. Beads on top of pallets inside containers are unloaded using a forklift.<br>b. Beads arranged on one pallet are stored in the selected location, and the arrival details are written on the note paper.<br>c. Beads are stored according to the order of arrival or the FIFO method.<br>d. Beads are stored in a closed warehouse with a minimum 30 cm stack distance from the wall. |
| Operation | a. Beads entering the first production area are those that arrived first in the warehouse.<br>b. Beads are pulled into the production area using a crane.<br>c. If bead stocks decrease, the warehouse team will report to PPIC. |

### *4.2 House of Risk Phase 1*

During this stage, the identification of potential risks was conducted for each inbound process activity, which consisted of risk events and risk agents.

#### *4.2.1 Identification of risk events and risk agents*

The identification of risk events was accomplished through interviews with pre-determined informants. The purpose of these interviews was to directly understand the various risk issues that commonly arose in the inbound process at the raw material warehouse for beads.

Table 3. Risk event identification and assessment of severity

| Activity | Risk Event | Code | Severity |
|---|---|---|---|
| Procurement | a. Goods arrive not in accordance with the quantity stated on the purchase order. | E1 | 7 |
| | b. Original purchase order is lost after being received by the supplier. | E2 | 4 |
| | c. Delay in the arrival of raw materials. | E3 | 5 |
| | d. Supplier is unable to fulfil orders according to the quantity stated on the purchase order. | E4 | 7 |
| Transportation | a. Waybill is not accompanied by a purchase order reference | E5 | 6 |
| | b. Changes in the quality of beads | E6 | 7 |
| | c. Packaging damage | E7 | 4 |
| | d. Occurrence of work accidents | E8 | 8 |
| Storage | a. Delay in the production process. | E9 | 6 |
| | b. Receipt of goods exceeding storage capacity | E10 | 6 |
| | c. Unloading process exceeds cut-off time | E11 | 4 |
| | d. Delay in storage data processing | E12 | 4 |
| Operation | a. Employees inhaling too much gas from raw material beads | E13 | 9 |
| | b. Employees struggling to lift fallen beads | E14 | 5 |

The severity ratings in Table 3 were derived from the interviews and data input by the raw material warehouse section and staff of the beads raw material warehouse. The severity rating scale ranges from 1 to 10 to assess the level of impact severity if a risk occurs in the warehouse. These severity ratings help determine priorities in managing the identified risks. In procurement, risks such as incorrect order quantities, lost purchase orders, delayed raw materials, and unfulfilled supplier orders are noted with severities ranging from 4 to 7. Transportation risks, including missing purchase order references, quality changes, packaging damage, and work accidents, have severities from 4 to 8. Storage risks like production delays, storage capacity issues, and delayed data processing have severities between 4 and 6. Finally, operational risks focus on employee health hazards, with severities of 5 and 9.

Subsequently, the identification of risk agents was done after obtaining the risk events from each inbound process activity at the raw material warehouse for beads. This was achieved through interviews with informants using predetermined codes.

Table 4. Risk agent identification

| Risk Agent | Code | Occurrence |
|---|---|---|
| a. Employee negligence | A1 | 9 |
| b. Poor communication | A2 | 8 |
| c. Uneven stacking of raw materials | A3 | 4 |
| d. Limited digitalisation and documentation systems | A4 | 5 |
| e. Ineffective management | A5 | 7 |
| f. Insufficient number of employees | A6 | 6 |
| g. Lack of employee knowledge about Occupational Health and Safety (K3) | A7 | 6 |
| h. Absence of Personal Protective Equipment (PPE) | A8 | 4 |
| i. Insufficient work tools | A9 | 7 |
| j. High influx of goods at one time | A10 | 4 |
| k. SAP system downtime | A11 | 3 |
| l. Long distance from beads unloading location to the warehouse | A12 | 4 |

During this stage, an assessment was conducted on the occurrence rating (probability of risk) of each risk agent factor identified by the PT ABC company. Such information was then used to calculate the Aggregate Risk Potential (ARP) at the end of the first phase of HOR. The scale for determining the occurrence rating ranges from 1 to 10, indicating an almost rare or almost frequent occurrence of risk agents in the company, respectively. The occurrence assessment of risk agents was accomplished through interviews with the raw material warehouse section and employees of the beads raw material warehouse.

#### *4.2.2 Correlation assessment and calculation of Aggregate Risk Potentials (ARP)*

An assessment was conducted on the level of correlation between risk events and risk agents. The assessment results indicate criteria values of 0, 1, 3, and 9 for low, medium, and high correlations, respectively. The calculation of Aggregate Risk Potentials (ARP) was done by multiplying the occurrence, severity, and total correlation between risk events and risk agents, as shown in the following formula:

$$ARPj = Oj \sum (Si \times Rij) \quad (1)$$

where:

ARPj = Aggregate Risk Potential
Oj = Occurrence
Si = Severity
Rij = Correlation between risk event and risk agent

Table 5. Calculation of aggregate risk potentials (ARP)

| Risk Event | Risk Agent | | | | | | | | | | | | Severity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A1 | A2 | A3 | A4 | A5 | A6 | A7 | A8 | A9 | A10 | A11 | A12 | |
| E1 | 0 | 9 | 0 | 1 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| E2 | 3 | 0 | 0 | 9 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| E3 | 0 | 9 | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 5 |
| E4 | 0 | 3 | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| E5 | 3 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 6 |
| E6 | 3 | 0 | 9 | 0 | 0 | 3 | 0 | 0 | 9 | 1 | 0 | 0 | 7 |
| E7 | 9 | 0 | 9 | 0 | 0 | 9 | 0 | 0 | 9 | 1 | 0 | 9 | 4 |
| E8 | 9 | 1 | 3 | 0 | 3 | 9 | 9 | 9 | 9 | 1 | 0 | 3 | 8 |
| E9 | 0 | 9 | 1 | 0 | 3 | 1 | 0 | 0 | 9 | 3 | 0 | 0 | 6 |
| E10 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 6 |
| E11 | 0 | 9 | 0 | 0 | 3 | 9 | 0 | 0 | 9 | 9 | 0 | 9 | 4 |
| E12 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 4 |
| E13 | 0 | 0 | 0 | 0 | 0 | 1 | 9 | 9 | 0 | 9 | 0 | 0 | 9 |
| E14 | 3 | 0 | 9 | 0 | 0 | 9 | 1 | 0 | 9 | 9 | 0 | 3 | 5 |
| Occurrence | 9 | 8 | 4 | 5 | 7 | 6 | 6 | 4 | 7 | 4 | 3 | 4 | |
| ARP | 1.566 | 1.912 | 696 | 215 | 2.079 | 1.350 | 948 | 612 | 684 | 1.096 | 108 | 444 | |
| Rating | 3 | 2 | 7 | 11 | 1 | 4 | 6 | 9 | 8 | 5 | 12 | 10 | |

The calculation of ARP in Table 5 was then used to sort the risk agents from the highest to the lowest order. The highest ARP was obtained by A5 (2.079), followed by A2 (1.912), A1 (1.566), A6 (1.350), and A10 (1.096). After determining the priority of risk agents, mitigation was conducted to establish their priority. Additionally, the ARP values were used to create a Pareto diagram that shows issues based on the order of occurrence from highest to lowest (Maulana, 2020). The purpose is to identify the most significant problems that the company should address in order to reduce losses. Figure 1 illustrates the Pareto principle.

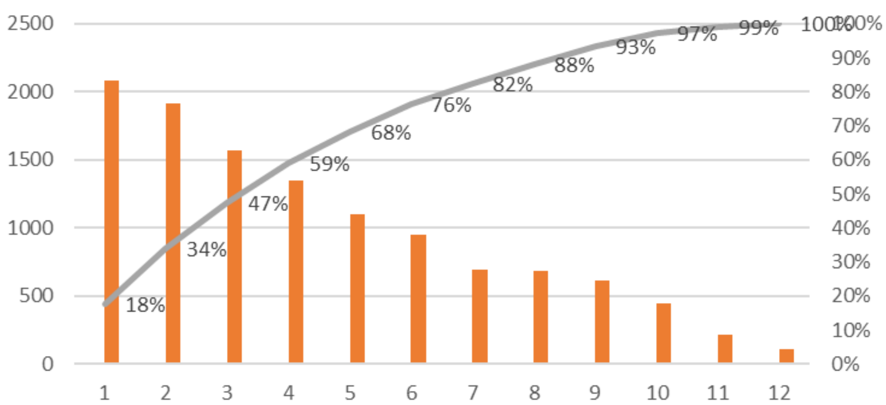


Figure 1. Pareto Diagram

In this research, the Pareto calculation principle follows the 80:20 rule, which means that 80% of the problems will be resolved by addressing 20% of the risk agents (Maulana, 2020). Figure 1 shows the ranking of risk agents from the highest to lowest ARP values. There were 6 priority risk agents contributing 80% and 6 non-priority risk agents contributing 20%. Subsequently, only the priority risk agents were used for selecting priority risk mitigation strategies in HOR Phase 2.

### *4.3 House of Risk Phase 2*

Phase 2 of the HOR methodology aims to determine strategies that can mitigate prioritised risk agents, thereby minimising the occurrence of risks that could harm the company. It involves designing mitigation strategies, assessing the correlation between these strategies and the risk agents, calculating the Total Effectiveness (TEk) and Degree of Difficulty (Dk), and computing the Effectiveness to Difficulty Ratio (ETDk) to identify which risk mitigation strategies should be prioritised for implementation. In this study, the risk mitigation strategies were derived from interviews with the raw material warehouse section and staff, as well as conducting literature studies related to similar issues. The recommended risk mitigation strategies are as follows:

1) PA1: Maintain or replace work equipment with new ones.
2) PA2: Establish clear and relevant Key Performance Indicators (KPIs).
3) PA3: Implement an electronic document management system.
4) PA4: Implement an integrated information management system, such as Enterprise Resource Planning (ERP).
5) PA5: Conduct selective recruitment of employees based on their expertise.
6) PA6: Develop and implement clear and open communication procedures for all relevant parties.
7) PA7: Provide specialised training for relevant skills and equipment usage.
8) PA8: Provide Occupational Health and Safety (K3) training and healthcare facilities.
9) PA9: Organise bead storage using a Warehouse Management System (WMS).
10) PA10: Create clear contracts regarding quantity, quality, delivery schedules, and penalties for non-compliance.

#### *4.3.1 Mapping house of risk phase 2*

The purpose of mapping risk mitigation strategies with current risk agents is to understand the relationship between them. This phase uses the same scale as HOR 1, where 0 indicates no correlation, 1 indicates low correlation, 3 indicates moderate correlation, and 9 indicates high correlation (Sholihah, Sumarna, & Sulistiyaningsih, 2023). The mapping of HOR Phase 2 involves the following stages:

a. Measuring the correlation between risk mitigation strategies and risk agents to determine the extent of the influence of mitigation strategies on the identified risk agents.
b. Calculating the Total Effectiveness (TEk) of each risk mitigation strategy to determine the effectiveness of the risk mitigation strategies. The formula for Total Effectiveness (TEk) is as follows:

$$\text{TEk} = \sum \text{ARPj Ejk} \tag{2}$$

where:

TEk = Total Effectiveness
ARPj = Aggregate Risk Potential
Ejk = Risk Event Identification

c. Measuring the Degree of Difficulty (Dk) of each predetermined risk mitigation strategy. A scale ranging from 1 (very easy to implement) to 5 (very difficult to implement) (Sholihah, Sumarna, Sulistiyaningsih, 2023) is used to assess the difficulty in implementing each mitigation action based on the company's capabilities and the costs involved. The Dk values are then used to calculate the ETDk values in the subsequent stage.
d. Calculating the Effectiveness to Difficulty Ratio (ETDk) for implementing risk mitigation strategies. This is achieved using the following formula:

$$ETDk\,\frac{TEk}{Dk} \tag{3}$$

where:

ETDk = Effectiveness to Difficulty Ratio
TEk = Total Effectiveness
Dk = Degree of Difficulty

Table 6 shows the calculated values for TEk, Dk, and ETDk. To ensure that the risk mitigation strategies were valid for implementation, including readiness in terms of cost and human resources, interviews were conducted with the raw material warehouse section and employees of the beads raw material warehouse. The identification of strategies was followed by determining the priority of risk mitigation strategies. The results in Table 6 indicate that the prioritised mitigation actions are based on the largest ETDk values, namely PA6, PA2, PA4, PA10, PA3, PA7, PA9, PA8, PA5, and PA1. PA6 pertains to creating and implementing clear and open communication procedures for all relevant parties. This strategy involves developing and enforcing transparent communication protocols to ensure that all stakeholders, including suppliers, warehouse staff, and management, are well-informed and aligned. It prevents misunderstandings and ensures that everyone is aware of their roles and responsibilities, reducing the likelihood of errors and delays.

Table 6. Output of HOR phase 2

| Kode | *Preventive Action* | | | | | | | | | | ARP |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PA1 | PA2 | PA3 | PA4 | PA5 | PA6 | PA7 | PA8 | PA9 | PA10 | |
| A5 | 0 | 9 | 9 | 9 | 0 | 9 | 0 | 0 | 0 | 9 | 4.212 |
| A2 | 0 | 0 | 0 | 9 | 0 | 9 | 0 | 0 | 0 | 0 | 2.565 |
| A1 | 1 | 9 | 0 | 0 | 0 | 3 | 9 | 0 | 9 | 0 | 2.424 |
| A6 | 0 | 3 | 3 | 0 | 9 | 1 | 3 | 0 | 0 | 0 | 2.142 |
| A10 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 9 | 2.079 |
| A7 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 9 | 0 | 0 | 1.632 |
| *Total Effectiveness* | 8.661 | 66.150 | 44.334 | 60.993 | 19.278 | 75.303 | 29.874 | 14.688 | 28.053 | 56.619 | |
| *Degree of Difficulty* | 4 | 2 | 2 | 2 | 4 | 2 | 2 | 2 | 2 | 2 | |
| *Effectiveness to Difficulty* | 2.165 | 33.075 | 22.167 | 30.497 | 4.820 | 37.652 | 14.937 | 7.344 | 14.027 | 28.310 | |
| *Rank of Priority* | 10 | 2 | 5 | 3 | 9 | 1 | 6 | 8 | 7 | 4 | |

Furthermore, PA2 focuses on establishing clear and relevant Key Performance Indicators (KPIs) to define specific, measurable performance metrics that are relevant to the company's operations. By setting clear KPIs, the company can monitor and evaluate the performance of various processes and individuals, identify areas for improvement, and ensure that objectives are being met effectively. Finally, PA4 proposes implementing an integrated information management system, such as Enterprise Resource Planning (ERP), to streamline and integrate various business processes like procurement, inventory management, and production planning. Such system provides real-time data and analytics that can improve decision-making, efficiency, and coordination across different departments, ultimately reducing risks associated with data discrepancies and process inefficiencies.

These findings highlight the critical role of clear communication and integrated systems for mitigating risks in inbound logistics, aligning with broader trends in supply chain digitisation. The identification of priority risk agents, such as poor communication and limited digitalisation, highlights the need for comprehensive risk management strategies. Implementing mitigation actions like establishing clear communication procedures and adopting integrated information systems can significantly reduce the risks associated with inbound logistics operations. The findings contribute to existing knowledge by demonstrating the practical application of the House of Risk (HOR) method in identifying and prioritising risk agents and mitigation strategies, providing a structured approach to enhance supply chain resilience. The use of the Pareto principle in this context further supports the idea that addressing a small number of high-impact risks can effectively mitigate the majority of potential issues, thus optimising resource allocation and improving overall efficiency in supply chain management.

## 5. CONCLUSION

This study focuses on utilising the inbound logistics of raw materials, specifically beads used for manufacturing Expandable Polystyrene (EPS) cups, at a cup noodle manufacturing plant in Semarang, Indonesia. It highlights the challenges faced in the inbound logistics process, such as discrepancies in delivered quantities, delayed arrivals, supplier issues, packaging damage, work accidents, and production delays. These challenges necessitate the development of efficient handling and storage procedures to ensure smooth production.

The House of Risk (HOR) method was employed to identify, analyse, and prioritise potential risks in the inbound process. By mapping inbound activities and assessing risk events and risk agents, the study calculated Aggregate Risk Potentials (ARP) to determine the severity and occurrence of risks. The analysis identified the most critical risk agents and developed mitigation strategies to address them. The prioritised mitigation actions were determined based on the Effectiveness to Difficulty Ratio (ETDk), ensuring that the strategies are feasible in terms of cost and human resources. The top three prioritised actions are:

a. PA6: Developing and implementing clear and open communication procedures for all relevant parties. This strategy ensures transparent communication, thus aligning stakeholders and preventing misunderstandings.

b. PA2: Establishing clear and relevant Key Performance Indicators (KPIs). This strategy focuses on defining measurable performance metrics to monitor and evaluate processes, identify areas for improvement, and achieve objectives.
c. PA4: Implementing an integrated information management system such as Enterprise Resource Planning (ERP). This strategy involves adopting an ERP system to streamline and integrate various business processes, ultimately improving decision-making, efficiency, and coordination.

Other important strategies include creating clear contracts, implementing an electronic document management system, providing specialised training, organising bead storage using a Warehouse Management System (WMS), and improving occupational health and safety measures. By prioritising these mitigation actions, the study aims to enhance the efficiency and reliability of the inbound logistics process in the raw material warehouse, ultimately contributing to the company's operational success and reducing the likelihood of disruptions.

## ACKNOWLEDGEMENTS

This study was not supported by any grants from funding bodies in the public, private, or not-for-profit sectors.

## FUNDING STATEMENT

Not applicable

## AUTHORS CONTRIBUTION

M. E. N. B. Tarigan (Methodology, Validation, Formal Analysis, Data Curation, Investigation),

S. R. Mege (Conceptualisation, Writing – original draft, Writing – review & editing, Project administration, Supervision)

## AVAILABILITY OF DATA AND MATERIALS

The data supporting the findings are available on request from the corresponding author.

## ETHICS STATEMENT

Not Applicable

## CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

## GENERATIVE ARTIFICIAL INTELLIGENCE DECLARATIONS

The author(s) declare that no generative AI or AI-assisted technologies were used in the writing of this manuscript. All content, including text, figures, and tables, was created by the author(s).

## REFERENCES

Adawiyah, R. (2022). Key warehouse management activities: receiving, storage, picking, and shipping. Journal Of Logistics and Supply Chain Management, 11(2), 134-145.

Ardiansyah, P. (2022). Application of the house of risk method in supply chain risk management at cv. Tunas Karya. Journal Of Supply Chain Management, 11(2), 45-60.

Arta, I., & Satriawan, H. (2021). The objectives and importance of risk analysis in business management. Journal Of Risk Management Studies, 10(2), 112-130.

Aulia, D. (2023). Application of the House of Risk (HOR) method in risk management: A comprehensive approach. Journal Of Risk Analysis and Mitigation, 12(3), 144-159.

Bowersox, D. J. (2010). Supply Chain Logistics Management. Mcgraw-Hill.

Cade, E. (2022). Defining risk: Perspectives and applications. Journal Of Risk Analysis, 15(1), 45-58

Danusantoso, A. (2023). Effective inbound logistics management and its influence on production performance. International Journal of Production and Operations Management, 13(1), 56-67.

Kristiawan, I., & Husada, D. (2014). The impact of raw material quality on final product quality. Journal of Industrial and Manufacturing Engineering, 7(3), 205-218

Kurniati, A., Pujawan, I. N., & Geraldin, L. H. (2017). Application of the House of Risk (HOR) method in various industries. International Journal of Risk Management, 8(3), 205-218.

Maulana, I. (2020). Integrating the SCOR model and the house of risk method for enhanced supply chain risk management. Manufacturing And Supply Chain Review, 14(4), 301-318.

Mulyaningtyas, A. (2023). Implementing the house of risk method in production processes: a case study of wire rope sling production. Production Engineering Journal, 19(1), 112-130.

Pujawan, I. N., & Geraldin, L. H. (2009). House of risk: A model for proactive supply chain risk management. Business Process Management Journal, 15(6), 953-967.

Reynoldus, T., & Gumabo, A. (2022). Utilizing the house of risk and SCOR model for supply chain risk assessment at Pt Bandar Trisula. Risk Management Insights, 10(3), 176-192.

Ruswanto, B. (2022). The role of warehouses in industrial business operations. Journal Of Business Logistics, 9(4), 211-223.

Sholihah, A. (2023). Application of the house of risk method to the inbound logistics process at Pt XYZ. Logistics And Supply Chain Review, 16(2), 89-103.

Sholihah, N., Sumarna, N., & Sulistiyaningsih, E. (2023). Implementing the House of Risk (HOR) method in supply chain risk management. International Journal of Risk and Supply Chain Management, 15(2), 198-214.