ISSN [Online]: 2776-6381

MAPPING IDEA & LITERATURE FORMAT | RESEARCH ARTICLE

Reducing Packaging Defects in Wheat Flour Production Using Soft Systems Methodology

Edna Maryani[1], Pratama Jaya[2]

[1,2] Department of Industrial Engineering, Faculty of Sains & Technology, Universitas Faletehan, Banten, Indonesia.
Email: ednamaryn@gmail.com[1]

ARTICLE HISTORY

Received: December 23, 2025
Revised: February 21, 2026
Accepted: February 28, 2026

DOI
https://doi.org/10.52970/grmilf.v6i2.1990

ABSTRACT
Product packaging quality plays a crucial role in maintaining product safety, reducing rework, and sustaining company competitiveness. This study aims to reduce defects in 25 kg wheat flour packaging at PT. XYZ by identifying dominant defect types and analyzing their root causes. A Soft Systems Methodology (SSM) approach—an interpretive, systems-based framework used to analyze complex, unstructured problem situations—was applied to structure the problem, develop conceptual models, and propose improvements. Based on production data, 653 packaging defects were recorded. The dominant defects were packaging leakage at the seams (51.60%) and damage during loading (36.29%), representing 87.89% of total defects. Root cause analysis using Pareto and fishbone diagrams identified human factors, improper methods, and material quality as the primary contributors. Improvement proposals include selecting higher-quality thread, optimizing operator working schedules, providing ergonomic support tools, establishing loading limits, and strengthening SOP implementation. The implementation of these improvements is expected to reduce rework levels, improve productivity, and enhance packaging reliability.

Keywords: Soft Systems Methodology, Packaging Quality Control, Wheat Flour Packaging, Defect Reduction, Root Cause Analysis, Quality Improvement.

I. Introduction

In today's highly competitive manufacturing environment, product quality has become a strategic determinant of organizational sustainability and market competitiveness. Companies are no longer evaluated solely on the intrinsic quality of their products, but also on the reliability and integrity of their packaging systems (Sukania et al., 2015). Packaging plays a critical role in protecting product quality, maintaining food safety, preventing contamination, and reducing operational losses caused by defects and rework. In the food industry, defective packaging can lead to product spoilage, reduced customer trust, increased production costs, and reputational damage (Marsh & Bugusu, 2007; Robertson, 2016). Therefore, quality control in packaging operations is not merely a technical activity but a strategic management concern. Within wheat flour production, packaging defects represent a significant operational challenge. Large-scale flour packaging, particularly in 25 kg polypropylene sacks, is vulnerable to defects such as seam leakage, tearing during loading, and environmental damage (Mohede et al., 2018). These defects not only increase rework levels but also reduce production efficiency and increase quality-related costs. Previous studies emphasize that a small number of defect types often account for the majority of quality problems, highlighting the importance of

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systematic defect identification and prioritization (Montgomery, 2020; Juran & De Feo, 2017). However, many manufacturing companies still rely primarily on technical corrective actions without adopting a broader systems perspective to address underlying organizational and process-related causes (Yan et al., 2022).

Beyond technical deficiencies, packaging defects are often influenced by human factors, work methods, material quality, and environmental conditions (Mu'is et al., 2023). Research in quality management shows that sustainable improvement requires integrating root cause analysis with systemic organizational change (Antony et al., 2019; Sunder et al., 2020). In this context, addressing packaging defects cannot be limited to mechanical adjustments alone; it requires a structured approach capable of analyzing complex and unstructured problem situations involving multiple stakeholders. To address these challenges, this study adopts Soft Systems Methodology (SSM), an interpretive and systems-based approach designed to structure complex organizational problems and generate feasible improvements (Fernando & Asrol, 2025). Developed initially to analyze messy, ill-defined situations, SSM emphasizes stakeholder perspectives, conceptual modeling, and the identification of changes that are both systematically desirable and culturally feasible (Checkland, 2000; Reynolds & Holwell, 2010). Unlike purely quantitative quality control techniques, SSM allows researchers to integrate technical defect analysis tools—such as Pareto diagrams, fishbone diagrams, and Failure Mode and Effect Analysis (FMEA)—within a broader systemic framework. Despite extensive research on quality control tools, limited studies integrate systems thinking approaches with traditional defect analysis in food packaging operations. Most studies focus on statistical control methods without addressing the organizational dynamics underlying recurring defects (Oakland, 2014; Slack & Brandon-Jones, 2019). Consequently, there remains a gap in developing a holistic framework that combines defect prioritization, root cause identification, and actionable organizational improvements within a single structured methodology.

Based on this gap, the problem addressed in this study is the absence of a comprehensive framework to systematically identify dominant packaging defects, analyze their root causes holistically, and implement sustainable improvement strategies in wheat flour production. Therefore, this research aims to reduce packaging defects in 25 kg wheat flour sacks by integrating quality control tools within the Soft Systems Methodology framework. Unlike previous studies that apply Pareto analysis, fishbone diagrams, or FMEA as standalone analytical tools in manufacturing quality improvement (Antony et al., 2022; Liu et al., 2020), this research explicitly embeds these instruments within the seven-stage Soft Systems Methodology (SSM) framework. While earlier research in food manufacturing predominantly emphasizes statistical defect reduction and process optimization, it rarely integrates systemic problem-structuring approaches that consider stakeholder perspectives and organizational feasibility. By positioning traditional quality control tools within the interpretive structure of SSM, this study extends prior work by linking technical defect prioritization with culturally feasible organizational change. This integrative positioning distinguishes the present study from the existing literature and enhances its methodological originality. The study contributes both practically—by proposing actionable improvement strategies—and theoretically—by demonstrating how SSM can be operationalized in industrial quality improvement contexts.

II. Literature Review and Hypothesis Development

2.1. Packaging Quality and Operational Performance in Food Manufacturing

Packaging quality is a critical determinant of operational performance in food manufacturing industries. In bulk commodities such as wheat flour, packaging serves not only as a containment mechanism but also as a protective barrier that maintains product integrity throughout storage and transportation. Defective packaging can lead to contamination risks, material losses, reduced shelf stability, and reputational damage. Recent studies indicate that packaging-related failures significantly increase production variability and contribute directly to the cost of poor quality (COPQ), particularly in high-volume food production systems (Kumar et al., 2018; Ali et al., 2020). Consequently, packaging quality management has evolved into a

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strategic function rather than a purely technical inspection activity. In large-scale flour production environments, defects such as seam leakage, tearing during loading, and environmental exposure often dominate quality records. These defects frequently arise in processes involving polypropylene sacks, where mechanical stress, improper sealing, and handling pressure create vulnerabilities. Empirical research in food supply chain management demonstrates that packaging defects are closely associated with inefficiencies in loading systems, inadequate storage conditions, and inconsistent material specifications (Rahman et al., 2019; Dora et al., 2021). The recurrence of these issues suggests that defect prevention requires systematic monitoring of process variables rather than relying solely on post-production inspection. Moreover, contemporary operational performance research emphasizes that packaging reliability contributes to supply chain resilience. Disruptions caused by packaging damage may delay distribution schedules, increase return rates, and require additional labor for rework. According to Costa et al. (2019), food manufacturing firms that integrate packaging quality control with operational planning achieve better production stability and lower defect recurrence rates. Therefore, improving packaging quality in wheat flour production must be addressed within a broader operational and organizational context.

2.2. Application of Quality Control Tools in Defect Reduction

Manufacturing industries traditionally employ analytical quality control tools to identify, prioritize, and mitigate the causes of defects. Pareto analysis remains one of the most widely used approaches for defect prioritization, enabling organizations to concentrate resources on dominant failure categories that generate the majority of quality problems (Chiarini, 2017). By highlighting the "vital few" contributors, Pareto analysis supports efficient decision-making and strategic allocation of corrective actions. In food packaging contexts, this method is particularly valuable for distinguishing between high-frequency defects and sporadic minor failures. Complementing Pareto analysis, fishbone diagrams facilitate structured root cause identification by categorizing defect sources into operational dimensions such as human factors, machinery, methods, materials, and environmental conditions. This systematic categorization enables a deeper understanding of the interrelated variables that influence packaging failures. In recent years, FMEA has further strengthened risk-based quality management by assessing failure severity, likelihood of occurrence, and detection capability (Liu et al., 2020). When applied in the food processing industry, FMEA supports preventive action planning and reduces the recurrence of critical failures (Sreedharan et al., 2018). Despite their effectiveness, recent literature highlights limitations of using these tools in isolation. Antony et al. (2022) argue that technical quality instruments often focus on symptom identification without addressing structural organizational drivers, such as workload imbalance, communication gaps, and weaknesses in process standardization. Similarly, Sony et al. (2021) note that quality improvement efforts fail to sustain impact when they do not incorporate behavioral and cultural considerations. This critique suggests the need to embed analytical defect tools within a broader systemic improvement methodology.

2.3. Systems Thinking and Soft Systems Methodology in Manufacturing Contexts

Systems thinking provides a conceptual lens for understanding complex industrial problems characterized by multiple interacting variables. Rather than isolating defects as discrete technical malfunctions, systems thinking interprets operational failures as outcomes of interconnected structures and feedback loops (Sterman, 2018). In manufacturing settings, this perspective facilitates holistic evaluation of production processes, workforce dynamics, and environmental influences. Battistella et al. (2021) emphasize that organizations applying systems-oriented approaches demonstrate stronger adaptive capacity and continuous improvement performance. Soft Systems Methodology (SSM) represents a structured systems-based framework designed to address unstructured or "messy" organizational situations. Unlike complex systems approaches that emphasize quantitative optimization, SSM prioritizes stakeholder engagement, problem structuring, conceptual modeling, and iterative learning. Winter and Checkland (2019) explain that

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SSM seeks changes that are both systematically desirable and culturally feasible, making it suitable for operational environments involving human and organizational complexity. Its seven-stage process enables comprehensive problem exploration and collaborative solution development. Recent empirical applications show that integrating systems thinking with operational improvement enhances the sustainability of quality initiatives. Ahmad et al. (2023) report that systems-based interventions in manufacturing contexts improve coordination and reduce defects. Similarly, Garza-Reyes et al. (2020) demonstrate that aligning process improvements with organizational structures strengthens performance outcomes. Therefore, incorporating SSM into packaging quality management can offer potential advantages for addressing both technical and behavioral contributors to defect recurrence.

2.4. Research Gap and Conceptual Positioning

Although Lean, Six Sigma, and Total Quality Management (TQM) approaches dominate contemporary quality management research, most studies emphasize statistical optimization and process efficiency rather than systemic organizational analysis (Ben Ruben et al., 2017; Psomas, 2021). While these approaches effectively reduce variation and improve process capability, they may overlook broader contextual and stakeholder factors that influence operational performance. Particularly in food packaging operations, limited research integrates traditional defect-analysis tools into a comprehensive systems methodology. In bulk wheat flour packaging, recurring defects such as seam leakage and loading damage often reflect complex interactions among material selection, operator workload, environmental conditions, and procedural compliance. The existing literature provides substantial evidence on defect-prioritization techniques but insufficient guidance on embedding these tools within structured problem-framing processes. As highlighted by Ivanov and Dolgui (2020), resilient operational systems require integrated analytical and organizational approaches to manage disruption risks effectively. Therefore, this study addresses a critical gap by integrating Pareto analysis, fishbone diagrams, and FMEA within the seven-stage Soft Systems Methodology framework. By positioning quality control tools within a systems-thinking framework, this research bridges technical defect analysis with sustainable organizational improvement. The proposed integration aims to ensure that packaging quality enhancements in wheat flour production are not only technically practical but also operationally feasible and institutionally sustainable.

III. Research Method

3.1. Research Design

This study employs a qualitative case study design combined with quantitative defect analysis. The research focuses on the packaging process of 25 kg wheat flour sacks at PT. XYZ. A case study approach was selected to allow in-depth exploration of operational processes, stakeholder roles, and defect patterns within a real industrial environment. (Almassri, 2024). The primary methodological framework used in this study is Soft Systems Methodology (SSM). SSM is a systems-based problem-structuring approach designed to analyze complex and unstructured organizational situations. Unlike purely statistical methods, SSM emphasizes stakeholder perspectives, conceptual modeling, and iterative comparison between conceptual models and real-world practices. (Françozo et al., 2022). In this research, SSM is used as a structuring framework, while traditional quality control tools are embedded within specific analytical stages. (Arnold & Wade, 2015). This integration represents the main contribution of the study. While Pareto analysis, fishbone diagrams, and FMEA are widely used in manufacturing, this research positions them within the seven-stage SSM framework to ensure that technical defect analysis aligns with systemic organizational improvement. (Oktavian et al., 2024).

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3.2. Data Collection and Sampling

Data for this study were collected from the wheat flour packaging department during a defined production period within the observed operational cycle. The unit of analysis was 25 kg packaged wheat flour sacks produced at the facility, as this product represents the primary output of the packaging line and contributes significantly to overall production volume. Focusing on a single standardized packaging size allowed for consistent defect measurement and facilitated comparison across production batches. The study utilized both quantitative and qualitative data to ensure a comprehensive analysis. Quantitative data included the number of defective packages, classification of defect types, frequency of defect occurrence, total production volume, and rework records. These data were obtained from official production quality control logs and daily inspection reports maintained by the quality assurance department. The quantitative data were used to calculate defect proportions, identify dominant failure types, and support prioritization analysis using quality control tools. In addition to numerical records, qualitative data were collected to understand the operational context behind the defect patterns. Direct observations were conducted to examine packaging and loading activities, including machine handling, material flow, and operator practices. Semi-structured interviews were conducted with key personnel to explore their perspectives on operational constraints, technical issues, and quality challenges. Furthermore, relevant documentation such as Standard Operating Procedures (SOPs) and maintenance records was reviewed to compare formal procedures with actual practices on the production floor. For the interview process, purposive sampling was applied. Participants were selected based on their direct involvement and responsibility in the packaging process. The sample consisted of packaging machine operators, loading personnel, quality control staff, and the production supervisor. This approach ensured that the collected information reflected practical experience and decision-making authority within the system. By selecting informants with direct operational knowledge, the study obtained relevant and reliable insights while maintaining methodological rigor. Moreover, the use of clearly defined sampling criteria enhances the replicability of this research in similar industrial manufacturing contexts.

3.3. Research Procedures and Analysis

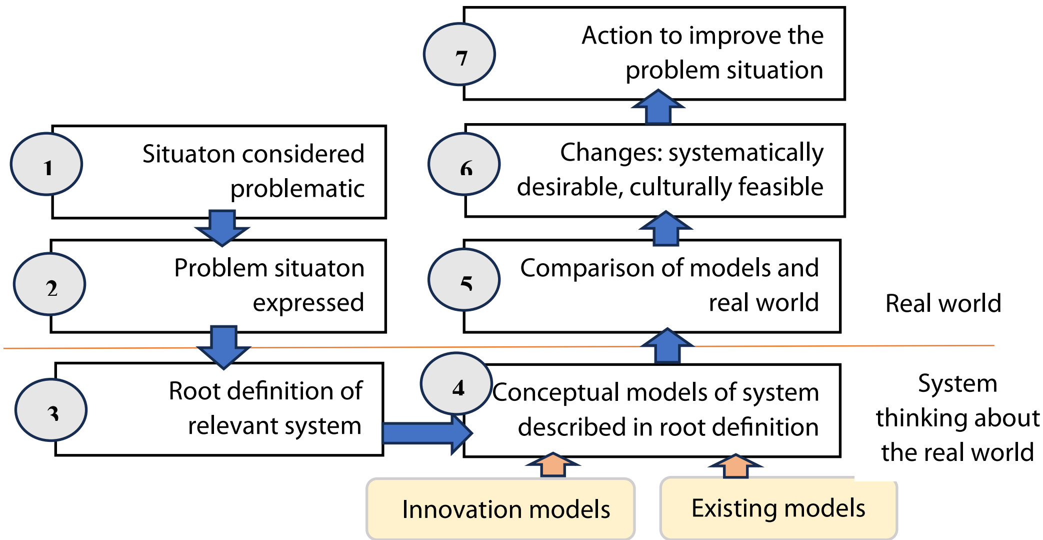

Figure 1. Overview Soft System Methodology (seven-stage model)
Source: Adapted and reconstructed by the authors based on Checkland (2000) and Winter & Checkland (2019).

The research procedures followed the seven stages of Soft Systems Methodology (SSM) as illustrated in Figure 1. In the first stage, the problem situation was identified as problematic. This stage began with preliminary observations in the wheat flour packaging department, where recurring defects in 25 kg sacks

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were recognized as a critical operational issue. The focus was not only on defect frequency but also on understanding why the situation was perceived as problematic by different stakeholders within the system. In the second stage, the problem situation was expressed. At this stage, the unstructured situation was explored in greater depth through field observations, informal discussions, and documentation review. The objective was to map the existing packaging workflow, identify interactions between operators, machines, and quality control personnel, and describe how defects occurred within the real production environment. The findings from this stage were organized to reflect operational realities rather than assumptions.

The third stage involved formulating the root definition of the relevant system. Here, the study defined the packaging quality control system using CATWOE analysis (Customer, Actor, Transformation, Weltanschauung, Owner, and Environment). This step clarified system boundaries and articulated the transformation process—from raw packaged flour output with potential defects into controlled, quality-assured products ready for distribution. The root definition provided a structured description of what the system is and what it should accomplish. In the fourth stage, conceptual models of the system described in the root definition were developed. These conceptual models represented logically structured activities required to achieve effective packaging quality control. At this point, both existing operational practices and proposed innovation models were incorporated. Quality control tools such as Pareto analysis, fishbone diagrams, and FMEA were embedded within the conceptual framework to strengthen analytical depth. The conceptual model served as a theoretical representation of how the system should function under ideal conditions.

The fifth stage consisted of comparing the conceptual models with real-world practices. This comparison aimed to identify gaps between the ideal system and actual operations. Discrepancies such as procedural noncompliance, machine maintenance issues, or inconsistencies in inspection routines were systematically analyzed. This stage connected system thinking with operational evidence, ensuring that improvement proposals were grounded in empirical findings. The sixth stage focused on identifying changes that were both systematically desirable and culturally feasible. Proposed improvements were evaluated not only based on technical effectiveness but also on practicality within the organizational culture. Consideration was given to workforce capability, managerial support, cost implications, and operational constraints. Only changes that met both systemic and contextual feasibility criteria were recommended. Finally, the seventh stage involved defining actions to improve the problem situation. The study formulated actionable improvement strategies, including refining inspection procedures, reinforcing operator training, scheduling preventive maintenance, and implementing more precise quality monitoring mechanisms. These actions were structured to reduce defect rates while enhancing process stability. Through this iterative seven-stage process, SSM provided a comprehensive framework that integrates system thinking with practical quality improvement in the wheat flour packaging process. (Nikhlis et al., 2020).

3.4. Quality Control Analysis Tools

The main features of the Soft System Methodology approach are: understanding and analyzing problems; analyzing relationships and roles among related parties; and analyzing relations and the political and social roles of the parties concerned. The method used is Soft Systems Methodology. Can be described as shown in the following chart 2.

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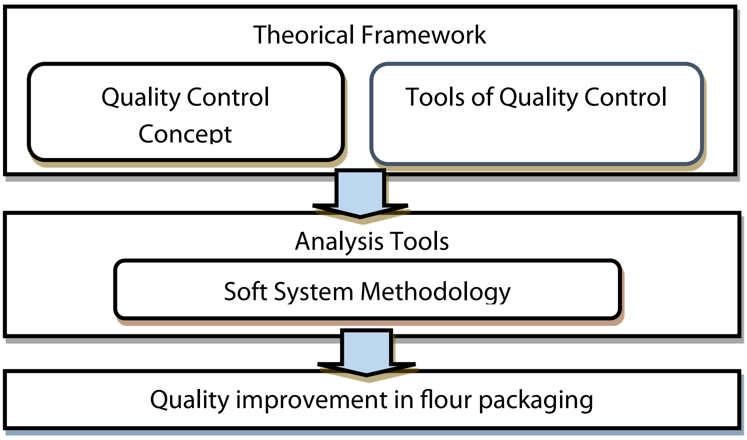

Figure 2. Built up the Theoretical and Methodological
Source: Developed by the authors (2025).

The theories related to this research are the quality control concepts and tools. Quality control plays a vital role because it determines the quality of the products the company produces. (Zacharias, 2022). In general, quality control consists of procedures; namely, the first step is to determine standards. Quality standards serve as guidelines for creating a high-quality product. The second step assesses suitability by comparing products against predetermined standards. The third step acts if necessary, corrects problems, and identifies causes through factors. The last step is to plan improvements and maintain a continuous effort to improve cost standards, achievements, security, and reliability. Quality Control tools are often called "magnificent tools," namely, flow charts, check sheets, fishbone diagrams, and Pareto diagrams. The Pareto diagram was made to identify key causes of problems and to compare the whole. Knowing the dominant causes will help us set priorities for improvement. The principle of Pareto is "little but important, many but trivial". A fishbone diagram helps analyze and identify factors that significantly influence the quality characteristics of workouts. In looking for the factors that cause deviations in the quality of work, there are 5 (five) significant main factors to consider: human, work methods, machinery/work equipment, raw materials, and work environment.

3.5. Measurement and Evaluation of Effectiveness

The effectiveness of the proposed improvements was evaluated using clearly defined performance indicators to ensure measurable outcomes. These indicators included reduced total defect frequency, decreased percentages of dominant defect types, reduced rework rates, improved operator compliance with Standard Operating Procedures (SOPs), and increased stability in the loading process. The impact of the Soft Systems Methodology (SSM) implementation was assessed by comparing defect data before and after the proposed improvements when implementation data were available. In cases where direct post-implementation data were not yet available, evaluation was conducted through simulation-based analysis, particularly by examining reductions in Risk Priority Numbers (RPN) derived from FMEA. This structured evaluation approach ensures that the application of SSM is empirically assessable and not merely descriptive or conceptual.

3.6. Ethical Considerations and Validity

Data collection was conducted with the formal permission of company management, and all interview participants were informed of the research's purpose and scope prior to participation. To enhance the credibility and validity of the findings, data triangulation was applied by integrating quantitative production logs, qualitative interviews, and direct field observations. Cross-verification of information was

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performed through follow-up discussions with supervisors to ensure consistency between reported practices and documented procedures. Furthermore, analytical findings were reviewed and validated through discussions with operational stakeholders to confirm their practical relevance and accuracy. These steps were undertaken to strengthen methodological rigor and ensure the reliability of the research conclusions. All conceptual models, rich pictures, Pareto diagrams, and fishbone diagrams presented in this study were developed and constructed by the authors based on empirical data collected at PT. XYZ, unless otherwise stated.

IV. Results and Discussion

4.1. Soft System Methodology Stage

The discussion can be made in several sub-chapters. Soft Systems Methodology is a research methodology that tends more towards synthesis than analysis. Soft System Methodology draws a strong distinction between the real-world problematic situation and the conceptual world of systems thinking. The discussion can be made in several sub-chapters. Soft System Methodology in the quality improvement of the packaging of wheat flour:

4.1.1. Stage One: Situation considered problematic

An overview of the problem situation is the amount of flour packaging that must be reworked. So, quality control is needed on 25 kg flour packaging.

4.1.2. Stage Two: Rich Picture of quality control of packaging of wheat flour

To approach a problematic situation, namely, introducing oneself to the situation faced later in the process and its structure, the community involved, goals and desires, relationships between them, hierarchical structure or strength, and sources of data and information. The application of SSM involved drawing a rich picture of the problem in an unstructured form. (Zarezadeh, 2024). The most effective way to describe the situation is to present it as a rich picture diagram.

Figure 3. Rich Picture of quality control of wheat flour
Source: Developed by the authors (2025).

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4.1.3. Stage three: Root Definitions

Table 1. Order of CATWOE work

Definition	Who
C (client)	Consumers, food producers
A (actor)	Flour food factory company, government policy, foodstuff supplier, packaging
T (transformation)	Repairing defective wheat flour packaging
W (weltanshauung)	Control of flour packaging quality to reduce rework.
O (owners)	The owner of a flour company
E (environment)	Food product standardization: Law No. 7/1996 concerning food, Law No. 69 / 1999 concerning food labeling and advertising, government regulation No. 28 concerning food quality and nutrition packaging, RI Minister of Health Regulation No.329 / Menkes / XII / 76 concerning food production and distribution, International Regulations on food, namely the FDA regarding the use of plastics and additives

The cited national and international food regulations are essential because they establish minimum safety, labeling, and packaging integrity standards required in the food manufacturing industry. Compliance with these regulations ensures that packaging materials do not contaminate food products, that labeling provides accurate consumer information, and that packaging systems maintain product quality throughout distribution. For readers unfamiliar with Indonesian food regulations, these legal frameworks function similarly to international food safety standards by defining acceptable materials, hygienic production practices, and consumer protection requirements. Therefore, packaging defect reduction is not merely an internal quality objective but a regulatory necessity.

CATWOE of quality control of wheat flour. Roof definitions :

(P) Many packages need to be redone due to defects in the packaging of 25 kg flour.
(Q): Identify defective packaging.
(R) : Known causes of defects in packaging 25 kg of flour.

Through CATWOE (Customer, Actor, Transformation, Weltanschauung, Owner, Environment) analysis, companies can understand the operational context from the perspectives of the various parties involved. (Saputri & Sriwana, 2024). A CATWOE analysis provides a framework for the right picture in conceptual modeling. The conceptual model is based on the relevant factors to achieve the goal. The sequence for working on CATWOE is as follows:

4.1.4. Stage four: Conceptual Models of Quality Control of Wheat Flour

The developed conceptual model is structured to reflect the company's operational realities, thereby facilitating systematic problem identification and supporting more targeted corrective actions. Based on the activities described, some elements can form a conceptual model. The following is a conceptual model for controlling the quality of flour packaging.

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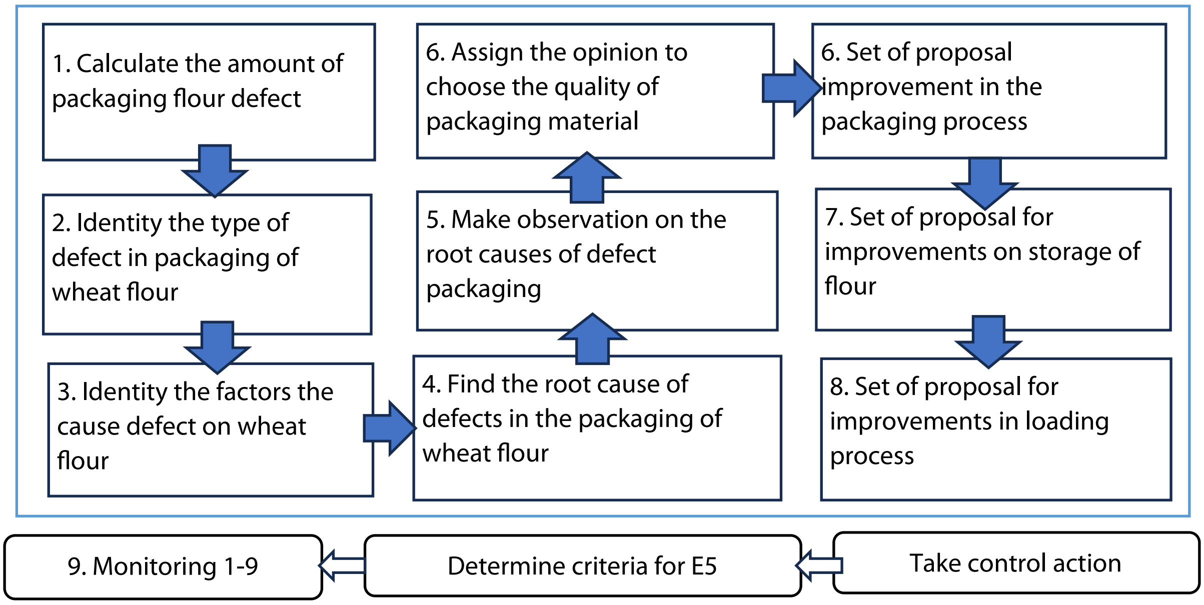

Figure 4. Building a conceptual model of quality control of wheat flour
Source: Developed by the authors (2025).

Validate the conceptual model by looking at the 5E performance measurement criteria :

E1 = Efficacy: The process of transformation by making suggestions for improvements in the packing process, loading, storage, and packaging materials to get good quality packaging.

E2 = Efficiency: Using existing resources, both human resources, machinery, materials, and working methods to the maximum to get optimum output.

E3 = Effectiveness: Produces output in the form of packaging of flour that is not defective, so it can reduce repetition and increase productivity.

E4 = Elegance: Improvement efforts on flawed flour packaging are driven by continuous improvement.

E5 = Ethicality: Improving the quality of flour packaging while taking into account the standardized ethics of using quality and harmless packaging materials.

The completion of the conceptual model does not conclude the analysis. Instead, it serves as the basis for critical comparison with real operational conditions, which is carried out in the next stage of the SSM process.

4.1.5. Stage five: Back in the real world

After developing the conceptual model in Stage Four, the analysis moves into Stage Five, where the proposed system model is systematically compared with actual operational practices. This transition marks a shift from the conceptual domain of systems thinking to empirical validation within the real-world production environment. A comparison of models with problem situations is shown in Table 2.

Table 2. Activity Model Conceptual in the Real World

Activity conceptual model	Terms	Instrument	Step by step	Output
Reducing rework on 25 kg flour packaging	Collect data on production	Food product standardization: Law No. 7/1996 concerning food, Law No. 69/1999 concerning food labeling and advertising,	Identifying the types of defects in packaging, identifying the root	Establish proposed improvements to the

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Activity conceptual model	Terms	Instrument	Step by step	Output
	and total rework	Government Regulation No. 28 concerning food quality and nutrition packaging, International Food Regulation, namely the FDA, concerning the use of plastics and additives	causes of packaging defects, and planning efforts to improve the packaging of flour, 25 kg	packaging of 25 kg wheat flour.

4.1.6. Stage six: Define the changes to be implemented

Based on the conceptual model's activity, the expected goal is to improve flour packaging to reduce rework. Namely, by conducting quality control analysis using the soft systems methodology to improve the company's productivity.

Table 3. Implement appropriate and desirable changes

The activity	Terms	Device	Step by step	Output
Reducing rework on 25 kg flour packaging	Collect data on production and total rework	Food product standardization: Law No. 7/1996 concerning food, Law No. 69/1999 concerning food labeling and advertising, Government Regulation No. 28 concerning food quality and nutrition packaging, International Food Regulation, namely the FDA, concerning the use of plastics and additives	Processing data to identify types of defects in packages with Pareto diagrams, Identify the root causes of packaging defects with the fishbone method. Analyze the highest level of disability with the Failure Mode and Effects Analysis approach. Determine Value Priority for troubleshooting. Planning efforts to improve the packaging of 25 kg wheat flour	Action Planning for failure mode from analysis results.

4.1.7. Stage seven: Taking action

Wheat flour that has been blended and stored in silo packing will then be packed into polypropylene sacks. From the silo, the flour will be weighed before packing. After weighing, the flour will be placed into the carousel, which serves as a packing machine. Wheat flour packaging damaged by the above causes the product to be unable to be marketed. For this reason, wheat flour will undergo a rework process, reproducing it and replacing the packaging.

4.2. Data Processing

A Pareto diagram is a bar diagram that specifically prioritizes problems by category and compares them from largest to smallest, with 80% (most problems) originating from 20% fewer causes. The main problem is illustrated in the diagram.

Table 4. Data on types of defects and percentages

Characteristic of a defect	The number of defects	Comparatif (%)	Cumulatif (%)
Impaled Forklift	53	8.11	8.11
Damaged by leaking from the seams	337	51.60	59.71

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Characteristic of a defect	The number of defects	Comparatif (%)	Cumulatif (%)
Damaged when Loading	237	36.29	96.00
Damaged by rainwater	26	4.00	100,00
Total	653		

In processing this data, researchers use Pareto diagrams to identify the dominant causes of defective products and fishbone diagrams to identify the root causes. A Pareto diagram of the characteristics of defects can be seen in Figure 5

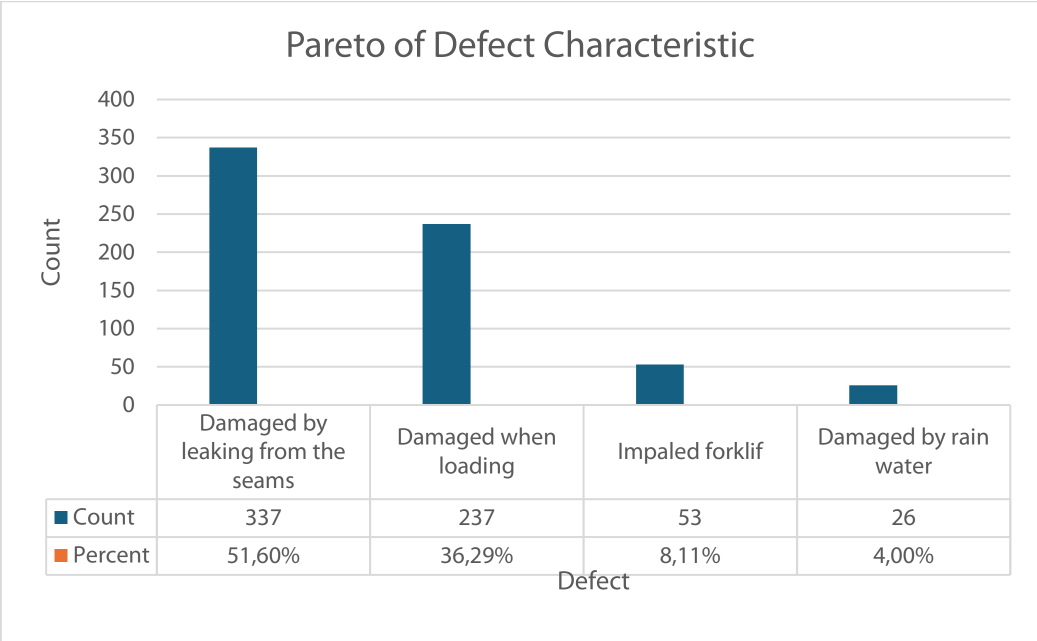

Figure 5. Pareto of Defect Characteristic
Source: Developed by the authors (2025).

The Pareto diagram above shows that the most dominant defect occurred in the product packaging: 51.60% leaked from the seams, and 36.29% were torn during loading. Thus, packaging that leaks from seams or tears during loading will be the priority for addressing the problem. The concentration of defects in two dominant categories (87.89%) is consistent with the Pareto principle widely reported in manufacturing quality studies (Chiarini, 2017; Montgomery, 2020). Similar patterns have been observed in food processing industries where a limited number of failure modes account for the majority of quality deviations (Antony et al., 2019). However, unlike studies that focus primarily on statistical prioritization, this research extends the analysis by embedding defect categorization within a systemic improvement cycle through SSM. This distinction allows for deeper exploration of organizational feasibility alongside technical prioritization.

4.3. Root Cause Analysis

Fishbone diagrams are a tool for identifying causal factors that influence the quality characteristics of a work outcome. This fishbone diagram is based on the number of dominant defects observed in wheat flour product packaging in the previous Pareto diagram and on the damage caused by leaking from the seams in Figure 6. The fishbone diagram above explains the cause of the defect in the package, which led to leakage from the seam. The cause of this defect is influenced by the 4M factors and the E factor, namely Man, Machine, Method, Material, and Environment. The dominance of human factors in both seam leakage and loading damage aligns with contemporary quality management literature, which emphasizes the role of behavioral

ISSN [Online]: 2776-6381

and organizational variables in defect occurrence (Sony et al., 2021). Fatigue, time pressure, and inadequate procedural reinforcement are commonly associated with increased operational errors in manufacturing systems. From a systems perspective, human error should not be interpreted solely as individual negligence but as a symptom of structural conditions such as workload imbalance, insufficient ergonomic design, or unclear performance targets. Therefore, the findings suggest that sustainable defect reduction requires organizational-level intervention rather than isolated operator correction.

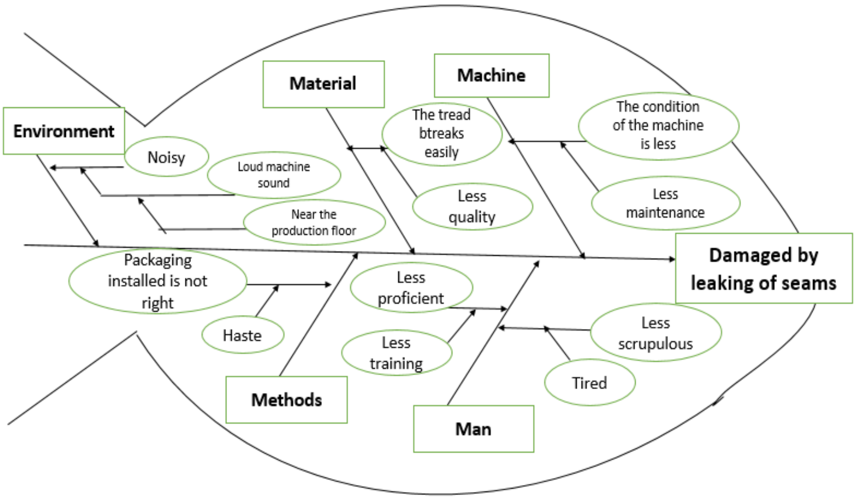

Figure 6. The fishbone diagram was damaged by leaking from the seams
Source: Developed by the authors (2025).

The issue is caused by human factors: the operator is not careful to monitor the engine condition or to properly install product packaging on the packing machine. Tired operators cause this inaccuracy. The lack of maintenance on the machine is the reason the packaging process is not neat. Unmanaged machines can shorten engine life and hamper production. Other contributing factors include poor-quality materials. The material in this study is yarn; the easily broken threads are the cause of the leaked product packaging that has been sewn. In the case of work methods, product defects are caused by improper packaging on the machine due to rushed operator activity. Causes of damage when Loading :

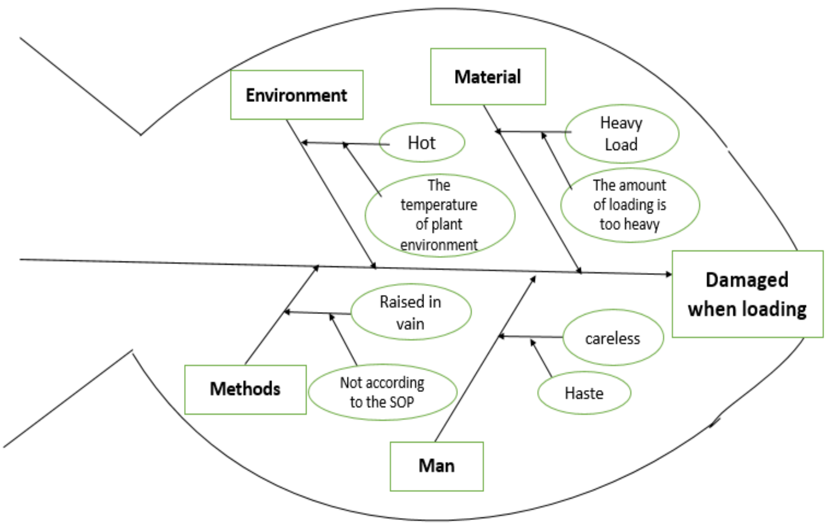

Figure 7. The fishbone diagram caused damage when Loading
Source: Developed by the authors (2025).

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Based on fishbone diagrams that occur on torn packages during loading, it appears that the factors causing damaged packaging are influenced by 3M + 1E. When loading, the engine is not used during operation, so in the fishbone diagram to find the cause of torn packaging, exclude machine factors. The cause of the product defect was the operator's haste when loading wheat flour into the truck, which led to flour spilling from the truck and the packaging becoming damaged. Another cause of method factors is improper product lifting, which does not comply with the SOP. The environment's temperature also influences this condition; it is hot, so the operator is out of work while working. The packaging that is torn during loading must also be identified as the cause of the defect in wheat flour products.

Table 5. Plans to Repair Packaging Shredded When Loading

Failure	Causes	Solution	Design Validation
The operator is not careful.	Operators rush to pursue loading targets	Make target limits on loading operators	Make a loading schedule for each operator
Noisy work environment	The work environment is not comfortable	Provides sound absorbers	Discipline operators to use earpacks
Poor lifting technique	There is no SOP	Make the appropriate appointment SOP	Periodically inspect SOPs
The burden is too heavy.	Load weight is not recommended	Make a tool for loading	Use tools for loading

4.4. Improvement of Packaging

Based on the analysis of the Soft Systems Methodology, it is evident that the packaging of wheat flour presents various types of disabilities. First, repair the leaky package from the seams. Human factors are the primary cause of packaging leaks at seams. The improvements made are to make optimal working hours, namely by giving 10 minutes to rest every 2 hours. One cause of operator inaccuracy is work fatigue. When there is 10 minutes of rest every 2 hours, it is expected to reduce leaky packaging from seams and help companies save on quality costs, namely the costs of controlling product quality and inspection. Second, repair torn packages when loading. In packaging that is torn during loading, the most significant risk factor is humans. Rushed operator activities at work increase the risk of product packaging falling from the top of the truck. For this reason, an improvement proposal is made to create a loading schedule for each operator, targeting each operator's loading limits.

The findings of this study are consistent with previous research, which emphasizes that human factors and procedural non-compliance are dominant contributors to packaging defects in food manufacturing (Antony et al., 2019; Sony et al., 2021). However, unlike prior studies that primarily focus on statistical defect reduction, this research demonstrates that integrating systemic problem structuring through SSM enhances the sustainability of corrective actions. The results do not contradict existing quality management theory; instead, they reinforce the argument that sustainable defect reduction requires alignment between technical controls and organizational behavior. This confirms Sterman's (2018) systems thinking perspective that operational failures are often manifestations of interconnected structural issues rather than isolated technical errors. Beyond operational efficiency, the proposed improvements have significant implications for consumer safety and satisfaction. Packaging leakage in wheat flour products may expose the product to contamination, moisture intrusion, and microbial risks, potentially compromising food safety standards. By reducing seam leakage and handling damage, the company strengthens product integrity throughout storage and distribution. Improved packaging reliability enhances consumer trust, minimizes the likelihood of product rejection in the supply chain, and supports compliance with food safety regulations. Therefore, the impact of this study extends beyond defect reduction and contributes directly to maintaining public health standards and strengthening brand credibility in competitive food markets.

V. Conclusion

This study identified seam leakage and loading damage as the primary contributors to packaging defects in 25 kg wheat flour sacks. These defects were found to significantly affect product quality and operational efficiency, highlighting the need for systematic corrective actions within the packaging process. By integrating Pareto analysis, fishbone diagrams, and Failure Mode and Effects Analysis (FMEA) within the Soft Systems Methodology (SSM) framework, the research demonstrates that defect recurrence is influenced by both technical and human and organizational factors. This confirms that quality-related problems in industrial operations are multidimensional and require holistic, system-based interventions rather than purely technical solutions. The findings support existing quality management theories emphasizing systemic improvement and extend their practical contribution by operationalizing SSM in an industrial packaging context. Based on the analysis, several improvement strategies are recommended, including ergonomic workstation adjustments, enhanced material selection, strengthened supervision, and stricter procedural enforcement. These proposed actions are both technically feasible and organizationally applicable, ensuring sustainable quality improvement. Future studies are encouraged to apply similar systems-based quality improvement approaches to other production lines or food manufacturing environments in order to validate the broader applicability and long-term effectiveness of this integrated methodology. The authors would like to express their sincere appreciation to PT. XYZ Flour Mills for the valuable support, opportunity, and collaboration provided throughout the implementation of this study.

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