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Demand Uncertainty and Manual Packaging System Toward Supply Chain Resilience

Ni Putu Nita Astri Lestari, Agus Purnomo
Universitas Logistik dan Bisnis Internasional, Bandung, Indonesia
e-mail: nitaastri662@gmail.com

Abstract

Supply chain resilience is a challenge for manufacturing companies amidst market demand uncertainty and operational limitations, one of which is the manual packaging system at PT. Songgolangit Persada, a manufacturing industry producing EM4 fishery probiotics. The study was conducted to determine how demand uncertainty, manual packaging systems, and supply chain resilience at PT. Songgolangit Persada. Data were collected by distributing questionnaires filled out by 50 respondents of PT Songgolangit Persada production staff and quantitative methods. Data were analyzed using SmartPLS 3. The analysis stated that demand uncertainty was not significant with supply chain resilience with a p-value of 0.905 (> 0.05). The manual packaging system had a significant negative effect with a p-value of 0.000 (< 0.05). Limitations in operational technology at the packaging stage can be a factor that reduces supply chain resilience. This study provides a theoretical contribution to the supply chain management literature by combining two important operational factors. Practically, these results provide implications that modernizing packaging systems and investing in automation technology are important strategies to improve supply chain efficiency and adaptability. Future research could explore additional variables such as the use of automation technology and risk mitigation strategies within the broader context of supply chain disruptions.

Keywords: *Demand uncertainty, manual packaging system, PT. Songgolangit Persada, supply chain resilience*

INTRODUCTION

Market demand uncertainty has increasingly become a crucial challenge for manufacturing industries, driven by rapid consumer trend shifts, economic fluctuations, and external disruptions such as global crises and pandemics. These dynamics create instability across supply chain operations, affecting production continuity, delivery accuracy, and customer service performance. Manufacturing companies that still rely on manual operational systems particularly manual packaging processes face greater risks of inefficiency and vulnerability in their supply chain performance.

PT. Songgolangit Persada, a manufacturing company that produces EM4 fishery probiotics in Indonesia, exemplifies these challenges. The company's dependence on manual packaging systems and its exposure to fluctuating demand have raised concerns regarding its supply chain resilience. Supply chain resilience refers to the system's ability to withstand, adapt to, and recover from disruptions. Achieving such resilience requires a deep understanding of internal and external factors that may weaken the system's stability and responsiveness.

Manual packaging systems tend to increase operational complexity, as they are prone to human errors, slower throughput, and limited adaptability to rapid market changes. Previous

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studies, such as Kusrini and Resti [1] have shown that small and medium enterprises in Indonesia often experience delays and inefficiencies due to manual handling at the packaging stage. Meanwhile Pettit, Fiksel, and Croxton [2] emphasize the importance of responsiveness and adaptability in managing global supply chain risks. Similarly, Wieland and Durach [3] propose the "Persist–Adapt–Transform" framework as a resilience model to navigate long-term disruptions. However, empirical studies linking manual packaging systems directly to supply chain resilience remain scarce, particularly within the context of high market uncertainty.

This research addresses that gap by evaluating how demand uncertainty and manual packaging systems both individually and interactively affect the supply chain resilience of PT. Songgolangit Persada. Unlike previous studies that often focus on a single operational variable, this study simultaneously examines two key factors that influence resilience from both external and internal perspectives. It highlights real operational issues in a developing-country manufacturing context, where manual processes are still predominant. The study aims to contribute theoretically by providing new insights into how internal operational limitations interact with external uncertainties to shape resilience. Practically, the results are expected to offer strategic recommendations for improving operational efficiency through modernization and gradual automation of packaging systems. Strengthening these systems is essential for enhancing flexibility, minimizing risks, and ensuring the company's long-term sustainability amid growing uncertainty in the global market.

METHOD

This research employed a quantitative explanatory approach to examine the causal relationship between demand uncertainty, manual packaging systems, and supply chain resilience at PT. Songgolangit Persada. The study aims to identify the extent to which operational factors influence the company's ability to maintain stability and adaptability under fluctuating market conditions. The research was conducted at PT. Songgolangit Persada, a manufacturing company producing EM4 fishery probiotics. The explanatory quantitative design was selected because it allows the testing of hypotheses and relationships among variables through statistical analysis.

Research Design

The study utilized a quantitative explanatory method to determine the effect of demand uncertainty (X1) and manual packaging system (X2) on supply chain resilience (Y). The model was developed based on the theoretical framework and previous studies related to operational management and supply chain performance [4], [5].

Data Source and Sampling Technique

The research used primary data collected through questionnaires distributed to 50 respondents, consisting of production managers, supervisors, and production staff at PT. Songgolangit Persada. These respondents were selected purposively because they are directly involved in the company's production and packaging processes. The sample size was determined using the 10-times rule, which recommends a minimum of ten observations per indicator used in the model. The total indicators consisted of three for demand uncertainty, four for manual packaging systems, and four for supply chain resilience, resulting in a minimum requirement of 40 respondents. The total of 50 participants thus fulfilled and exceeded the minimum sample size

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requirement.

Research Instrument

The research instrument was a structured questionnaire using a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The indicators for each variable were adapted from previous validated studies and adjusted to the operational context of PT. Songgolangit Persada. The questionnaire measured respondents' perceptions regarding fluctuations in demand, the performance of manual packaging systems, and the company's resilience in managing supply chain disruptions.

Data Analysis Technique

Data were analyzed using SmartPLS 3 software. The analysis process consisted of two stages, namely outer model and inner model testing.

1. Outer Model Evaluation

The outer model was assessed to determine the validity and reliability of the constructs. Indicators with a loading factor greater than 0.70 were considered valid. The Average Variance Extracted (AVE) value above 0.50 indicated convergent validity, and Composite Reliability (CR) greater than 0.70 confirmed internal consistency. Discriminant validity was verified using the Heterotrait-Monotrait (HTMT) ratio, which should be below 0.90.

2. Inner Model Evaluation

The inner model tested the structural relationships among variables by examining path coefficients and t-statistics obtained through bootstrapping with a 95% confidence level. The R-square (R^2) value measured the strength of the model's explanatory power, categorized as weak (0.25), moderate (0.50), and strong (0.75).

Operational Definition of Variables

a. Demand Uncertainty (X1) refers to fluctuations and unpredictability in customer demand that affect production planning, inventory control, and overall operational stability.
b. Manual Packaging System (X2) represents the manual execution of packaging processes by production staff, including efficiency, worker skills, and the potential for human error.
c. Supply Chain Resilience (Y) indicates the company's capability to anticipate, respond to, and recover from disruptions while maintaining operational continuity and product delivery.

RESULTS AND DISCUSSION

This section presents the results of data analysis and the discussion based on the findings obtained from the survey conducted among 50 production employees of PT. Songgolangit Persada. The analysis was carried out using SmartPLS 3 to evaluate the outer and inner models of the structural equation model. The results describe the relationships among demand uncertainty, manual packaging systems, and supply chain resilience. Most employees had two to three years of service, indicating a relatively experienced workforce in the production line. The age range of respondents varied from 21 to 47 years, which shows that the company employs both young and senior workers.

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Outer Model Analysis

The outer model test was conducted to determine the validity and reliability of the constructs. All indicators had loading factor values above 0.70, showing that each indicator strongly represents its respective variable. The results of validity and reliability testing are presented below.

Table 1. Results of validity and reliability testing

Variable	Cronbach's Alpha	Composite Reliability	AVE	Description
Demand Uncertainty	0.812	0.875	0.701	Reliable and Valid
Manual Packaging System	0.777	0.856	0.599	Reliable and Valid
Supply Chain Resilience	0.962	0.972	0.898	Reliable and Valid

(Source: author's analysis (2025))

AVE value for each variable exceeded 0.50, confirming convergent validity. The discriminant validity test (Fornell-Larcker Criterion) also indicated that the square root of AVE for each construct was higher than the correlation among constructs, confirming that the three variables are distinct and independent.

Inner Model Analysis

The inner model analysis was used to test the relationship between demand uncertainty and manual packaging systems with supply chain resilience. The model demonstrated a strong explanatory power, with an R^2 value of **0.777**, meaning that 77.7% of the variance in supply chain resilience can be explained by the two independent variables, while 22.3% is explained by other factors outside the model.

Table 2. Hypothesis Testing Results

Hypothesis	Relationship	Path Coefficient (β)	t-Statistic	p-Value	Result
H1	*Demand Uncertainty → Supply Chain Resilience*	0.015	0.120	0.905	*Rejected*
H2	*Manual Packaging System → Supply Chain Resilience*	0.871	8.345	0.000	*Accepted*

(Source: author's analysis (2025))

The results show that demand uncertainty does not have a significant effect on supply chain resilience (p-value = 0.905 > 0.05). In contrast, the manual packaging system has a strong and significant positive effect on supply chain resilience (p-value = 0.000 < 0.05). These findings indicate that the internal operational factor specifically the packaging process plays a more decisive role in strengthening resilience than external market fluctuations. The insignificant relationship between demand uncertainty and supply chain resilience suggests that PT. Songgolangit Persada has developed sufficient adaptability to respond to fluctuations in market demand. The company's internal mechanisms, such as production planning and inventory

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management, appear capable of buffering against demand variations, thus minimizing their direct impact on supply chain performance. This result aligns with the findings of [10] who argued that strong internal control mechanisms can mitigate the effects of external volatility on supply chain outcomes. Conversely, the significant effect of the manual packaging system on supply chain resilience demonstrates that operational efficiency at the packaging stage is a critical determinant of the company's ability to sustain performance during disruptions. A well managed manual packaging process enhances workflow consistency, minimizes errors, and accelerates product readiness for distribution. This supports the argument by [9] that internal process optimization directly contributes to operational stability and resilience in manufacturing contexts. The findings imply that the efficiency of manual packaging systems is an essential internal factor that strengthens supply chain resilience. Improving packaging practices through worker training, standardization of operating procedures, and gradual adoption of semi-automated systems can significantly enhance the company's adaptability and response capacity. While demand uncertainty was not statistically significant, it should not be overlooked. Continuous monitoring of market trends and adaptive demand forecasting can help the company anticipate changes more accurately. Future research may include additional variables such as automation technology adoption or supplier risk management to provide a broader understanding of supply chain resilience mechanisms.

CONCLUSION

This study aimed to evaluate the influence of demand uncertainty and manual packaging systems on supply chain resilience at PT. Songgolangit Persada. Based on the results of statistical analysis using SmartPLS 3, it was found that demand uncertainty did not have a significant effect on supply chain resilience, while the manual packaging system showed a strong and significant positive effect. These findings highlight that internal operational factors particularly the effectiveness of the packaging process play a more decisive role in building supply chain resilience than external market fluctuations. The insignificant impact of demand uncertainty suggests that the company has developed adaptive internal mechanisms capable of stabilizing operations despite changes in customer demand. Conversely, the significant influence of the manual packaging system indicates that process efficiency, worker skill, and packaging accuracy are crucial in ensuring the continuity and reliability of the supply chain. In practical terms, PT. Songgolangit Persada is encouraged to focus on improving its packaging processes through continuous employee training, standardization of operating procedures, and gradual adoption of semi-automated packaging technologies. Strengthening these aspects can increase operational stability, reduce errors, and enhance responsiveness to disruptions. From an academic perspective, this study contributes to the literature on supply chain management by demonstrating the critical role of internal operational factors in resilience building within manufacturing industries. Future research may include additional variables such as automation technology adoption, supplier risk mitigation strategies, and external environmental uncertainties to provide a more comprehensive understanding of supply chain resilience mechanisms.

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