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The Impact of Supply Chain Management on Water Distribution: Literature Review

Bagus Dwi Kuntoro, Muhammad Ilham Wahyudi, Didi Andriawan
Universitas Sapta Mandiri, Balangan, Indonesia
Email: bagusdwykuntoro@gmail.com, ilhamwahyudi971@gmail.com, didi@itsmandiri.ac.id

Abstract

This study aims to analyze the effect of Supply Chain Management (SCM) on the effectiveness of water distribution in a clean water provider company, in this case PT Air Minum Tabalong Bersinar (Perseroda) in the urban area of Tabalong Regency. Facing challenges such as distribution delays, water loss, and demand fluctuations, SCM implementation can improve efficiency and service. The study used a quantitative approach with a survey method involving 130 respondents, consisting of employees and customers of PT Air Minum Tabalong Bersinar (Perseroda). The independent variables include raw water supply, inventory management, distribution, and information technology, while the dependent variable is the effectiveness of water distribution. Data analysis was carried out using multiple linear regression in SPSS version 25. The results showed that the four SCM variables simultaneously and partially had a significant effect on distribution effectiveness. The distribution component had the dominant influence, followed by inventory management and information technology. An R^2 of 68.7% indicated that this analysis model could explain most of the variation in distribution effectiveness. These findings emphasize the importance of SCM integration, especially in distribution management and information systems, to improve timeliness, service quality, and customer satisfaction. This research provides practical contributions to management in designing more adaptive and efficient supply chain-based distribution strategies. Recommendations are directed at increasing the use of technology and strengthening relationships with stakeholders.

Keywords: Supply Chain Management, Water Distribution, Effectiveness, Distribution, Information Technology.

Corresponding: Bagus Dwi Kuntoro
E-mail: bagusdwykuntoro@gmail.com

INTRODUCTION

water is a basic human need that must be continuously available, both in terms of quantity and quality. In Indonesia, efforts to reliably distribute water are becoming increasingly crucial as increasing urbanization, population growth, and climate change disrupt the availability of raw water sources (Asrol, 2024; Kementerian PUPR, 2020; Velani et al., 2023). Although various policies have been implemented by the government through the Regional Water Company (PDAM) and other State/Regional Owned Enterprises, various challenges in terms of distribution delays, water loss (non-revenue water), and supply-demand imbalances still frequently occur (Abebe, 2024; Bappenas, 2020; Pagano et al., 2025).

To address these challenges, a supply chain management (SCM) approach is highly relevant (Asrol, 2024; Du, 2022). SCM is an integrated process that efficiently manages the flow of products, information, and funds from initial suppliers to end consumers (Chopra & Meindl, 2016; Velani et al., 2023). In the context of water distribution, SCM encompasses raw water source planning, treatment processes, clean water storage, inventory control, and distribution to end consumers. Inefficient management at any of these stages can lead to untimely distribution, decreased water quality, and even financial losses.

Previous research has shown that systematically implementing SCM can improve distribution efficiency and reduce distribution costs in various sectors, including public services (Christopher, 2011). However, studies on the specific impact of SCM in the context of water distribution in Indonesia are still very limited. This is despite the unique characteristics of water distribution, such as limited natural resources, complex infrastructure, and strict regulations (Pagano et al., 2025).

Therefore, this study aims to empirically analyze the impact of implementing Supply Chain Management principles on the effectiveness of water distribution in urban areas. The main focus of this study covers four SCM components: raw water supply management, distribution systems, inventory management, and the use of information technology (Abebe, 2024; Du, 2022; Velani et al., 2023). It is hoped that the results of this study can provide practical contributions to policymakers and water distribution managers in improving the quality of public services.

Supply Chain Management (SCM) is a systematic approach that manages the flow of goods, information, and finances across a network of organizations, from raw material suppliers to end consumers (Chopra & Meindl, 2016; Velani et al., 2023). SCM not only focuses on internal company operations but also coordinates and integrates processes across organizations to create value for customers (Christopher, 2011). In the context of public services like water supply, SCM plays a critical role by coordinating water resources, processing, infrastructure management, and equitable distribution. It also includes an IT component that connects suppliers, producers, distributors, and consumers through data links. Water distribution is the process of delivering processed water from production facilities to end consumers via pipelines or other methods (Darmasetiawan, 2025).

This study aims to examine the impact of the implementation of Supply Chain Management (SCM) on water distribution, focusing on how SCM principles can improve efficiency, reduce waste, and improve the accuracy and quality of water distribution. Through a literature review, this study will explore the relationship between supply chain management and water distribution performance, as well as the role of technologies such as IoT in supporting operational integration in distribution systems. The benefit of this research is to provide a better understanding of the application of SCM in the water distribution sector, which can be the basis for water supply companies to optimize resource management, improve customer service, and improve operational efficiency. In addition, this research is also expected to provide useful insights for public policy in supporting more sustainable and efficient management of water resources.

RESEARCH METHOD

This study used a quantitative approach with an explanatory research approach, aiming to explain the causal relationship between Supply Chain Management (SCM) variables and the effectiveness of water distribution. This study was conducted using a structured questionnaire survey of respondents directly involved in the water distribution process.

The research was conducted at an urban water provider, PT Air Minum Tabalong Bersinar (Perseroda) in Tanjung City, and included interviews with several customers (both household and commercial). The study was conducted over three months, from January to March 2024.

The population in this study consists of two groups. The first group consists of employees of PT Air Minum Tabalong Bersinar (Perseroda) involved in supply chain activities, such as distribution, operations, planning, and IT. The second group consists of household and industrial customers who receive water distribution services from PT Air Minum Tabalong Bersinar (Perseroda).

The sampling technique used purposive sampling, with the following criteria. Employees of PT Air Minum Tabalong Bersinar (Perseroda) who have worked for at least one year in the operational or distribution unit and customers who have used the water service for at least the past six months. The sample size consisted of 30 respondents from PT Air

Minum Tabalong Bersinar (Perseroda) employees 100 respondents from household and industrial customers. The research variables used in this study are as follows:

Table 1. Research Variables

Variable Type	Variable Name	Key Indicators
Independent	Supply Chain Management (SCM)	Raw Water Supply
		Inventory Management
		Distribution Systems
		Information Technology
Dependent	Effectiveness of Water Distribution	Water Distribution Accuracy and Durability
		Water Quality at the Most Distant Point
		Distribution Costs
		Customer Satisfaction

Source: BPKP report of South Kalimantan Province on the performance and finances of PT Air Minum Tabalong Bersinar (Perseroda) in 2024

In this case, each indicator is measured using a Likert Scale of 1–5 (1 = strongly disagree, 5 = strongly agree). According to (Sugiyono, 2016), the Likert Scale is a scale used to measure respondents' attitudes towards an object of attitude, opinion, or perception. There are several data collection techniques. The first is a questionnaire; administered to both groups of respondents to gauge their perceptions and experiences regarding the SCM process and water distribution. The second is a semi-structured interview; conducted with 3 (three) Operational Managers to obtain supporting qualitative information.

Secondary data was taken from the annual performance report of the distribution unit of PT Air Minum Tabalong Bersinar (Perseroda), customer data, and records of water loss (non-revenue water). Then, for data analysis techniques, Validity and Reliability Tests were used aims to assess the quality and consistency of problem generation tests used in creativity research (Abdulla Alabbasi et al., 2025); To ensure that the questionnaire instrument is suitable for use.

The validity test used Pearson correlation which refers to a statistical measure used to measure the strength and direction of the linear relationship between two quantitative variables, such as between problem finding (PG) test scores and divergent thinking (DT) or creative achievement scores (Abdulla Alabbasi et al., 2025), According to (Malkewitz et al., 2023) while reliability used Cronbach's Alpha (values > 0.7 are considered reliable) and Multiple Linear Regression Analysis is a classical statistical technique used to predict the value of a dependent variable based on the values of two or more independent variables (Lu et al., 2025); Used to test the simultaneous and partial influence of SCM variables on distribution effectiveness.

The regression equation used: $Y=\beta0+\beta1X1+\beta2X2+\beta3X3+\beta4X4+\varepsilon$, wherein;

Table 2. Regression Equation

Variables		Equation
Y	=	Effectiveness of Water Distribution
β_0	=	Constant/Intercept Regression
X1	=	Raw Water Supply
β_1	=	The coefficient of influence of X_1 on Y
X2	=	Inventory Management
β_2	=	The coefficient of influence of X_2 on Y
X3	=	Distribution Management
β_3	=	The coefficient of influence of X_3 on Y
X4	=	Information Technology
β_4	=	The coefficient of influence of X_4 on Y
ε	=	Error/Residual

Hypothesis Testing:
[t] test to see the partial influence of variables;
[F] test to see the effects simultaneously;
Coefficient of Determination (R^2) test to measure the magnitude of the influence of SCM on distribution effectiveness.
Data processing was carried out using the SPSS version 25 application.

RESULTS AND DISCUSSION

This study involved 130 respondents, consisting of 30 employees of PT Air Minum Tabalong Bersinar (Perseroda), most of whom worked in the operational and distribution units (60%), while the remainder worked in procurement management, information technology, and other departments. The study also involved 100 customers, (80%) of whom were residential customers and (20%) were commercial customers (restaurants and small hotels). The majority of respondents stated that they experienced delays in air distribution at least once a month, and (35%) complained about changes in air quality during the dry season.

Based on the validity and reliability test results, all questionnaire items had correlation values >0.30, thus being declared valid. Therefore, the Cronbach's alpha values for each variable are as follows:

Table 3. Cronbach's Alpha Value for Each Variable

Variable	Value
Raw Water Supply	0,842
Inventory Supply	0,813
Water Supply Distribution	0,876
Information Technology	0,853
Distribution Effectiveness	**0,861**

following the results above, all values of each variable are > 0.7, so the instrument is declared reliable. Then, for the results of the Multiple Linear Regression Analysis using the Regression Model and entering the numbers, the results are as follows:

$$\mathbf{Y = 2{,}114+0{,}271X^1+0{,}256X^2+0{,}415X^3+0{,}309X^4+\varepsilon}$$

It is known that the average value of the questionnaire results for variables $X^1 - X^4$ for each variable is as follows:

$$\mathbf{Y = 2{,}114+0{,}271X^1+0{,}256X^2+0{,}415X^3+0{,}309X^4+\varepsilon}$$
$$\mathbf{Y = 2{,}114+0{,}271(4.0)+0{,}256(3.8)+0{,}415(4.2)+0{,}309(4.0)}$$
$$\mathbf{Y = 2{,}114+1{,}084+0{,}9728+1{,}743+1{,}236}$$
$$\mathbf{Y = 2{,}114+5{,}036}$$
$$\mathbf{Y = \boxed{7{,}1498}}$$

Based on the results of the calculations above, the **Y** value or Effectiveness of Water Distribution is **7,1498**.

Statistical Test Results:
• R^2 = 0.687 → meaning 68.7% of the variation in distribution effectiveness is explained by the four SCM variables.
• [F]-Test: F = 23.876, p-value = 0.000 → the regression model is simultaneously significant.

• Partial [t]-Test:

Table 4. Partial [t]-Test Results

Variable	Partial [t]	p-Value
Raw Water Supply (X_1)	t = 2,312	p = 0,023
Inventory Supply (X_2)	t = 3,115	p = 0,002
Water Supply Distribution (X_3)	t = 4,872	p = 0,000
Information Technology (X_4)	t = 2,801	p = 0,006

(X_3) variable have a significant partial effect on distribution effectiveness. All result and data processing above was carried out using the SPSS version 25 application.

Raw water supply has a positive impact on water distribution. This study found that companies with robust raw water supply infrastructure and pumping components tend to have better operational stability, as evidenced by studies in the water utility sector (Velani et al., 2023). The resilience of the distribution system is largely determined by technical readiness such as pumps, pipes, and raw water sources, as well as well-managed supply partnerships (Abebe, 2024; Pagano et al., 2025). This is in line with the views of (Chopra & Meindl, 2016) and is reinforced by (Du, 2022) and (Asrol, 2024), who stated that information integration and strong relationships between supply chain elements can increase overall reliability and efficiency.

Then, Inventory management plays a significant role in ensuring distribution continuity. For example, PT Air Minum Tabalong Bersinar (Perseroda), for example, has implemented a real-time tank and chemical monitoring system to anticipate processing chemical shortages early (Abebe, 2024; Pagano et al., 2025). These findings reinforce the view that technology-based chemical stock control accelerates response to demand fluctuations (Asrol, 2024; Du, 2022; Gunasekaran et al., 2004). Furthermore, recent studies have shown that digitally integrated inventory management plays a significant role in maintaining the stability of water distribution services (Velani et al., 2023).

Distribution contributed the most (0,876) in the Cronbach's Alpha analysis model and (β_3 = 0,415) in the Regression analysis model, indicating that the fleet, pipeline network, and delivery system are the most critical elements in the effectiveness of water SCM (Asrol, 2024). One of the main problems found in the field is customer complaints about uneven distribution due to pressure drops in the old piping system, which has not been fully integrated with an automatic monitoring system (Abebe, 2024; Pagano et al., 2025). This finding is in line with (Liu et al., 2020) and is reinforced by (Du, 2022), who emphasized that reliable water distribution requires an IoT-based pressure monitoring system to maintain service stability and continuity.

Information technology facilitates coordination and reporting of damage in water distribution systems. For example, PT Air Minum Tabalong Bersinar (Perseroda), has implemented a GIS and SCADA-based system that has proven effective in detecting leaks and controlling network pressure in real time (Abebe, 2024; Pagano et al., 2025). The implementation of this technology aligns with the digitalization trend in SCM in the utility sector, where information technology is a crucial tool for rapid decision-making and integration across operational units (Asrol, 2024; Du, 2022). This supports the findings of (Jayaram & Tan, 2010), which emphasize the role of information systems in supporting supply chain coordination and efficiency. Recent research by (Velani et al., 2023) even shows that the use of digital platforms can reduce response time to technical disruptions by up to 40%. Providing IoT technology for smarter, more efficient, and integrated water distribution supply chain management, supporting supply chain management needs in maintaining the availability and sustainable management of water resources (Devasena et al., 2019).

The four SCM components contribute significantly to the effectiveness of water distribution. Distribution management is the dominant factor, followed by inventory management, information technology, and raw water supply. The practical implication of these results is the need to improve distribution system integration and develop Information Technology (IT) within PT Air Minum Tabalong Bersinar (Perseroda)'s operations to ensure more timely, efficient, and high-quality distribution.

CONCLUSION

The research concludes that Supply Chain Management (SCM) significantly impacts water distribution effectiveness ($Y = 7.1498$), with its four core variables—raw water supply, inventory management, distribution, and information technology—jointly influencing timeliness, quality, and customer satisfaction, wherein distribution management exerts the dominant effect. This underscores the critical role of efficient distribution networks and delivery systems in clean water services. Recommendations include enhancing SCM integration across units, bolstering distribution systems with technologies like GIS and SCADA, strategically developing raw water supply and infrastructure for continuity, and optimizing inventory to handle demand fluctuations during dry seasons or emergencies, ultimately boosting operational efficiency and public service quality. For future research, longitudinal studies could explore the long-term effects of SCM digitalization (e.g., AI-driven predictive analytics) on water distribution resilience amid climate change-induced variability in Indonesian regencies.

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