

Optimizing E-Commerce Logistics in Emerging Markets: A Comparative Evaluation of Fulfillment by DARAZ and Personnel Based Model Using Value Stream Mapping and Fuzzy Delphi Analysis

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Abstract

The rapid growth of e-commerce in emerging markets has created pressing challenges for logistics systems, particularly in balancing delivery speed, reliability, and cost efficiency. This study conducts a comparative evaluation of two fulfillment models employed by Daraz in Bangladesh: Fulfillment by Daraz (FBD) and Fulfillment by Personnel (FBP). The evaluation utilized hybrid research methodology, sequentially integrating several techniques: value stream mapping was employed for process flow visualization, five whys analysis was used to trace operational inefficiencies, and a two-stage fuzzy delphi method quantified the critical logistics factors. FBD driven by centralized automation and optimized warehouse management, achieved superior performance in key metrics, specifically lead time efficiency, delivery reliability, and customer trust. A major trade-off, however, is its association with higher storage costs and reduced packaging flexibility. Conversely, while FBP offers vendors crucial advantages in inventory control and branding autonomy, this model is significantly constrained by issues such as manual delays and weaker overall logistics integration. The fuzzy Delphi evaluation identified eight key determinants-including cost, warehouse location, responsiveness, and on-time delivery-that decisively impact fulfillment efficiency. Overall, FBD emerged as the more effective model for sustaining competitiveness in Bangladesh's dynamic e-commerce environment. The proposed hybrid evaluation framework offers a scalable decision-support tool for logistics strategy optimization in similar developing economies, with implications for future integration of real-time data and hybrid fulfillment solutions.

Keywords

E-commerce, supply chain, value stream mapping, fuzzy delphi method, logistics optimization.

1. Introduction

By 2025, digital sales are expected to reach over USD 1.4 trillion, which is equal to the total global retail sales recorded just five years prior, and account for nearly half of the growth in global retail value, according to Euromonitor (Evans, 2021). There are two main models that e-commerce logistics usually follow: business to business (B2B), where businesses exchange goods or services in large quantities, and business to consumer (B2C), where platforms like Amazon and Daraz handle online ordering and direct dispatch to customers (Yu et al., 2016). The B2C e-commerce model is facing increasing difficulties as businesses must speed up fulfillment to stay competitive due to growing customer expectations for quick, on-demand delivery (Choi et al., 2019). The exponential growth of e-commerce in developing economies, notably Bangladesh, has imposed considerable demands on logistics systems to enhance delivery speed, reliability, and cost efficiency. Evolving consumer expectations, influenced by global e-commerce

incumbents such as Amazon, have established expedited delivery specifically same-day and next-day fulfillment as the industry norm, thereby necessitating the adoption of more agile and responsive logistics frameworks by regional platforms to sustain operational competitiveness and ensure customer loyalty. Although lean methodologies, particularly value stream mapping (VSM) and root cause analysis, have been extensively validated in optimizing logistics performance in developed economies (Forno et al., 2014), there exists a pronounced gap in their empirical application within the logistics ecosystems of developing countries. These environments are frequently characterized by infrastructural inadequacies, labor-intensive processes, and operational fragmentation, which pose distinct constraints on logistics optimization. Furthermore, regional platforms like DARAZ, operating under significantly different regulatory, technological, and infrastructural conditions compared to their global counterparts, remain underrepresented in existing academic discourse. This study seeks to address this critical research gap by conducting a comparative evaluation of two logistics fulfillment models implemented by DARAZ, Fulfillment by DARAZ (FBD) and Fulfillment by Personnel (FBP) (Daraz+, n.d.). Utilizing a combination of VSM, five whys root causes analysis, a Fuzzy Delphi method (FDM), the research aims to identify the more effective operational model in terms of logistical performance. The proposed methodology contributes to the formulation of a scalable decision-support system, with implications for enhancing logistics efficiency across analogous e-commerce platforms in other developing regions. In developing country like Bangladesh, the dominant e-commerce platform offers two types of supply chain operation model-FBD, FBP to fasten the delivery and the business has to choose one of the methods which is suitable for them (Daraz+, n.d.). This study aims to determine the root causes of low sales volume and key logistical factors that influence the performance of the supply chain, hence establish future stream mapping, based on the most suitable logistics strategy.

The rest of this paper is organized as follows. Section 2 provides a literature review related to e-commerce supply chain. The methodology under study is elaborated in Section 3. Section 4 explained the data collection strategies. Section 5 discusses results and evaluation. Finally, conclusions and directions for future studies are detailed in Section 6.

2. Literature Review

Since the 1990s, as information technology has advanced, e-commerce has also changed, moving from simple digital listings to complete online buyer-seller interactions. (Santos et al., 2017) Recent research highlights several critical logistics areas that are essential for achieving success in e-commerce, including Supply Chain Network Design, Outbound and Reverse Logistics, and Warehousing. Key performance indicators (KPIs) and strategic approaches have been identified for each domain, with a growing emphasis on sustainability practices. (Zennaro et al., 2022) Research is needed to address the challenges of integrating online and offline logistics operations effectively. E-commerce and modern logistics have positively affected the development of the regional economy. The freight volume and e-commerce transaction values are closely related to GDP growth, highlighting the need for investment in an integrated supply chain system and logistics technology. But the understanding of logistics and e-commerce regional conditions with an optimized way is missed in most studies. (Tang & Wang, 2020) Distribution in e-commerce aims to implement last-mile delivery strategies with a sustainable approach. However, several barriers, including financial issues and retailer-supplier relationships, hinder environmentally friendly logistics solutions. (González-Romero et al., 2025) In the analysis of centralized and decentralized decision-making systems, outcomes as the sales price increases more in the e-commerce supply chain (ECSC) than in the traditional supply chain. The reason behind such a result is the service level offered by e-commerce platforms. However, in decentralized decision-making, the fairness of the manufacturers is considered a key factor; the profit of the manufacturer in the e-commerce platform and ECSC is negatively correlated. So leading enterprises in e-commerce should develop a mutually beneficial relationship with the manufacturer and maintain the long-term effective operation of the ECSC. (Wang et al., 2019) A comparative analysis of different logistics distribution modes namely self-supporting logistics, third-party logistics (3PL), and joint distribution reveals varied levels of efficiency depending on the business model and scale of operations (Zheng et al., 2020). In the context of Indonesian e-commerce companies, the role of Knowledge Management (KM) and Organizational Innovativeness (OI) has been extensively studied, with findings indicating that both factors significantly enhance Competitive Advantage (CA), which in turn contributes to improved e-commerce performance. (Dwi LESTARI et al., 2020) The investigation of modern digital supply chains and supplier selection reviewed by using multi-criteria decision-making (MCDM) frameworks, which highlights the importance of integrating fuzzy logic to accommodate imprecise information in evaluating suppliers. The critical determinants identified the factors that highlighted in the Fuzzy Delphi analysis to be conducted, reinforcing the interconnectedness of supplier evaluation and fulfillment efficiency. (Baki et al., 2025) During the COVID-19 pandemic, the critical importance of resilience and the integration of sustainability metrics within supplier evaluation frameworks has become increasingly evident.

The proposed framework employs a multi-criteria decision-making (MCDM) methodology, specifically integrating the Spherical Fuzzy Analytical Hierarchical Process (SF-AHP) with Grey Complex Proportional Assessment (G-COPRAS). By utilizing spherical fuzzy sets and grey numbers, the framework effectively captures the nuanced and often ambiguous linguistic evaluations provided by experts. Furthermore, post-hoc analysis facilitates the selection of the most suitable supplier. (Dang et al., 2022) The extent of Value Stream Mapping (VSM) than traditional VSM to supply chains, enables organizations to visualize the operation of competitive priorities, volume, and On-Time Delivery of a supply chain. (Suarez-Barraza et al., 2016) The VSM efficacy is also demonstrated in mitigating industrial waste and enhancing sustainability in logistics operations, it helps to facilitate the visualization and analysis of waste flows, identify both opportunities and challenges within waste management operations, minimize waste generation, encourage the adoption of lean manufacturing practices, and ultimately foster the achievement of an environmentally responsible, zero-waste environment. (Schoeman et al., 2020) The 5 Whys analysis is a root cause analysis tool to identify the root causes of problems within a more general framework used to decrease the changeover time of a die, called single minute exchange of die (SMED). To find the root causes of a system, upstream the production stages, as well as the environment. (Braglia et al., 2017a) The application of Oriented Fuzzy Simple Additive Weighting (OF-SAW) method over traditional fuzzy addresses the limitations of defuzzification in logistics decisions was an innovative approach that allows for a more practical ranking of alternatives in multi-criteria decision problems. (Piasecki et al., 2019) Effective integration of VSM and fuzzy Delphi-based scoring methods for an e-commerce supply chain shows the optimization of supply chain by using lean tools. The root cause analysis found the inefficiencies in the logistics strategies, and the framework delivers a tangible improvement in the operational performance. (Qin & Liu, 2022a).

In summary, the literature on optimizing e-commerce logistics in emerging markets highlights the critical role of fulfillment models, decision-support tools, and sustainability considerations in enhancing logistics efficiency. Despite these advances, most research focuses on global incumbents like Amazon, overlooking regional platforms in emerging economies. In South Asia, DARAZ operates under distinct infrastructural and regulatory constraints. There is limited empirical evidence on applying lean tools and fuzzy-based decision frameworks to optimize such contexts. This study addresses that gap by employing VSM, the Five Whys method, and the Fuzzy Delphi approach to evaluate DARAZ's two fulfillment models-FBD and FBP and provide insights into improving e-commerce logistics in Bangladesh.

3. Methods

The methodology and the steps taken to assess are schematically shown in Figure 1.

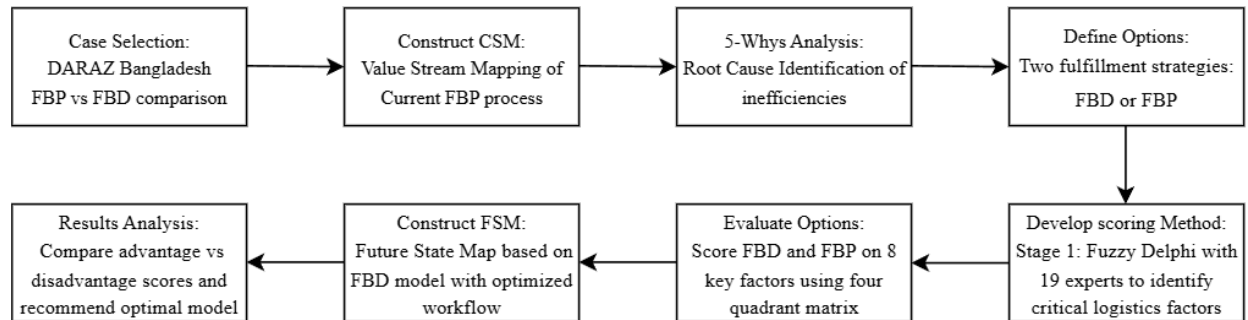








Figure 1. The methodology flow chart of the analysis processes

3.1 Value Stream Mapping

VSM is a key tool within the lean methodology, used to distinguish between activities that add value and those that generate waste in terms of the materials, information flow, and human movement. The primary aim of VSM is to enhance the flow of products, information, and finances by minimizing non-necessary value-added (NNVA) activities and eliminating non-value-added (NVA) activities promptly, thereby increasing the time spent on value creation. The VSM process typically involves three fundamental steps: developing a Current State Map (CSM), creating a Future State Map (FSM), and implementing improvements based on the comparison (Forno et al., 2014). VSM uses different symbols to show different parties and activity link and the flows of a production process. Symbol that were used in the creation in CSM & FSM is given in the Table no 1.

Table 1. Represents symbols and the meanings of the symbols used to construct the CSM & FSM

No	Meaning	Symbol
1	supplier or customer	
2	Process Control	
3	Inventory	
4	Electric Information Flow	
5	Material flow	
6	External Shipping	

3.2 Constructing Current Stream Mapping:

In current situation, most of the e-commerce retailers on DARAZ follows the stream mapping which is shown in Figure 1. where retailers give monthly/weekly order to the supplier on the basis of customer order, after receiving the product from the supplier, the retailers store the product on their personal warehouse, then sorting, attaching label, packaging, weighting all are done by retailers, then on the basis of customer order, the retailer sends the product to DARAZ distribution center then it is delivered to consumer. The Current stream mapping is shown in the Figure 2.

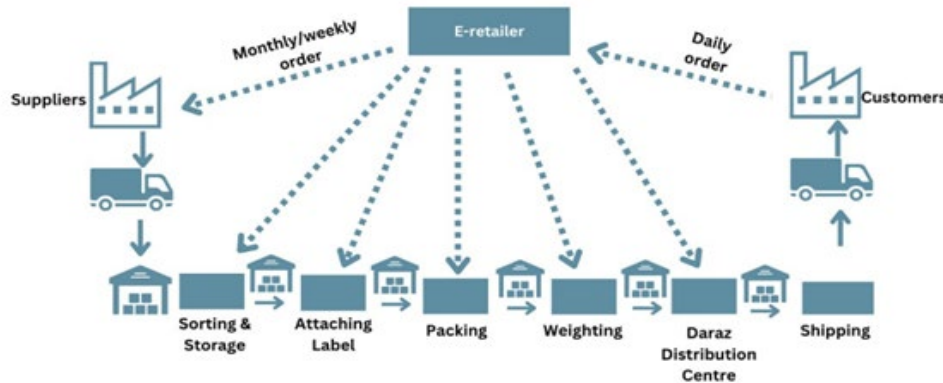


Figure 2. The Current Stream Mapping of E-commerce retailer

3.3 5-Whys analysis:

The "Five Whys" is a problem-solving technique introduced by Masaaki Imai and later popularized in the 1970s through the Toyota Production System. The method involves identifying a problem and repeatedly asking "Why?"—starting with the question "Why did this issue occur?" and then continuing to ask "Why?" for each identified cause. This process typically involves asking the question five times to trace the root cause by uncovering a chain of related underlying issues (Braglia et al., 2017b). Here the 5 whys analysis identifies delayed delivery as the root cause of low sales volume, as customers are dissatisfied with slow shipping. The delay originates from prolonged product stays in the retailer's warehouse, caused by manual labeling and packing of orders after they are received. Further delays occur due to late handovers or congestion at the DARAZ fulfillment center, which is worsened by high order volumes during peak times and inefficient sorting processes. To address these issues, the analysis suggests eliminating delivery delays by streamlining warehouse workflows, pre-labeling and pre-packing popular items, scheduling regular drop-offs to DARAZ, and utilizing DARAZ Fulfilled services for faster and more efficient order processing. The entire process of 5 whys analysis is showed in Table no 2.

Table 2. Represents Analysis process of the five whys method and the resulting solutions.

Questions	Cause	Solution
Why the sales volume is low	The customers are not happy with the delayed delivery	Eliminated the delivery delay
Why the product delivery delayed?	The product stays too long in the retailer's warehouse before reaching DARAZ Centre.	Reduce processing time at the retailer's warehouse and improve workflow.
Why does it take time at the retailer's warehouse?	The retailer labels and packages orders manually after receiving them.	Pre-label and pre-pack popular items to speed up dispatch.
Why does DARAZ take time to ship the product?	The handover to DARAZ is delayed, or there is congestion at the DARAZ fulfillment center.	Schedule daily drop-offs or arrange priority handling at DARAZ centers.
Why is the DARAZ fulfillment process slow?	Too many orders at peak times and inefficient sorting	Use DARAZ Fulfilled service for direct storage in DARAZ warehouses, ensuring faster shipping.

3.4 Scoring Method for Logistic Model Selection:

There are basically two operation model available for DARAZ e-retailer, 1) Use the service provided by DARAZ which is called FBD. 2) Use personal warehouse but the delivery is done by DARAZ known as FBP. Under the FBD option, the retailer's suppliers deliver the products straight to the DARAZ warehouse. As soon as the products are available in the DARAZ warehouse, they will be listed on the DARAZ website. After an order is received, DARAZ will package and ship the items to the consumer. In FBP option, the e-commerce retailer stores the product in personal warehouse, sorting and packaging all done by personal workers and after placing order, the product is supplied to DARAZ distribution center, from here it is delivered to consumer (Daraz+, n.d.). It is difficult to compare the two solutions side by side because each has special service characteristics to provide. A two-stage scoring approach (Qin & Liu, 2022b) is used to quickly and effectively choose the alternative that best suits the retailer's logistical needs is designed to evaluate the possibilities. The first step involves identifying important logistic factors using the FDM. The second step involves mapping the main logistical factors to the service elements that each choice provides. Expert views are then gathered to determine each option's overall score. The choice that receives the highest score will be chosen.

3.4.1 Stage I: Determination of the Key Logistic Factors:

The supply chain has a lot of logistical Factors. These logistic factors is given in Table no 3.

Table 3. Represents logistic factors to be considered in the supply chain

No	Factors	No.	Factors
1	Cost	8	Capability to Fill Emergency Orders
2	Warehouse Location	9	Responsiveness
3	Sales Growth	10	On-Time Delivery
4	Logistic Equipment	11	Eco-Friendly Packaging
5	Optimization capabilities	12	Lead Time Efficiency
6	Logistic Information System	13	Warehouse Security
7	Customer Service		

Because different businesses have different development strategies and unique characteristics, the significance of these factors varies for each individual business. Delphi is a technique that combines the views of experts using several questionnaires to pinpoint important elements (Ishikawa et al., 1993).

Table 4. Represents Linguistic Term and the corresponding triangular fuzzy numbers(Qin & Liu, 2022b)

Linguistic Term	Fuzzy Number
Very Unimportant	(0,0,0.2)
Moderately Unimportant	(0.0,0.2,0.4)
Unimportant	(0.2,0.4,0.6)
Important	(0.4,0.6,0.8)
Moderately Important	(0.6,0.8,1)
Very Important	(0.8,1,1)

- As indicated in Table no 3, suggest possible significant logistical factors to take into account. Other factors are just as important as the usual ones, such as cost, timely delivery, and customer service. Delivery time and cost are affected by warehouse location, and a partner's ability to support growth is indicated by sales growth. Being responsive demonstrates the ability to adjust to changes in the market and in policy. Safe and effective handling is guaranteed by logistical equipment, and overall performance is enhanced by optimization capabilities. Coordination and tracking are made possible by a robust logistics information system. The ability to place emergency orders demonstrates preparedness for spikes in demand, and environmentally friendly packaging promotes sustainability. Customer satisfaction is impacted by lead time efficiency, and inventory loss or damage is prevented by warehouse security.
- As indicated in Table no 4, assign linguistic phrases that represent the suggested logistic factors' degree of relevance together with the corresponding reference fuzzy numbers (Liu & Wang, 2009). It is more feasible to express the logistic factors' relevance as a range between 0 and 1. Nineteen experts were sent Table no 4 and the suggested logistic parameters as surveys to determine each logistic factor's score.
- Convert the expert opinion into fuzzy number/score using Table no 4, Calculate the Fuzzy weight score for each logistic factor based on the scores received from expert. The calculation process is done as follows: The importance score of factor j evaluated by expert i is denoted as $f_{ij} = (a_{ij}, b_{ij}, c_{ij})$ for $i = 1, 2, 3, \dots, 19; j = 1, 2, \dots, 13$. The fuzzy weight of factor j is denoted as $f_j = (a_j, b_j, c_j)$, where $a_j = \min(a_{ij})$, $b_j = (\prod_{i=1}^{19} b_{ij})^{1/19}$, $c_j = \max(c_j)$ (Qin & Liu, 2022b).
- Compare the fuzzy weight score of each factor with a threshold f to identify key logistic factors, where $f = \{\text{average}(a_j), \text{average}(b_j), \text{average}(c_j)\}$, the average values of the weight of all factors. A factor j with $f_j \geq f$ will be selected, while a factor with $f_j < f$ will be rejected. The fuzzy weight score for each logistic factor and the threshold fuzzy number f , and the decision for each logistic factor is given the Table no 6.

3.4.2 Stage 2: Scoring Logistic Operation Models:

The key logistic factors identified in the first stage were used to evaluate the service features offered FBD and FBP. To establish a quantitative comparison, a structured evaluation method was conducted using expert responses from supply chain professionals. Each logistics factor was assessed through FDM, and only those factors with fuzzy weights above the threshold (0.2, 0.745, 1) were selected for scoring in this stage. The selected features such as cost, warehouse location, logistic information system, customer service, responsiveness, on-time delivery, lead time efficiency, and warehouse security were further evaluated based on their advantage or disadvantage in each fulfillment model (FBD or FBP). The scoring method used a four-quadrant matrix shown in Table no 5 where each feature was rated based on urgency and importance. For urgent and important features, a score of 5 was given. For either urgent or important (but not both), a score of 3 was assigned. A score of 1 was used for features considered neither urgent nor important (Qin & Liu, 2022b).

Table 5. Represents Four Quadrant Scoring Criteria

Score	Urgent	Not Urgent
Important	5	3
Not Important	3	1

The advantages and disadvantages of the service features from FBD and FBP and their associated logistic factors are provided in Tables 6, 7, 8, 9, 10. The tables were sent to the e-retailer management team as questionnaires. The scores were given to the FBD and FBP models based on each selected factor's contribution-either as an advantage or disadvantage by a panel of experts in the supply chain.

3.5 Future Stream Mapping:

As the FBD model is beneficial for e-commerce retailers in DARAZ, so the current stream mapping should be changed according FBD model, which is given in the Figure no 3, all the symbols used in the figure is declared in Table 1.

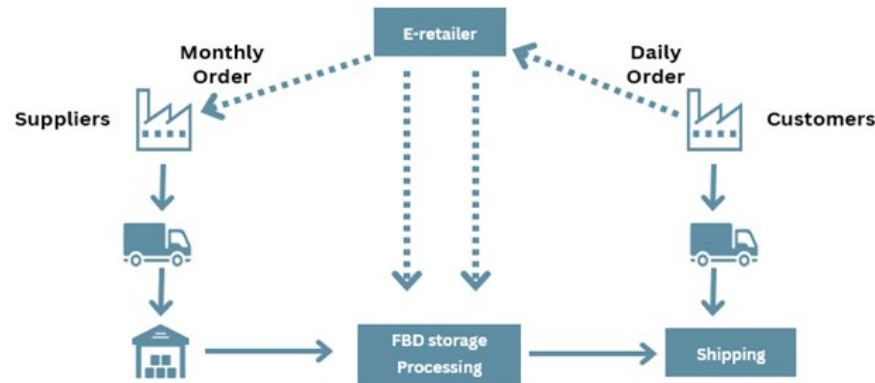


Figure 3. The future VSM with FBD model

4. Data Collection

This research employed a two-stage data collection strategy, combining secondary evidence with structured expert input.

In the first stage, process-related information was extracted from published literature, industry reports, and case-based studies focusing on e-commerce logistics in Bangladesh. These materials provided the foundation for developing the CSM and enabled the application of the Five Whys technique to diagnose root causes of operational inefficiencies.

The second stage relied on primary data gathered through a Delphi-style expert survey. Nineteen professionals with direct experience in supply chain management including logistics managers, warehouse supervisors, and practitioners engaged in e-commerce operations participated in the study. The panel assessed the relative significance of 13 logistics factors, including cost, warehouse location, responsiveness, customer service, on-time delivery, lead time efficiency, and warehouse security. Their evaluations, expressed through linguistic scales, were transformed into fuzzy numbers and aggregated using the fuzzy Delphi approach.

In a subsequent step, the same expert panel was asked to score the advantages and disadvantages of two fulfillment models-FBD and FBP. This evaluation was conducted using a four-quadrant urgency–importance framework, where each factor was rated according to its relevance and urgency. The consolidated scores formed the basis for the comparative assessment of FBD and FBP.

5. Result and Discussion

This study compared two operational models used by e-commerce retailers on DARAZ: FBD and FBP, using VSM, Five Whys analysis, and a two-stage fuzzy Delphi-based scoring method. CSM revealed significant delays due to manual packaging, inefficient handover processes, and warehouse bottlenecks. Five Whys Analysis identified the root causes of delayed delivery, such as manual processing and limited coordination with DARAZ centers, leading to reduced customer satisfaction and lower sales. FDM determined eight key logistics factors: cost, warehouse location, logistic information system, customer service, responsiveness, on-time delivery, lead time efficiency, and warehouse security.

5.1 Numerical Results

The scoring evaluation revealed that FBD model achieved an advantage score of 26 and a disadvantage score of 19, resulting in a net advantage of 58% over 42% disadvantages shown on Tables 7, 8. In contrast, the FBP model received equal scores of 23 for both advantages and disadvantages, indicating a balanced 50% net advantage shown in Table 9, 10. The advantage percentage of FBD is higher than the advantage percentage of FBP, also the disadvantage percentage of FBD is lower than FBP, so choosing FBD is beneficial for e-commerce retailer in DARAZ result shown in Table 11. Based on overall performance, the FBD model was found to be more effective due to better tracking, reduced manual effort, and improved lead time efficiency.

Table 6. Represents Results from FDM

Factors	Fuzzy Weight	Decision
Cost	(0.4, 0.834, 1)	Selected
Warehouse Location	(0,4, 0.799, 1)	Selected
Logistic Information system	(0.0, 0.759, 1)	Selected
Sales Growth	(0.0, 0.582, 1)	Rejected
Logistic Equipment	(0.0, 0.644, 1)	Rejected
Optimization capabilities	(0.2, 0.733, 1)	Rejected
Customer service	(0.2, 0.882, 1)	Selected
Capability to feel emergency order	(0.0, 0.651, 1)	Rejected
Responsiveness	(0.4, 0.853, 1)	Selected
On-Time delivery	(0.4, 0.973, 1)	Selected
Eco-Friendly Packaging	(0.0, 0.505, 1)	Rejected
Lead Time Efficiency	(0.4, 0.775, 1)	Selected
Warehouse Security	(0.2, 0.703, 1)	Selected
Threshold Number	(0.2, 0.745, 1)	

Table 7. Represents Total FBD Advantages Score

Advantages	Factors	Score
Fast order fulfilment through DARAZ managed operations	Lead time efficiency, on- time delivery	5
DARAZ handles packaging and labeling, reducing seller effort	Cost, customer service	5
Products stored in secured DARAZ warehouse	Warehouse security	3
Better logistic tracking and delivery system	Logistic information system	5
Lower chances of packaging error	Responsiveness	5
High visibility and buyer trust (DARAZ trust)	Customer service	3
		26

Table 8. Represents Total FBD disadvantages Score

Disadvantages	Factors	Scores
Less flexibility in packaging and branding	Customer service	3
Higher storage and service fee	Cost	5
Longer processing time in some peak cases	Responsiveness	5
Dependency on DARAZ system and policies	Logistic info system	3
Difficulty in stock retrieval once sent to warehouse	Warehouse location	3
		19

Table 9. Represents Total FBP Advantages Score

Advantages	Factors	Score
Full control over inventory and packaging	Customer service, warehouse	5
Personalized branding and packaging	Customer service	3
Lower storage cost	cost	5
Flexibility in dispatch scheduling	responsiveness	5
Fast order processing if stock managed efficiently	On-time delivery	5
	Total score	23

Table 10. Represents Total FBP Disadvantages Score

Disadvantage	Factor(s)	Score
Requires investment in warehouse space and labor	Cost, warehouse security	5
Risk of delays if manual process inefficient	Lead time efficiency	5
Manual errors in packaging and labeling	Customer service	5
Limited tracking and logistics integration	Logistic information system	3
Far warehouse location increases transfer time	Warehouse location	5
	Total Score	23

Table 11. Represents Summary of the Overall Scoring Results for FBD and FBP

	FBD		FBP	
	Score	Proportion	Score	Proportion
Advantages	26	58%	23	50%
Disadvantage	19	42%	23	50%
Total	45	100%	46	100%

5.3 Proposed Improvements

Comparative evaluation highlights significant opportunities to enhance logistics performance for e-commerce platforms in emerging markets. First, transitioning from personnel-based FBP to FBD can address critical inefficiencies in lead time and delivery reliability. However, to mitigate FBD's limitations particularly higher storage costs and reduced branding flexibility hybrid models should be considered. These may combine DARAZ-managed warehousing for high-demand items with seller-managed storage for niche or customized products, thus balancing efficiency with flexibility. Second, the study recommends process automation and workflow redesign at both DARAZ warehouses and retailer facilities. Pre-labeling, pre-packaging of fast-moving items, and scheduling routine drop-offs to fulfillment centers can significantly reduce order cycle times. Integration of advanced logistics information systems, including real-time inventory visibility and predictive demand analytics, is essential for aligning supply chain responsiveness with fluctuating consumer demand. Finally, implementing continuous improvement frameworks such as real-time performance dashboards, lean-based monitoring, and periodic fuzzy Delphi re-evaluations will ensure that logistics models remain adaptive to changing market dynamics. Collectively, these improvements position FBD as a scalable, resilient, and customer-centric logistics strategy, while offering a structured pathway for emerging market platforms to converge toward global e-commerce standards.

5.4 Validation

The validation of the proposed framework was conducted at two complementary levels. First, methodological rigor was ensured by employing techniques with established credibility in prior research. Value Stream Mapping (VSM) has been extensively used to analyze process flows and eliminate inefficiencies in logistics systems (Forno et al.,

2014), while the Five Whys method is widely recognized as a reliable root cause analysis tool (Braglia et al., 2017a). Similarly, the fuzzy Delphi approach has been validated in numerous decision-making contexts for its ability to capture expert consensus under uncertainty (Ishikawa et al., 1993; Liu & Wang, 2009). Together, these methods reinforce the robustness of the study's analytical framework.

Second, internal validation was achieved through expert-based assessment. The panel of 19 supply chain professionals who participated in the Delphi survey also provided inputs for the comparative scoring of FBD and FBP. The fuzzy Delphi aggregation process applied a thresholding mechanism, which filtered out factors with weak consensus and ensured reliability in the retained set of key logistics determinants (Qin and Liu 2022).

Additionally, the convergence of results across multiple methods served as an internal consistency check. Findings from VSM, Five Whys, and the fuzzy Delphi analysis consistently identified FBD as the superior model in terms of lead time efficiency, delivery reliability, and customer trust, despite its higher cost implications. This methodological triangulation enhances confidence in the validity of the conclusions.

6 Conclusion

This study systematically investigated the comparative efficiency of FBD and FBP within Bangladesh's e-commerce landscape, applying VSM, Five Whys root cause analysis, and a fuzzy Delphi-based multi-criteria evaluation. All research objectives were achieved: (i) the root causes of low sales and delivery inefficiencies were identified, (ii) critical logistics factors influencing fulfillment performance were established, and (iii) a future state mapping framework was proposed to optimize operations. The findings demonstrate that while FBP offers greater autonomy in branding and inventory control, its reliance on manual processes results in prolonged lead times and operational fragmentation. By contrast, FBD significantly enhances delivery reliability, lead time efficiency, and customer trust through automation and centralized warehouse management, despite higher costs and reduced flexibility. The unique contribution of this study lies in developing a hybrid evaluation framework that combines lean tools (VSM, root cause analysis) with fuzzy Delphi decision modeling. This integrated approach provides a scalable, evidence-based decision-support system for e-commerce platforms in emerging markets where infrastructure, resources, and consumer expectations diverge from developed economies. By bridging this contextual research gap, the study not only advances academic discourse but also delivers actionable insights for practitioners seeking to align logistics strategies with global e-commerce benchmarks.

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