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Collaborative Neighbourhood Logistics in e-Commerce Delivery: A Cluster Analysis of Receivers and Deliverers

Cam Tu Nguyen [1], Lanhui Cai [1], Mingjie Fang [2], Yanfeng Liu [3] and Xueqin Wang [1,*]

[1] Department of International Logistics, Chung-Ang University, Seoul 06974, Republic of Korea
[2] College of Economics & Management, Nanjing Agricultural University, Nanjing 210095, China
[3] Graduate School of Management of Technology, Pukyong National University, Busan 48547, Republic of Korea
* Correspondence: xueqinwang@cau.ac.kr

Abstract: The rapid growth of e-commerce and surges in shipment volumes have increased the pressure on transport systems, requiring innovations in collaborative logistics where consumers participate in dual roles as receivers and deliverers. However, existing research often addresses these roles in isolation, overlooking the flexibility with which users switch between them. Moreover, the literature has focused predominantly on monetary value in paid crowdsourced or social value in free social delivery, without fully exploring how users perceive value across both models. Addressing these gaps, this study profiles users of collaborative logistics services from both receiver and deliverer perspectives and examines their motivations in paid and unpaid delivery contexts. Based on survey data from 493 participants in Singapore, cluster analysis identified four distinct user segments: hesitators, potential customers, active users, and loyal advocates. The findings indicate that user preferences differ by role, with functional value prioritised in paid delivery and social value more prominent in free models. Free models attract a higher proportion of favourable users, highlighting the significance of non-monetary incentives. This study contributes to the literature by offering an integrated perspective on user roles and value perceptions and provides practical insights for developing more inclusive, community-oriented last-mile logistics solutions.

Keywords: collaborative logistics; neighbourhood delivery; last-mile delivery; crowdsourced delivery; social delivery; urban transportation; e-commerce; consumers; cluster analysis

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1. Introduction

Last-mile delivery is a consistently challenging aspect of logistics [1], particularly with the rapid growth of e-commerce [2]. These developments have increased the number of issues faced in last-mile logistics to unprecedented levels [3,4]. The recent surge in shipment volume has notably increased externalities such as air pollution, climate change, traffic congestion, and accidents [5]. Moreover, these pressures reduce the overall efficiency of transport systems, leading to substantial losses in both time and financial resources [6].

The e-commerce platforms and logistics industry have adopted more collaborative approaches to optimise resource utilisation, offering greater flexibility in timing and cost-effectiveness to address these challenges [5,7,8]. Based on the concept of the sharing economy, which enables economic and social systems for the sharing of goods, services, or information, collaborative logistics [9] provides a model in which logistics stakeholders share resources such as information, logistics hubs, and vehicles to enhance efficiency and achieve sustainability objectives [10,11].

The potential of collaborative logistics has been demonstrated across diverse contexts and is widely addressed in the literature. One notable development is the integration of consumer labour, allowing end consumers to become active participants in logistics processes. This trend has led to the adoption of 'collaborative neighbourhood logistics', also known as 'neighbourhood relay delivery', in which individuals from local communities act as non-professional couriers to deliver parcels to their neighbours [7,12,13].

In this context, the role of users evolves beyond that of passive customers who receive services; they become contributors to value co-creation [14]. Understanding how end consumers perceive the value of collaborative logistics models and their willingness to participate is essential for advancing and expanding collaborative logistics and reducing the pressure related to last-mile delivery in the e-commerce economy. Therefore, the primary objective of this study is to profile users of collaborative neighbourhood logistics.

Users of collaborative neighbourhood logistics can generally be categorised from either a consumer/receiver or provider/deliverer perspective. A receiver is a user who schedules deliveries via a mobile application or platform, whereas a deliverer is a user who collects parcels on behalf of others, effectively acting as a collaborative courier, while also retrieving their own parcels or following a personal route to destinations such as home, work, or school.

Recognising the critical role of users in collaborative logistics, numerous research studies have explored aspects such as consumer attitudes [15], customer acceptance, and differences in customer appraisals [16] or profiles [17]. Others have examined the deliverer's characteristics [18] and willingness or intention to participate [19]. Notably, however, most of this research has predominantly focused on a single role, without addressing the topic from a comprehensive perspective that considers both roles, particularly given that users can shift between the roles of receiver and deliverer. Indeed, users are often not confined to a single role but frequently take on both simultaneously.

A successful collaborative neighbourhood logistics model depends on a balanced and sufficient number of participants in both roles, as any imbalance could disrupt operations. Therefore, this study aims to address the first research question as follows:

RQ1: What are the profiles of users in collaborative neighbourhood logistics considering the perspectives of both receivers and deliverers?

Furthermore, although many studies on collaborative neighbourhood logistics have examined the use of human resources from a community pool, significant differences remain in perceived value in a monetary context between paid and free options. Regarding paid options such as crowdsourced delivery, prior studies have primarily examined financial incentives [20], whereas research on free options such as social delivery has focused on social value [7]. However, the argument has been made that participants in the paid option may also expect high value on social contributions to their community despite the incentivised nature of the service. Conversely, potential participants in the free option group, despite the nature of social value, may hesitate to engage because of the absence of financial compensation. By investigating delivery options in both the monetary and motivational contexts, this study examines the second research question as follows:

RQ2: How do users with different profiles perceive the relative importance of social and monetary value in collaborative neighbourhood logistics?

By conducting a cluster analysis, this study attempts to provide distinct profiling of users by adopting a dual-role perspective, recognising that individuals may function concurrently as both receivers and deliverers. This approach addresses a gap in prior research, which has largely examined these roles in isolation. Furthermore, this study advances our understanding of users' perceived value by investigating both paid and unpaid delivery models. By integrating user roles and motivational contexts, this research

offers a comprehensive framework for understanding participation dynamics in collaborative neighbourhood logistics and contributes to the development of more sustainable and community-orientated last-mile delivery solutions.

This paper is organised into five main sections. Section 2 is the literature review summarising prior studies on communal logistics. Sections 3 and 4 provide the conceptual framework and methodology of this study, respectively. Finally, Section 5 discusses the analysis results and highlights the contributions and implications of this study.

2. Literature Review

2.1. Collaborative Neighbourhood Logistics

The concept of collaborative neighbourhood logistics integrates multiple frameworks to address contemporary challenges in logistics services. The term *collaborative logistics* is rooted in the principles of the *sharing economy* [9], which facilitates the collective production, access, and circulation of resources such as goods, services, or information in interconnected economic and social systems [21,22]. Within the logistics context, collaborative logistics focuses on stakeholders sharing resources—such as information, logistics hubs, and vehicles to optimise operations and improve efficiency [23–25].

A closely related concept, *collaborative consumption*, also plays a key role in shaping collaborative logistics, particularly in last-mile delivery [9,26]. As a subset of the sharing economy, collaborative consumption allows consumers to engage in activities such as sharing, bartering, lending, trading, renting, gifting, and swapping goods through digital tools and peer-to-peer networks [9,27,28]. This approach not only redefines what consumers access but also transforms how they consume. At its core, collaborative consumption highlights individuals' active role in leveraging technology to enable distributed production and consumption within a community [29,30].

In the last-mile delivery domain, this transformation extends to participation in logistics activities in which consumers provide and share services through peer-to-peer networks. Specifically, consumers can utilise the extra carrying capacity in their vehicles, such as cars, motorbikes, bicycles, or even public transport, while following set routes to transport goods to others in their *neighbourhood* [25].

Such collaborative practices are fundamentally connected to the concept of *value co-creation*, representing a significant shift in the role of consumers [31]. Once viewed as passive recipients of services, consumers are now recognised as active co-creators and resource integrators within service ecosystems [32,33]. This transformation places consumers at the centre of both production and consumption processes, fundamentally reshaping their role in service delivery [34].

By integrating the principles of the sharing economy, collaborative consumption, and value co-creation, the concept of collaborative neighbourhood logistics emerges as a dynamic solution for last-mile delivery, especially in the e-commerce context. Open-market platforms and mobile applications that leverage information connectivity facilitate this approach. These platforms enable consumers to participate actively in logistics [35], such as by picking up and delivering parcels for their neighbours or receiving parcels on behalf of others.

2.2. Consumers Perspectives and Motivations

Given consumers' active role, profiling the core users involved in collaborative neighbourhood logistics is essential [36,37]. Accordingly, this study examines user profiles based on the user's perspective and motivation.

From the user perspective, this study investigates two primary roles: receivers and deliverers. Receivers are individuals who, for various reasons, are unable to pick up their

parcels themselves or prefer door-to-door delivery. They schedule pickup and delivery services through an application or platform, hiring collaborative couriers within their neighbourhood or community to perform logistics tasks. Deliverers are users who have the available capacity in their vehicles and are willing to perform delivery tasks for others within their neighbourhood or community.

Various studies have explored the significance of stakeholders in collaborative neighbourhood logistics (Table 1). Buldeo Rai and Verlinde [17] explored consumers' profiles and the types of logistics in which they were interested. Other studies have investigated customer attitudes towards driver disclosure and ethnicity [15], as well as appraisals related to timeliness, price, reliability, and the types of products delivered [16]. Koh and Peh [38] examined how consumer health concerns influenced intentions to use and adopt technology during the COVID-19 pandemic.

Table 1. Literature on collaborative logistics from the user perspective.

Sources	Method	Perspective	Research Scope
Buldeo Rai and Verlinde [17]	Cluster analysis	Receiver	Investigating the types of consumers interested in crowdsourced last-mile delivery and the crowd logistics services they find intriguing.
Koh and Peh [38]	Survey	Receiver	Exploring the influence of consumer health on usage intention and technology adoption.
Ta and Esper [15]	Experiment	Receiver	Examining the effects of various crowdsourced delivery system designs, including driver disclosure and ethnicity, on customer attitudes towards drivers and retailers.
Ta and Esper [16]	Archival	Receiver	Studying the differences in customer appraisals of e-logistics service quality dimensions between crowdsourced delivery and traditional delivery methods, and how product types influence these differences.
Bortolini and Calabrese [39]	Survey	Receiver and deliverer	Assessing the feasibility of implementing an emerging crowd logistics system in northern Italy.
Mittal and Oran Gibson [40]	Simulation and survey	Sender and deliverer	Investigating the participation decisions of both senders and carriers over time and the impact of the resulting feedback loop on platform growth and performance.
Bathke and Münch [18]	Conjoint analysis	Deliverer	Exploring the characteristics of crowd-shippers.
Rechavi and Toch [41]	Data mining and spatial analysis	Deliverer	Studying the strategies of crowdsourced couriers in relation to delivery pricing and courier experience.
Barbosa and Pedroso [42]	Regression analysis	Deliverer	Examining the compensation scheme that determines reward values for a professional fleet's routes and the probability couriers will accept.
Le and Ukkusuri [19]	Binary logit and regression model	Deliverer	Assessing willingness to work as crowd-shippers and travel time tolerance in emerging logistics services.
Nguyen and Yuen [26]	Survey	Deliverer	Investigating crowd logistics drivers' extrinsic and intrinsic motivations for participation.

A substantial literature stream has been produced on the perspectives of deliverers. For example, Bathke and Münch [18] investigated the characteristics of deliverers, while Rechavi and Toch [41] studied issues related to compensation and rewards. Furthermore,

Le and Ukkusuri [19] explored willingness to work, while Nguyen and Yuen [26] focused on extrinsic and intrinsic motivations for participation among deliverers.

While these studies provide important insights, they tend to examine individual user types or motivational drivers separately, with limited efforts to synthesise the findings across roles or delivery models. This fragmented approach limits a comprehensive understanding of how different user profiles and motivations relate to one another, particularly when users alternate between roles.

However, few studies have adopted a broader perspective. For example, Mittal and Oran Gibson [40] researched the participation decisions of both senders and carriers over time and the effects of the resulting feedback loop on platform growth and performance. Even fewer studies have addressed the perspectives of both receivers and deliverers simultaneously, although Bathke and Münch [18] partially considered this dual viewpoint.

Notably, users are not confined to a single role but can participate in both roles simultaneously, depending on their circumstances and needs. For example, an individual might utilise the available capacity of their vehicle to deliver a parcel to someone else while also registering their packages to be delivered by others. In such scenarios, an individual acts as both a receiver and deliverer.

This dual-role participation highlights the adaptability of collaborative neighbourhood logistics, in which users alternate dynamically between roles based on their situational needs and capacities. Therefore, this study addresses a critical gap in the literature by examining user perspectives through the dual lens of receivers and deliverers.

From a motivational perspective, collaborative neighbourhood logistics have been studied using various terminology, including crowd logistics, crowdsourced delivery, crowdshipping, neighbourhood relay delivery, and free social delivery. These terms reflect the diversity of collaborative neighbourhood logistics models, particularly in relation to motivations such as the nature of payment or incentives and the emphasis on social contributions (see Table 2).

Table 2. Literature on collaborative logistics from motivations.

Sources	Context	Option	Research Scope
Akeb and Moncef [7]	Crowd model, neighbour relays	Paid	Researching the modelling of parcel delivery by individuals (neighbours) in urban areas.
Dai and Jia [43]	Crowdshipping	Paid	Assessing the willingness and preferences of express companies and car owners to participate.
Castillo and Bell [44]	Crowdsourced delivery	Paid	Exploring how elements such as driver autonomy, compensation, fleet size, fleet mix, and demand intensity affect cost and service in last-mile delivery.
Dayarian and Savelsbergh [45]	Crowdshipping and same-day delivery	Paid	Employing in-store customers to deliver online orders on their way home.
Devari and Nikolaev [12]	Crowdsourcing, social network	Free	Utilising friends within a social network to assist in last-mile delivery.
Carbone and Rouquet [9]	Collaborative consumption	Free	Identifying and describing four types of logistics: peer-to-peer, business, crowd, and open logistics.
Wang and Wong [31]	Co-creating consumer logistics, self-collection, crowd-sourced delivery	Paid and free	Examining the motivational effects of empowerment and shared responsibility perceptions, as well as the moderating effects of private–social and paid–unpaid contexts.

Crowd logistics, crowdshipping, and crowdsourced delivery commonly refer to paid logistics models in which crowdsourced drivers make deliveries and receive financial

incentives, compensation, or rewards for their services. Akeb and Moncef [7] simulated and integrated a crowd logistics model in Paris, determined the optimal number of neighbours and parcels for delivery, and proposed a payment structure in which deliverers earn money per parcel. Similarly, Dai and Jia [43] examined a crowdshipping model and found that express companies were willing to pay 30 Chinese yuan for each vehicle participating in crowdshipping activities. Dayarian and Savelsbergh [45] proposed a model in which in-store customers deliver online orders on their way home, thereby providing financial incentives for these services. Notably, aligning with monetary motivation, Castillo and Bell [44] explored the impact of tipping on driver behaviour, revealing that its effects are geography-contingent. Specifically, they found that tipping has unexpectedly detrimental effects in areas where the population density is high rather than low.

In contrast to the financial benefits offered by these collaborative logistics models, neighbourhood relay and social delivery are characterised by free delivery services provided by users within their local communities. In these models, deliverers do not receive monetary compensation but instead gain social value by contributing to their communities' well-being and fostering a sense of collective responsibility.

From the inception of crowdsourced logistics innovations, Devari and Nikolaev [12] proposed a model leveraging friends or acquaintances within social networks to assist with last-mile deliveries. This model emphasises the social value couriers bring to the community rather than offering financial incentives or compensation. Carbone and Rouquet [9] highlighted the emergence of crowd logistics and presented various models emphasising social value and community engagement over financial rewards. Furthermore, Wang and Wong [31] examined co-created consumer logistics across both paid and unpaid options, confirming that monetary rewards are crucial for formalising productive consumer roles in logistics. They also revealed that without economic benefits, consumers perceive their participation in logistics as self-serving, irrespective of the co-creation context.

Despite these varied motivations, there has been limited effort to connect the findings across paid and unpaid models or to examine how different value orientations (functional, monetary and social) influence role flexibility and participation intentions.

Therefore, a research gap remains in the literature regarding users' motivations across monetary and social value dimensions, encompassing both paid and free scenarios. This study aims to narrow this gap by examining collaborative neighbourhood logistics through two distinct scenarios and perspectives, which are discussed in further detail in the following sections.

3. Methodology

3.1. Questionnaire Design

This study collected data using a survey questionnaire comprising three sections. The cover page introduced the purpose of the study and also highlighted the confidentiality statement, stating that their data would be anonymised and used only for academic purposes.

The survey further explored community members' perceptions of the different roles in which they could be service providers (deliverers) or service recipients (receivers). This led to four distinct scenarios:

1A Paid crowdsourced delivery (e.g., booking a scheduled delivery through a mobile app).
1B Paid parcel pickup for others (e.g., collecting parcels for a service fee while picking up your own).
2A Receiving parcel neighbours picked up for free (e.g., neighbours helping each other).
2B Free parcel pickup for neighbours (e.g., neighbours helping each other).

The scenarios were developed and derived from two major models in collaborative logistics: paid crowdsourced delivery and free social delivery. These models represent two distinct incentive structures, monetary compensation versus social contribution. When crossed with two participant roles (service provider/deliverer and service recipient/receiver), they present four representative and contrasting scenarios. This design enables a comprehensive analysis of user preferences and perceptions.

The second section of the questionnaire focused on respondents' perceptions of the functional, monetary, and social values associated with the four neighbourhood collaborative delivery scenarios. Respondents were asked to imagine themselves in each delivery situation and rate the value on a scale from 1 (lowest value) to 7 (highest value) based on their role in each scenario. Table 3 presents questions related to Scenario 1A as examples, and similar questions were asked for the other scenarios. Additionally, attention-check questions were randomly inserted to ensure that respondents paid attention to the survey. Respondents who failed these checks were considered negligent, and their responses were discarded.

Table 3. Sample questions.

Variables	Description	Low—Value/Probability—High						
	Imagine that you face the following scenario: (1a) Paid crowdsourced delivery as receiver (e.g., book a scheduled delivery on a mobile app similar to Grab)							
Functional value	When shopping online, to what extent does this delivery/collection option create functional value (e.g., save time and effort) for you?	1	2	3	4	5	6	7
Monetary value	When shopping online, to what extent does this delivery/collection option create monetary value (e.g., save costs) for you?	1	2	3	4	5	6	7
Social value	When shopping online, to what extent does this delivery/collection option create social value (e.g., being helpful to others, being respected by others, avoiding undesirable social situations) for you?	1	2	3	4	5	6	7
Intention	When shopping online, how likely are you to use this delivery/collection option?	1	2	3	4	5	6	7

The final section collected demographic and shopping-related information on respondents' age, gender, and income.

While this study employs single-item measures for certain constructs, prior research has established their reliability for assessing well-defined, concrete concepts—particularly in scenario-based investigations [46]. This research's approach focuses on specific behavioural scenarios (e.g., preferences between paid crowdsourced and free social delivery options) where single-item measures are both theoretically justified and pragmatically necessary [47]. As demonstrated in similar policy and logistics studies [48], this method effectively captures participant perceptions in experimental frameworks.

The descriptive statistics results are presented in Table 4.

Table 4. The results of descriptive statistics.

Scenario	Functional (M ± SD)	Monetary (M ± SD)	Social (M ± SD)	Intention (M ± SD)
1A	4.44 ± 1.83	3.99 ± 1.82	4.18 ± 1.68	4.01 ± 1.98
1B	3.76 ± 1.74	4.07 ± 1.78	4.43 ± 1.67	3.63 ± 1.92
2A	4.17 ± 1.85	4.25 ± 1.82	4.72 ± 1.77	3.75 ± 1.98
2B	4.03 ± 1.87	3.96 ± 1.81	4.82 ± 1.78	3.58 ± 1.95

3.2. Data Collection

Survey administration was outsourced to Qualtrics, a professional survey agency, ensuring a rigorous and reliable data collection process. The sample was restricted to residents of Singapore, a highly urbanised and technologically advanced city-state with a well-developed logistics infrastructure and active governmental support for innovation in last-mile delivery. Moreover, Singaporean consumers are generally digitally literate and accustomed to engaging with technology-driven services, making them suitable participants for exploring consumer co-creation behaviours in collaborative logistics. A lumpsum fee was paid to the agency, which covered both the service charges and respondent incentives. The project manager prepared the questionnaire, which was then converted to an online format, and the survey link was randomly distributed to potential respondents.

A pilot survey was conducted over three days before official data collection began. This initial phase allowed us to test the clarity of the survey and gather feedback from early respondents to make any necessary adjustments. After addressing any issues raised during the pilot phase, the survey was launched on a larger scale, with full-scale data collection lasting 10 days.

Qualtrics utilised its extensive panel network and randomly distributed the survey link via email and Short Message Service (SMS) to 18,900 potential participants, ensuring that the survey reached a diverse and representative group. A total of 1255 respondents accessed the survey; however, 349 responses were discarded because of incomplete information or failure to complete the survey. A further 413 responses were excluded for failing the attention-check questions. Ultimately, 493 valid responses were retained for analysis.

3.3. Sample Profile

As shown in Table 5, the sample exhibited a balanced gender distribution, with 247 male and 246 female respondents. A significant proportion (78.3%) of respondents had at least a diploma from a polytechnic institute. The age distribution was also well-balanced among those under 50, with 29% aged 16–35 and another 29% aged 35–50, while the largest group comprised individuals over 50 (55.38%).

Table 5. Survey sample demographics.

	Frequency	**Percentage**
Gender		
Male	247	50
Female	246	50
Education level		
Secondary or below	52	10.55
Post-secondary	55	11.16
Polytechnic	113	22.92
University or higher	273	55.38
Age		
16–35	144	29
35–50	143	29
>50	206	41
Income/month (SGD)		
Household with no working adult	13	2.64
<4000	114	23.12
4001–8000	137	27.79
8001–12,000	120	24.34
12,001–16,000	69	14.00
16,001–20,000	13	2.64
>20,000	27	5.48

Regarding income, the majority of respondents reported earnings between 4001 and 8000 Singapore Dollars (SGD) (27.79%) or 8001 and 12,000 SGD (24.34%) per month, whereas 23.12% earned less than 4,000 SGD per month, indicating that most users belong to the lower or middle class, according to the Singapore Department of Statistics [49].

Overall, the sample provides a diverse representation of the Singaporean population, ensuring the robustness of the findings.

4. Results and Discussion

This study examined collaborative neighbourhood delivery under both paid and free conditions. The paid form of collaborative neighbourhood delivery is called 'paid crowd-sourced delivery', and the unpaid form is 'free social delivery'. In particular, this study explored the differences in consumer participation from both the receiver and deliverer perspectives by accessing clustering analysis for each scenario.

4.1. Determination of Optimal Cluster Number

To identify the natural number of clusters within the dataset, the Elbow Method was initially applied, followed by the use of the Hopkins Statistic and a two-dimensional PCA cluster visualisation to confirm the suitability of the selected k value.

The Elbow plot (Figure 1) suggests that the 'elbow' point occurs around $k = 2$ or $k = 3$, indicating diminishing returns in the reduction in within-cluster sum of squares (WCSS) beyond these values. However, these statistical indicators alone may not always be sufficient to determine the most analytically meaningful number of clusters. Although a two-cluster model suggests a more concise structure, it may oversimplify the data and obscure important distinctions.

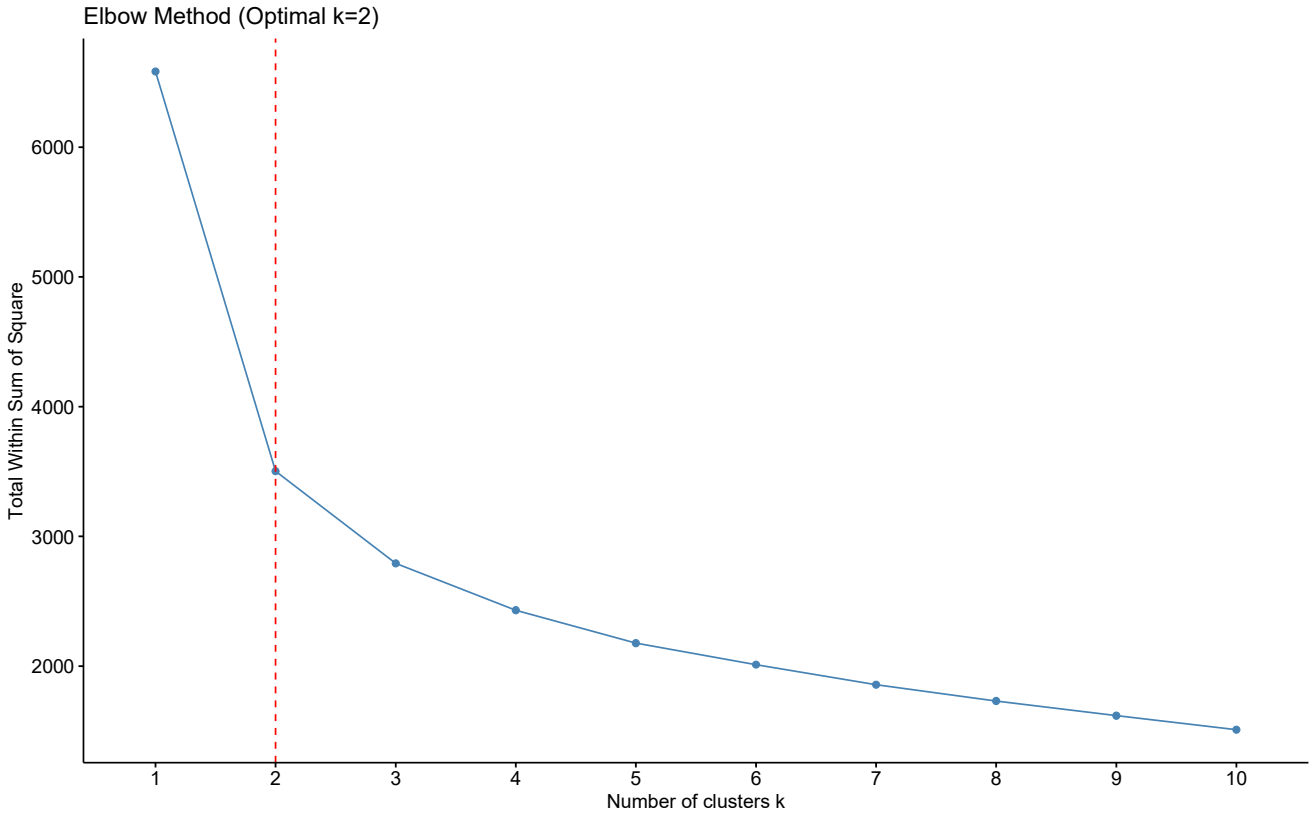


Figure 1. Elbow method plot.

To enable more meaningful distinctions among user segments essential for both theoretical development and practical application, a four-cluster solution was further

explored. This structure is empirically supported by the Hopkins Statistic, which reveals a value of 0.68 for Scenario 1A. This exceeds the commonly accepted threshold of 0.5, indicating a non-random cluster tendency, as recommended by Banerjee and Dave [50]. Moreover, the Hopkins Statistic values for the remaining three scenarios are progressively higher: 0.80, 0.81, and 0.86 respectively, thereby providing additional confirmation of the presence of meaningful cluster structures [51] and supporting the use of $k = 4$.

To demonstrate the consistency of this four-cluster structure across all four scenarios, Two-dimensional Principal Component Analysis (2D PCA) visualisations of the clusters are presented (see Figures 2–5). Overall, the results indicate four well-separated clusters with minimal overlap across all scenarios. Specifically, the total variance explained by the two principal components was 81.1% in Scenario 1A (Dim1 = 67.1%, Dim2 = 14.0%), 78.7% in Scenario 1B (Dim1 = 64.2%, Dim2 = 14.5%), 82.7% in Scenario 2A (Dim1 = 68.4%, Dim2 = 14.3%), and 84.1% in Scenario 2B (Dim1 = 69.8%, Dim2 = 14.3%). Such evidence justifies the selection of a four-cluster configuration over simpler alternatives.

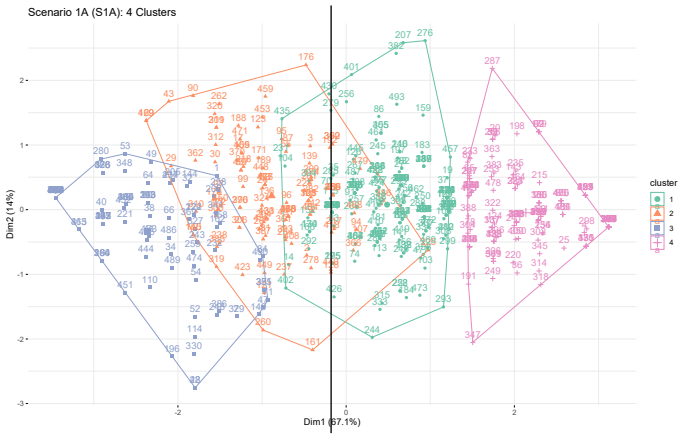


Figure 2. 2D PCA cluster visualisation for scenario 1A.



Figure 3. 2D PCA cluster visualisation for scenario 1B.

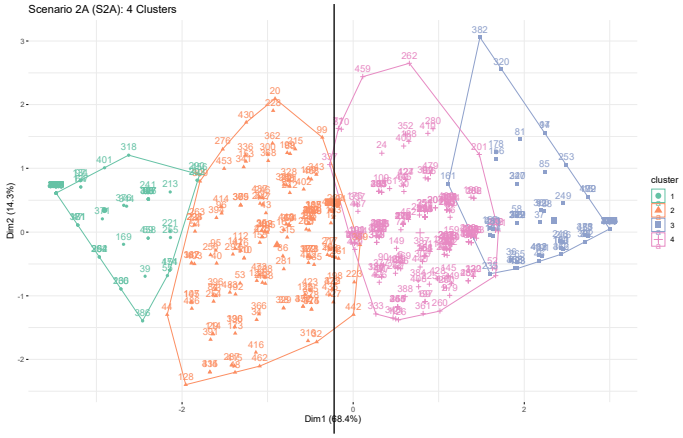


Figure 4. 2D PCA cluster visualisation for scenario 2A.

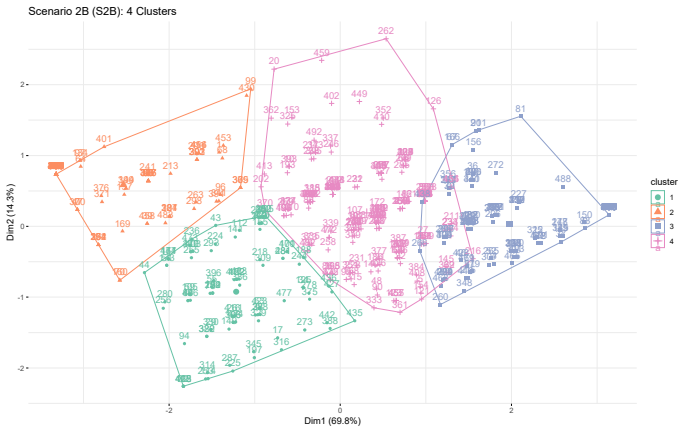


Figure 5. 2D PCA cluster visualisation for scenario 2B.

4.2. K-Means Clustering and Cluster Characterisation

To better understand consumer patterns and preferences in community logistics services, a K-means cluster analysis was conducted using SPSS. This method was chosen for its computational efficiency with large datasets [52] and its suitability for continuous survey data. Additionally, K-means provide more interpretable results, making them particularly useful for analysing collaborative logistics applications.

The analysis was performed across four scenarios, capturing both receiver and deliverer perspectives under two different delivery models: paid crowdsourced delivery and free social delivery.

Tables 6–9 present the results of the K-means cluster analysis. Overall, the Analysis of Variance (ANOVA) results indicated significant differences between clusters for all variables ($p < 0.001$).

Table 6. K-means cluster analysis results for receivers of paid crowdsourced delivery.

Value	Cluster 1 n = 97 (19.7%)	Cluster 2 n = 144 (29.2%)	Cluster 3 n = 80 (16.2%)	Cluster 4 n = 172 (34.9%)	F-Value	Significance
Functional	1.99	4.63	4.01	5.85	221.156	<0.001
Monetary	1.78	3.84	3.14	5.76	316.702	<0.001
Social	2.52	4.02	3.83	5.42	106.454	<0.001
Intention	1.52	2.81	5.23	5.84	572.416	<0.001

Table 7. K-means cluster analysis results for deliverers of paid crowdsourced delivery.

Value	Cluster 1 n = 105 (21.3%)	Cluster 2 n = 101 (20.5%)	Cluster 3 n = 130 (26.4%)	Cluster 4 n = 157 (31.8%)	F-Value	Significance
Functional	1.81	3.83	3.28	5.40	215.542	<0.001
Monetary	1.85	4.38	3.79	5.59	226.680	<0.001
Social	2.52	4.99	4.13	5.59	139.785	<0.001
Intention	1.43	2.02	4.31	5.59	598.958	<0.001

Table 8. K-means cluster analysis results for receivers of free social delivery.

Value	Cluster 1 n = 75 (15.2%)	Cluster 2 n = 125 (25.4%)	Cluster 3 n = 151 (30.6%)	Cluster 4 n = 142 (28.8%)	F-Value	Significance
Functional	1.72	3.36	4.26	6.07	268.766	<0.001
Monetary	1.61	3.72	4.30	6.05	271.986	<0.001
Social	2.08	4.74	4.71	6.11	174.638	<0.001
Intention	1.37	2.04	4.60	5.61	427.821	<0.001

Table 9. K-means cluster analysis results for deliverers of free social delivery.

Value	Cluster 1 n = 78 (15.8%)	Cluster 2 n = 84 (17.0%)	Cluster 3 n = 166 (33.7%)	Cluster 4 n = 165 (33.5%)	F-Value	Significance
Functional	1.68	2.12	4.30	5.75	358.848	<0.001
Monetary	1.67	2.46	4.16	5.55	256.692	<0.001
Social	1.85	5.49	4.48	6.20	320.529	<0.001
Intention	1.37	1.72	3.54	5.54	371.047	<0.001

The results revealed four distinct clusters, each characterised by unique attributes and preferences. Based on varying levels of participation intention, these clusters were classified as: (1) hesitators, (2) potential customers, (3) active users, and (4) loyal advocates. These labels are not arbitrarily assigned but are conceptually grounded in established segmentation frameworks. For example, prior studies in innovation adoption have identified consumer segments such as "early adopters," "late adopters," and "cautious laggards," typically derived from diffusion of innovation theory [53]. Similarly, research on customer loyalty frequently distinguishes between "committed customers," "price-sensitive consumers," and "disloyal users," based on varying levels of brand attachment and involvement [54]. Drawing from these theoretical foundations, the cluster labels in this research reflect a continuum of user engagement and offer a more nuanced understanding of consumer behaviour in the context of collaborative logistics.

Hesitators are typically consumers who are unwilling to participate in or experiment with collaborative neighbourhood delivery. Their assessments of the social, functional, and monetary value are consistently low, indicating that they do not perceive these logistics models as suitable for their needs. This is further reflected in their low intention ratios, reinforcing their reluctance to engage with such services.

Potential customers are open to the idea of collaborative neighbourhood delivery and show a more positive perception of its value. They evaluate the social, functional, and monetary benefits with a comparatively optimistic outlook. However, despite recognising these potential benefits, their intention to participate remains relatively low. This suggests

that while they have the potential to become active users, they have not yet fully committed to engaging with the service.

Active users highly value the benefits of crowd logistics and, most importantly, are willing to try new things and participate as users. Finally, loyal advocates, as shown in the radar charts below, have a high assessment of the service and believe in the value it can provide. Therefore, they trust that their needs can be fulfilled, and engaging with and using collaborative neighbourhood delivery logistics services is worthwhile for them.

4.2.1. Scenario 1: Crowdsourced Delivery (With Payment Fee)

From the receiver's perspective, paid crowdsourced delivery involves scheduling deliveries through mobile applications, similar to services such as Grab. This approach allows individuals to receive their cargo from unprofessional deliverers or their neighbourhoods but is more flexible at a time that is suitable for them. Figure 6 presents the cluster analysis of consumer intentions to participate in crowdsourced logistics for receivers.From the deliverer's perspective, paid crowdsourced delivery partners act as delivery agents, utilising flexible schedules and taking advantage of their mobility to complete delivery tasks, including picking up parcels on behalf of others for a service fee, effectively working as crowd delivery persons while collecting their own parcels. Figure 7 shows the cluster analysis results from the deliverer's perspective in crowd logistics.

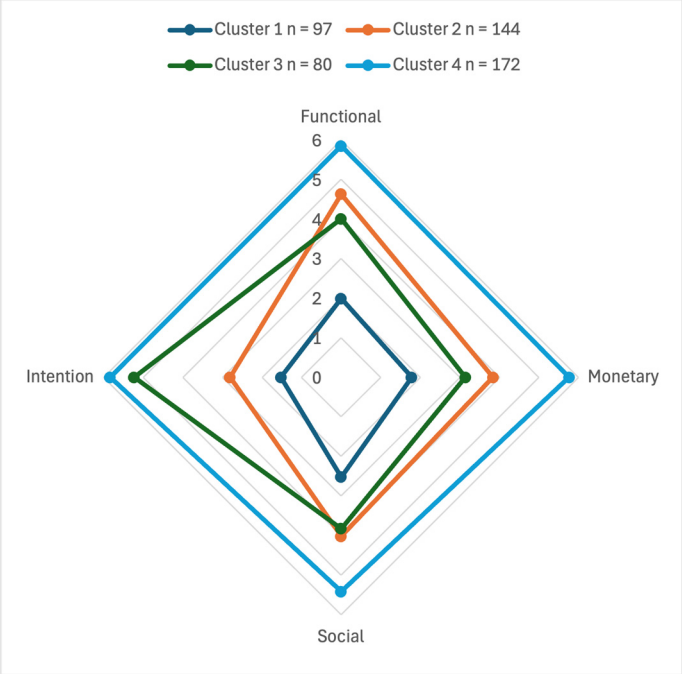


Figure 6. Profiles of receivers in crowdsourced delivery.

Differences between receiver and deliverer perspectives of paid crowdsourced delivery

When comparing the perspectives of receivers and deliverers, the four clusters exhibit similar trends but also notable differences, particularly in the nature of the services. For example, from the receiver's perspective, functional value is rated higher than both monetary and social value across all clusters. An explanation for this is that with a paid service, consumers primarily assess whether the service delivers real value. These findings, particularly the receivers' heightened expectations regarding service reliability, align with those of Mladenow and Bauer [55], who emphasise the prioritisation of functional value in such contexts. Consequently, they focus on the functionality of crowdsourced delivery to determine whether it meets their needs. Furthermore, receivers tend to demonstrate a

higher intention to participate than deliverers because becoming a receiver is a passive role that requires minimal effort compared to the more active role of a deliverer.

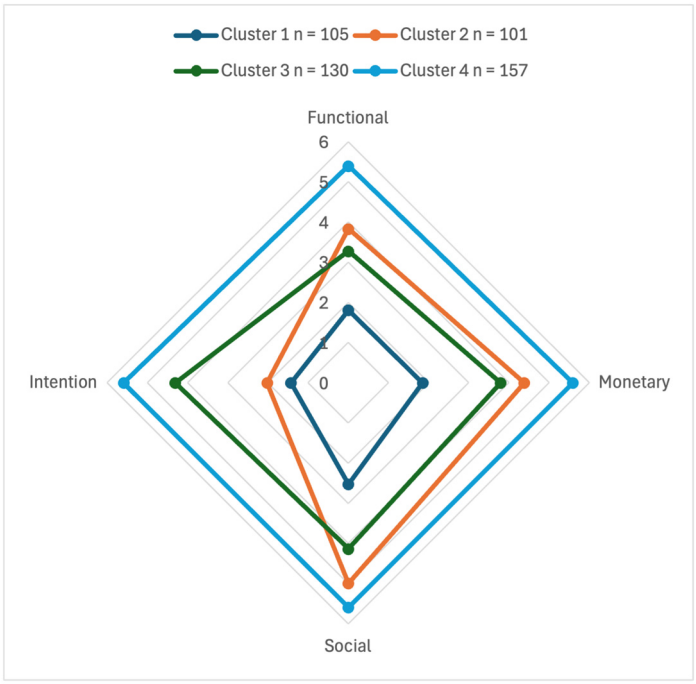


Figure 7. Profiles of deliverers in crowdsourced delivery.

In contrast, from the deliverer's perspective, all four groups prioritise the social and monetary impact, followed by functional value and intention. Deliverers are primarily concerned with the economic gains they can make and the social advantages of being seen as valuable contributors. They want to provide services by helping their neighbours while simultaneously earning financial rewards. This suggests that social and monetary values take precedence over functional values in their decision-making process.

Beyond these differences in value perception, the cluster sizes also reveal meaningful associations. In the receiver model, most participants were in Clusters 2 and 4, indicating that they were either potential customers or committed users of crowdsourced delivery. However, an interesting transition emerged when examining the deliverer model. The number of participants in Clusters 2 and 4 declined significantly, with many shifting to Cluster 3 (active users). This shift suggests that participants reassessed their perceived value and service evaluation when considering the role of deliverers, transitioning into more realistic users whose decisions were influenced by both their expectations and experiences.

4.2.2. Scenario 2: Social Delivery (Free)

Similar to crowdsourced delivery with a payment fee, services categorised under free social delivery, specifically from the perspectives of the receiver and deliver, operate on a non-monetary basis. Receivers represent a model in which customers receive parcels picked up by neighbours for free. For example, individuals living in the same neighbourhood can assist each other with deliveries, fostering a sense of community and mutual support. Conversely, the deliverer model introduces a service in which users pick up parcels for their neighbours without charge, embodying the same principle of neighbourly assistance.

Aligned with the classification from Scenario 1, four clusters of free social delivery are categorised as hesitators, potential customers, active users, and loyal advocates based on their value evaluation and participation intention (Figures 8 and 9).

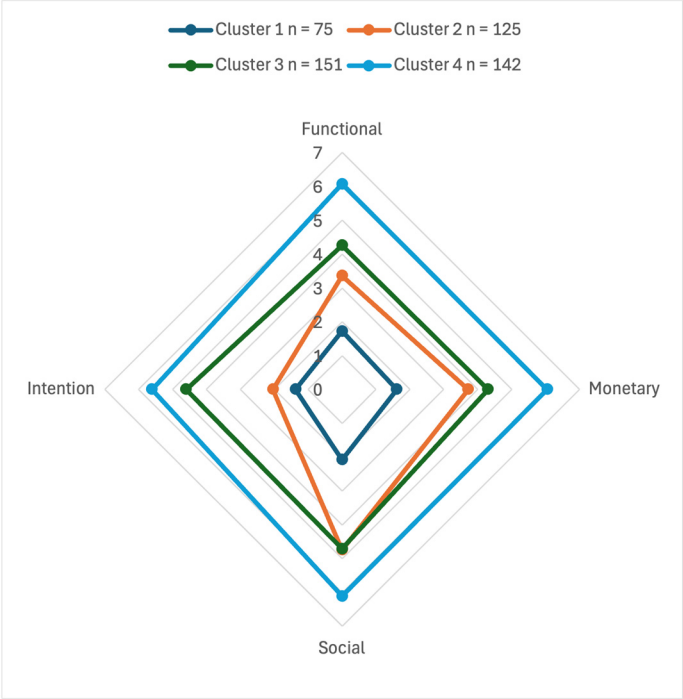


Figure 8. Profiles of receivers in social delivery.

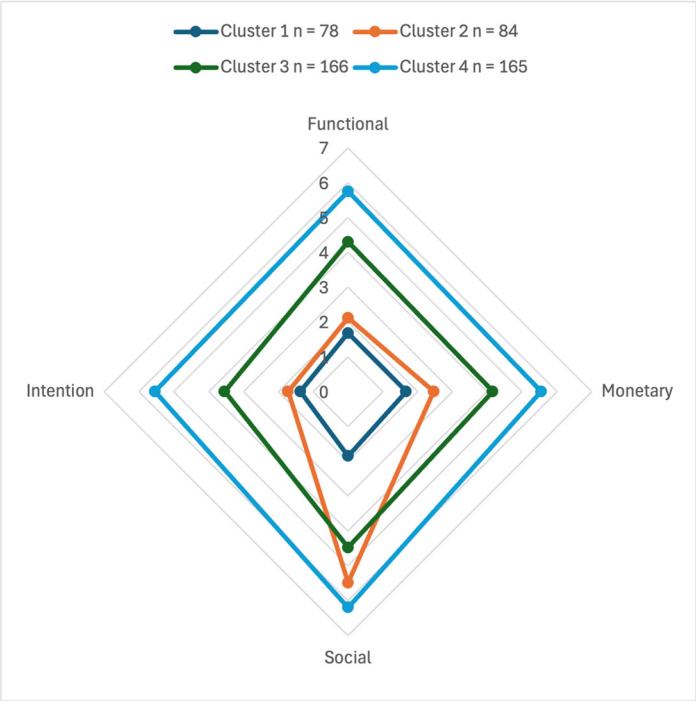


Figure 9. Profiles of deliverers in social delivery.

Differences between receiver and deliverer perspectives of social delivery

Differences in the clustering results between receivers and deliverers were primarily observed within the category of potential customers, with minor differences among hesitators, active users, and loyal advocates. Based on the different roles of receivers and deliverers, potential customers have diverse views of social delivery regarding functional, monetary, and social value.

For example, users acting as receivers tend to evaluate functional and monetary values slightly higher than deliverers do. This higher evaluation stems from trust in their

neighbours' kindness and competence, believing that these neighbours will effectively perform and complete delivery tasks.

However, users who act as deliverers perceive a significant contribution to the community, reflecting the highest level of social value. However, their evaluations of functional and monetary values and intention levels were not as high. This distinction may be explained by these consumers' low self-efficacy, as they may doubt their ability to perform as efficiently as professional shippers. They may also perceive the task as demanding or believe that their efforts are less meaningful than those of professional services.

In addition, the number of potential user groups shows notable differences between the receiver and deliverer roles. Notably, the number of potential users significantly decreased from 125 to 84 when they switched their position from recipient to deliverer. The sizes of Clusters 3 and 4, including active users and loyal customers, respectively, increased correspondingly. These shifts in cluster sizes confirm and support the explanation of user contribution dynamics. Users are hesitant to receive free services from the community. However, when they assume the role of deliverers, they tend to contribute more actively to their communities. This finding is consistent with the study by Buldeo Rai and Verlinde [25], which highlights that deliverers value social contributions more than receivers. This indicates that a sense of community and a desire to support others are stronger motivators for engagement when users are in the position of giving rather than receiving.

4.3. Comparison of Scenario 1A-B (Paid Option) and Scenario 2A-B (Free Option)

In addition to comparing the perspectives of receivers and deliverers, we analysed the nature of both paid and free logistics work. Deeper insights can be obtained from a vertical perspective by examining the clustering results for paid crowdsourced delivery services and free social delivery by neighbours.

Point 1. Consumers prioritise functional value in paid crowdsourced delivery but emphasise social value in free social delivery.

The cluster analysis results for the four cases above showed that functional value was perceived slightly more in crowdsourced delivery, whereas social value was perceived slightly more in free social delivery. This difference in value perception can be explained by the nature of each delivery method. When consumers pay for logistics services, they focus more on functional value, such as accuracy, safety, and convenience. This aligns with the findings of a previous study by Rougès and Montreuil [56], which confirms that consumers expect high-quality services in return for their money.

Social delivery scenarios, such as helping friends or neighbours pick up parcels, often depend on acquaintances or mutual assistance between neighbours. Therefore, the social value of the service is more important to consumers than its monetary and functional value. As demonstrated by Mittal and Oran Gibson [40] participants' motivations in these cases are often driven more by personal values and social considerations than by financial incentives. For example, consumers value benefits such as strengthening friendships, building trust, and fostering community bonds more than the functional or monetary aspects.

Point 2. Free services have more favourable deliverers and receivers (active users and loyal advocates) than paid services.

Comparing Figures 2 and 3 with Figures 4 and 5 reveals more hesitators and potential users in the paid model than in the free model, whereas the free model has more active and loyal users than the paid model. In the context of the free social delivery model, the numbers of hesitators in Cluster 1 and potential users in Cluster 2 are not very high. Most have transitioned to active and loyal users with approximately the same cluster size. This suggests that users have a favourable impression of this option, do not show much hesitation, and are inclined to join.

However, in the paid model, a larger proportion of consumers adopt a wait-and-see approach. When they engage in paid crowdsourced delivery, they intend to evaluate their experiences over the long term before becoming loyal members. Payment incentives appear to discourage deliverers and receivers from participating in neighbourhood delivery. Alternatively, engaging in delivery for a fee among neighbours appears to engender some level of social embarrassment.

5. Conclusions

This study addresses the gap in collaborative neighbourhood logistics research, where consumer roles as receivers and deliverers are often examined separately and value perceptions in paid and free delivery models remain underexplored. By profiling users in both roles and analysing their motivations, the study identifies key segments and highlights how functional value drives participation in paid services, while social value motivates engagement in free models. The results offer practical insights for logistics providers to enhance service engagement by proposing strategies for user roles and emphasising non-monetary incentives, such as community recognition and social rewards, particularly in promoting free collaborative delivery models.

5.1. Contribution

Unlike previous studies on collaborative logistics [12,17,26,31], which have predominantly examined either the consumer or the shipper perspective separately, this study offers a more comprehensive view by exploring consumers in dual roles, as both service recipients and service providers. By analysing behavioural patterns across two delivery models (paid and free) and two user roles (receiver and deliverer), four distinct user segments are identified: hesitators, potential customers, active users, and loyal advocates.

These findings contribute to existing frameworks in logistics and consumer behaviour by operationalising the concepts of consumer co-production and value co-creation within the context of collaborative neighbourhood logistics. Furthermore, the results support the theoretical assertion that consumers' perceived value and motivations play a critical role in shaping their choice of delivery mode and level of engagement in collaborative logistics.

By establishing these behavioural segments and linking them to value perceptions and delivery preferences, this study introduces a novel user classification model that deepens the theoretical understanding of consumer decision-making in the logistics domain.

As a practical contribution, this study provides a detailed profile of consumers who engage in collaborative logistics, offering valuable insights for e-commerce platforms and logistics service providers in managing and promoting consumer participation to improve service engagement. For example, the findings indicate that consumers prioritise functional value in paid crowdsourced delivery but emphasise social value more in free social delivery models. This distinction suggests that service providers should create their value propositions to reflect user preferences in different delivery contexts. Specifically, in free social delivery models, where social value is more emphasised, platforms can focus on fostering a strong sense of community and promoting social benefits such as local networking, trust-building, and mutual aid. Furthermore, free service models have more favourable users (active users and loyal advocates) than paid models do, suggesting that nonmonetary incentives play a crucial role in encouraging participation in collaborative logistics. This supports the recommendation for incorporating recognition systems, social rewards, and community-building initiatives to enhance voluntary engagement.

In addition, the results indicate that consumers have a higher intention to engage as receivers than as deliverers. This suggests that service providers should focus their marketing and service design strategies on user roles. For example, emphasising reliability

and efficiency may attract more receivers, whereas highlighting social impact and financial benefits may incentivise more deliverers.

5.2. Limitations and Future Research

Despite its contributions, this study had several limitations related to the sample context and logistics options examined. First, this study was conducted in Singapore, where e-commerce and collaborative logistics have emerged with various delivery options. However, vehicle choices in Singapore are subject to government regulations, differing from motorbike-based delivery services commonly used in other Southeast Asian countries and bicycle- or car-based services in Europe, North America, and North Asia. Therefore, further research is needed in different geographical contexts to examine the generalisability of the findings. Second, this study did not incorporate demographic variables such as age, income, or education into the cluster analysis due to scale differences and the absence of consistent patterns in preliminary tests. Future research could explore alternative clustering methods that integrate demographic characteristics to uncover potentially meaningful consumer segments.

In addition, this research primarily focused on two options in collaborative logistics: paid crowdsourced delivery and free social delivery. However, as new models and alternatives continue to emerge, further research is needed to explore additional logistics options and their implications for consumer behaviour. Finally, this study used simple cluster analysis to classify consumer profiles. Although cluster analysis is a useful segmentation technique, its analytical power may be limited compared to more advanced methodologies. Future research could apply more sophisticated clustering techniques or machine learning approaches to gain deeper insights into consumer logistics preferences and decision-making patterns.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Data are contained within the article.

Conflicts of Interest: The authors declare no conflicts of interest.

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