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Barriers to shippers’ resistance in adopting truck-sharing services

Abstract

Purpose – Truck-sharing stands out as an impactful strategy for minimizing emissions and optimizing the streamlined transport of goods. This study seeks to address a gap in understanding by investigating the barriers confronted by shippers in the adoption of truck-sharing services.

Design/methodology/approach – This study employs the innovation resistance theory to examine a range of potential barriers. A total of seven potential barriers are included for investigation. Survey data from Bangladeshis are analysed using an artificial neural network.

Findings – The barriers, ranked in order of importance, include image, tradition, value, usage, risk, psychological ownership, and privacy concerns. Thus, psychological barriers (image and tradition) mostly underpin resistance to change, showing that the issue is more rooted in shippers' perceptions than operations. Also, they often do not find a financial cause to use truck-sharing services. Usage barriers, explicitly addressing the practical application of truck-sharing services, have now assumed the third position, underscoring their significance in overcoming the barriers.

Research limitations/implications – The findings provide valuable insights for policymakers to reconsider their approaches in addressing the most formidable truck-sharing barriers.

Practical implications – This insight holds implications for shippers and transport companies, offering strategic guidance to optimize their engagement with and support for such services.

Originality/value – To the best of our knowledge, this study presents the initial examination of shippers' reluctance towards adopting truck-sharing services in a developing country.

Keywords: Sustainability, Empty truck, Environment, Emission, Crowdsourcing-based services

Paper type Research paper

1.0 Introduction

Road transportation has long been recognized for its negative impact on the environment (Liljestrand et al., 2015, Nikseresht et al., 2023). Thus, businesses have acknowledged the potential of reducing empty runs, which refers to the unused space in trucks during transportation (Islam, 2017, Santén, 2017, Samchuk et al., 2022). The implementation of the truck-sharing service, aimed at reducing empty trips, yields cost and emission reductions (Islam, 2018, Maeda and Maruyama, 2023). Truck-sharing is an innovative service wherein shippers collaborate to optimize the utilization of trucks by sharing their available transport capacity (Islam and Olsen, 2014, Islam et al., 2021). Moreover, the emergence of innovative services such as Crowdsourced Logistics (CSL), which leverage crowdsourcing-based services for supply chain management including transportation, highlights a current trend in the field. However, there remains a notable gap in research regarding the impact of this new approach (Castillo et al., 2018). This knowledge gap aligns with previous generalized findings indicating the potential influential role of users' resistance behavior in the adoption of such innovative services (Kaur et al., 2020). Tsakalidis et al. (2020) again emphasize the existence of significant barriers that must be effectively addressed prior to the realization of a potential "transport innovation revolution". This assertion finds complete support in Lindkvist's (2022) work, wherein it is highlighted that despite the acknowledged potential of many transport solutions to enhance sustainability, their widespread implementation remains limited due to the existence of many barriers. Therefore, this study posits this inquiry: *"What barriers hinder shippers from utilizing truck-sharing services?"*

Addressing this critical research question, this study underscores the significance of employing the innovation resistance theory to meticulously scrutinize a wide array of potential barriers. The inquiry also delves into the pressing issue of discerning the relationship between psychological ownership, characterized by the mental attachment to a truck, and the pertinent privacy concerns linked to shared information, especially concerning the intention to engage in truck-sharing. To underscore the importance of the problem, thus the study carefully examines a total of seven barriers. The utilization of survey data from Bangladesh, analyzed through a neural network method, emphasizes the urgency of finding solutions to this significant problem.

This study makes important contributions in two ways. Firstly, it represents the initial attempt, to the best of our knowledge, to apply the innovation resistance theory to analyze shippers' resistance behavior for truck-sharing. This holds importance as persuading users, such as shippers in this study, to adopt new services poses a major barrier in the service industry (Mani and Chouk, 2018, Islam et al., 2021). This difficulty arises due to the behavioural adjustments required from users to integrate a new service into their practices (Meuter et al., 2005, Wang et al., 2023). In the context of transport, such as truck-sharing, the veracity of this claim finds support in Vargas et al. (2020), and in Abideen et al. (2023), who emphasized that the freight market remains unprepared for the implementation of collaborative logistics services. Secondly, as far as we are aware of, to date, earlier studies have not addressed the potential influence of psychological ownership on individuals' participation in truck-sharing. The field of logistics research has yet to examine these "feelings of ownership" driven by psychology. Thus, scarce studies (e.g., Paundra et al., 2017) suggest that investigating psychological ownership is essential when studying individual variations in access-based transport services. Neglecting to address such inquiries may lead shippers to express their disapproval by rejecting truck-sharing services, as described by Mani and Chouk (2018) in the context of resisting innovative services.

The study is organized as follows. The later section delves into the pertinent literature. The third section introduces the methodology employed. The fourth section is dedicated to the analysis of the data and the presentation of findings. This is followed by a discussion of the results, accompanied by the managerial and academic implications arising from the study. Finally, the study concludes by providing an overarching overview of the research results.

2.0 Literature review

This section endeavors to provide a formal definition of the issue of empty truck trips, followed by an investigation into its resolution through the implementation of a truck-sharing service. Furthermore, it examines the operationalization of a truck-sharing service via crowdsourcing-based services. Given the horizontal collaboration inherent in truck-sharing services, a review of pertinent literature is conducted, emphasizing extant research gaps. Moreover, this section offers explanations regarding the innovation resistance theory, while also addressing additional barriers such as psychological ownership and privacy concerns.

2.1 The truck-sharing idea

2.1.1 Meaning of empty truck trips

This study investigates the phenomenon of empty truck trips from two distinct viewpoints, drawing upon the research of Piecyk and McKinnon (2010). The first view concerns underutilized vehicles, where a portion of the truck's capacity remains unused due to insufficient freight. The second view addresses full empty runs, which occur when a vehicle completes a journey without carrying any cargo. Empty runs are a global issue. For example, in the UK, they result in an annual cost of approximately £160 million and contribute to the emission of 426,000 tons of carbon dioxide (Department for Transport, 2017). According to the European Commission (2017), about 26% of road freight journeys in the EU are empty runs (Hirata and Fukaya, 2020). Table I presents a list of studies related to various aspects of empty truck trips.

Reference	Description
Islam and Olsen (2014)	This study investigates functional barriers to truck-sharing, leaving room for future research to explore additional barriers, particularly those of a psychological nature.
Islam (2017)	Using a synthesis of the limited literature, the study explores the theoretical causes of empty runs, the ways to avoid empty runs, and the benefits of avoiding those.
Sternberg and Harispuru (2017)	Road operations are usually inefficient. Empty truck trips serve as manifestations of inefficiencies within the transportation system. Therefore, the authors identify the causes of inefficiencies in freight transport operations through a lean approach.
Islam (2018)	The study conducts a simulation of the truck-sharing service. The results show that truck-sharing raises overall transport capacity and can handle increases in truck volume in the future. This could also reduce carbon emissions released from trucks.

Table I. Studies which are associated with different aspects of empty truck trips

2.1.2 The truck-sharing service

Truck-sharing services offer a platform where carriers and shippers can collaborate to maximize the utilization of available trucking capacity, reducing the number of empty or partially loaded trips. Shippers, therefore, strategically evaluate sustainable approaches to optimize their logistics operations in line with customer expectations, aiming to make the most of collaborative consumption models like truck-sharing. This not only enhances operational efficiency but also contributes to environmental sustainability by reducing the carbon footprint associated with logistics and transportation activities (Botsman and Rogers, 2011). The viability of truck-sharing services is underpinned by the users' willingness to pay for temporary access to underutilized assets, making it a cost-effective alternative to the outright purchase of transportation services. In a truck-sharing system, shippers play a crucial role in determining the volume of transport required and have the authority to specify the precise requirements of procured services through competitive bidding processes (Miklautsch and Woschank, 2022). This whole process culminates in the allocation of transportation contracts to carriers capable of meeting these specific needs.

2.1.3 How does a truck-sharing service work?

Consistent with Dotzel et al.'s (2013) conceptualization of innovation, truck-sharing embodies an intangible service capable of improving a shipper's efficiency in executing shipping tasks. Truck-sharing, facilitated by digital third-party services such as freight apps, enables the effective utilization of excess truck capacity (Föhring and Zelewski, 2015). These apps provide phone-based matching services to connect shippers with carriers. Li and Yu (2017) compile a range of freight-matching apps, and alternative platforms like www.findatruckload.co.nz also offer similar services. The truck-sharing process is comprehensively outlined by Authors (2024) [reference withheld for the blind review process] within the context of logistics and transportation activities. For instance, a dynamic truck-sharing system maintains a comprehensive database of user information, encompassing data from shippers, and road carriers. This database includes user profiles and preferences, as well as detailed trip information such as origins and destinations. Both carriers' and shippers' preferences are crucial in this system. These preferences are integral to the data collection policy of the sharing system, accommodating scenarios where a carrier might specify a maximum allowable deviation from their planned route for pick-ups or drop-offs. Users of the system have the capability to post or withdraw trip-sharing invitations as needed. Once user information is captured and stored in a database, the system performs queries to identify potential matches for advertised jobs. These queries adhere to predefined parameters set by users to ensure a consistent and efficient matching process. Parameters might include the similarity of destinations despite different starting points, acceptable distances for freight trips, overall profitability for all parties involved, and the compatibility of truck and freight characteristics. After potential matches are identified, "mathematical algorithm" is utilized to evaluate the shortlisted candidates, selecting the optimal user (for example, a shipper) based on the shortest distance to the truck's current location. Once a match is confirmed, the system notifies the selected customer about the offer, along with the potential savings in terms of cost and carbon emissions. The road carrier, in turn, receives a detailed trip plan including a map and customer contact information, facilitating the freight pick-up at the agreed-upon time and location. Post-service, customers are encouraged to provide feedback and rate the service provider, contributing to the improvement of the sharing system.

In the entire process, it is implied that **shippers** are responsible for the initial planning and logistics to ensure that cargo reaches the carrier in a timely and organized manner. They must provide accurate documentation, detailing the cargo, its destination, and required transportation conditions. Effective communication with carriers is crucial for coordinating pick-up times and freight specifications, optimizing the loading process, and minimizing underutilization. Conversely, **carriers** are responsible for the physical transportation of cargo. This includes ensuring proper truck maintenance, scheduling efficient routes, and managing the loading and unloading of freight to maximize utilization. Carriers must adhere to all regulatory standards during transport and play a key role in reducing underutilization by optimizing truck space.

2.2 Crowdsourcing-based truck-sharing service

While truck-sharing services predominantly rely on crowdsourcing-based platforms, there exist inherent barriers in utilizing these platforms for truck-sharing services. For instance, members of the crowd have the discretion to decide whether to offer a truck to the shipper, introducing higher levels of uncertainty (Castillo et al., 2018). Additionally, crowdsourced logistics (CSL) introduces uncertainty in vehicle availability as drivers may have autonomy over their schedules. While carriers own and manage the vehicles and are responsible for logistics planning and resource allocation, drivers, especially in trucking, may be independent contractors or work under contract terms that give them discretion over which trips to accept. Moreover, drivers may often have the freedom to choose their schedules, routes, and loads to accept based on various factors such as personal preferences, availability, and operational constraints. Furthermore, Saglietto (2021) emphasizes the importance of acquiring knowledge to ensure work quality in crowdsourcing-based logistics services. Saglietto also underscores the necessity of effectively managing potential risks associated with the allocation of responsibilities, privacy concerns, additional costs, delivery delays, and security matters. To illustrate these concerns, crowdsourcing-based services may complicate establishing insurance coverage and proper compensation for accidents or damages, leading to legal complications. Given the challenges linked to these barriers, Table II provides an analysis of relevant studies within the domain of crowdsourcing-based services that may hinder the seamless provision of truck-sharing services. It's worth mentioning that crowd-sourced logistics is predominantly found in business-to-consumer (B2C) markets, where a network of individuals or small businesses is used to directly deliver goods to consumers. This approach is frequently observed in e-commerce platforms, where independent drivers or delivery personnel are hired to deliver products to individual customers. In B2C crowd-sourced logistics, the emphasis is on delivering goods directly to customers' homes or specified locations (Seghezzi et al., 2021).

Collignon and Sternberg (2020)	The study's results show that many road carriers utilize a mix of different online marketplaces. The way they organize their marketplace portfolios is determined by their understanding of these services, the benefits they anticipate and receive, their attitude towards these marketplaces, and how carefully they manage them.
Castillo et al. (2018)	This study employs contingency theory to examine the logistics effectiveness of crowdsourced logistics (CSL) by simulating same-day deliveries to 1,000 customer locations in market conditions in New York. The findings are compared to those of a traditional fleet, providing insights into the performance of CSL in this context.
Vargas et al. (2020)	This paper introduces the FreightShare Lab Platform (FSLP) and its embedded business model, aiming to facilitate horizontal collaboration in freight logistics. In general, the use of developed models and algorithms clearly demonstrates a compelling argument for operators or road carriers to collaborate by sharing assets.
Bin et al. (2021)	The formation of synergy between crowd workers and crowdsourcing-based services has emerged as a factor in the advancement of urban logistics. Drawing upon commitment-trust theory and the concept of logistics synergy, this study presents a model that investigates the dimensions of ability trust, goodwill trust, logistics synergy, and their impact on crowdsourcing-based logistics services.
Buchman (2021)	It examines the factors that contribute to the relevance of services and explores the different types of service business models employed. However, the study acknowledges the significant barrier of establishing the necessary commercial and regulatory frameworks to enable the effective functioning of these services.
Saglietto (2021)	The study highlights the critical importance of acquiring knowledge to ensure the quality of work in logistics services that utilize crowdsourcing. It also stresses the need for effective management of potential risks, including the allocation of responsibilities, privacy issues, additional costs, delivery delays, and security concerns.
Jovanovic et al. (2022)	This study analyzes the factors that influence the adoption of a service by global actors in the supply chain industry. The value of the service depends on the digitization of workflows and the leverage of the ecosystem, while its governance includes strategic, technological, and interoperability aspects. These important mechanisms are crucial for the efficient management of a service ecosystem.

Table II. Studies pertain to barriers associated with crowdsourcing-based services

2.3 Horizontal collaboration in truck-sharing service

Truck-sharing represents a collaborative service involving enterprises operating at the same level. This approach offers various advantages, such as reducing empty trips, operational costs, greenhouse emissions, and enhancing the utilization of partially loaded trucks (Vargas et al., 2018). While existing literature underscores the importance of horizontal cooperation in truck-sharing, there exists a research gap in investigating the barriers encountered by shippers in their joint endeavors (Ouhader and Kyal, 2017). Additionally, Gansterer and Hartl (2018) recognize this research gap. However, taking a different perspective, Ferrell et al. (2020) highlight the necessity for logistics service providers to establish crucial connections, noting the lack of comprehensive theoretical exploration into the barriers encountered in achieving successful cooperation. In addressing these existing research concerns, a limited number of studies, such as the one conducted by Palmieri et al. (2019), have identified significant barriers that logistics service providers should consider to enhance the effective implementation of horizontal cooperation. Particularly noteworthy is the dearth of literature that specifically addresses collaboration or cooperation issues among road carriers, rather than focusing solely on shippers (Ouhader and Kyal, 2017). Despite several recent reviews on horizontal cooperation, including those by Basso et al. (2019), Mourad et al. (2019), and Pan et al. (2019), there remains a gap in understanding the specific barriers to cooperation among shippers. This research gap concerning shippers is explicitly acknowledged by Islam et al. (2021) as well. Thus, this study contributes to the existing body of research on truck-sharing among shippers, responding to the research call.

There are also numerous other research studies that discuss issues of horizontal collaboration in logistics. Therefore, the literature review by Abideen et al. (2023) provided insights into the optimal design of collaborative transportation networks, including aspects of profit-sharing, inventory bundling, distribution, vehicle routing, and transport planning to achieve effective horizontal collaboration. For example, the empirical study by Wallenburg and Schäffler (2016) found that implementing collaborative processes in performance measurement reduces conflicts among horizontal logistics service providers. They observed that joint action reduces conflict in symmetrical power cooperations, while information sharing decreases conflict in asymmetrical power cooperations. The empirical study by Lewis et al. (2015) examined the role of horizontal networks in collaborative marketing for small wine producers in a wine region through case study analysis. The empirical study by Buijs and Wortmann (2014) investigated the role of information technology (IT) in enabling horizontal supply chain collaboration among autonomous freight carriers through case study analysis. The theoretical and computational study by Lozano et al. (2013) developed a cooperative game theory approach to allocate benefits of horizontal cooperation in transport among companies, utilizing mathematical analysis. Finally, the mathematical modelling by Anand and Bahinipati (2012) developed a graph-theoretic approach to measure horizontal collaboration intensity in the semiconductor industry.

2.4 Research model development

This subsection presents an overview of the potential barriers considered during model development. The aim is to introduce barriers that could impact the intention to utilize truck-sharing services. These barriers encompass five aspects derived from the innovation resistance theory, alongside psychological and privacy concerns.

2.4.1 Innovation resistance theory. This theory pertains to active resistance towards innovation. This means, shippers' negative perceptions of truck-sharing may become evident as they develop a better understanding of it, reflecting the presence of "active innovation resistance." The unfavorable views can be attributed to five distinct causes, namely barriers related to usage, value, risk, tradition, and image (Ram and Sheth, 1989). Usage, value, and risk are functional barriers that shippers perceive as operational changes when considering truck-sharing services. Conversely, psychological barriers in the form of image and tradition emerge when the adoption of a truck-sharing service conflicts with the preexisting beliefs or images of shippers regarding such services (Laukkanen, 2016). While these barriers have been examined in various contexts, such as internet and mobile banking (Laukkanen, 2016), smart products (Mani and Chouk, 2017), and the internet of things (Mani and Chouk, 2018), their exploration in the context of truck-sharing services is lacking. There is a need for research to investigate how these barriers impact the adoption of truck-sharing services. According to Ram and Sheth (1989), the barriers (as shown in Figure 1) that cause to active innovation resistance can be explained as follows:

- Usage barriers arise when an individual's own practices, habits, or routines are incongruent with the theory of a truck-sharing service. Shippers may exhibit hesitation if the process of signing up for shared mobility is difficult or if they encounter difficulties in using the service.
- Value barriers arise when individuals struggle to justify the monetary tradeoff linked with innovative services. Shippers may be hesitant to adopt truck-sharing services if they are unable to articulate the value that these can provide in exchange for the costs involved.
- Risk barriers emerge when shippers experience uncertainty regarding the potential drawbacks or negative consequences of adopting truck-sharing services. Shippers may resist the adoption of truck-sharing services due to their awareness of the linked risks and concerns.
- Image barriers manifest when shippers hold unfavorable perceptions of truck-sharing due to its reputation (i.e., image). The negative images may stem from past experiences with transport companies or other barriers that have influenced their perceptions of truck-sharing.
- A “tradition” barrier arises when a shipper is resistant to adopting a service that does not align with their cultural or customary practices. The shipper may choose to maintain traditional methods of transport and view truck-sharing as a departure from their norms.

2.4.2 Psychological ownership. Psychological ownership refers to the sense of possession that a shipper experiences towards a truck. This can be observed through the use of possessive personal pronouns, such as "my" and "ours," indicating a strong feeling of ownership towards the truck (Van Dyne and Pierce, 2004, Jami et al., 2020). Thus, a shipper has reached a high level of psychological ownership when they feel "mine-ness" and feel like the rented truck in question belongs to "them" alone. These expressions can serve as indicators of individuals' attachment to the rented truck. Research found that the way people feel about things they own can affect how they behave towards those things (Dommer and Swaminathan, 2012). Surprisingly, individuals can develop a sense of psychological ownership towards items like rented trucks, even if they do not legally own them. Therefore, this psychological ownership does not require legal possession (Paundra et al., 2017). One of the main causes that contributes to the development of the "psychological ownership" concept is called "efficacy." This term refers to people's overall inclination to be in control of situations (Avey et al., 2009). This means that even when a vehicle is rented for a short period, a manager who identifies with a high level of psychological ownership may perceive it as belonging to their company. As a result, they might feel it should not be shared with others until the trip is completed (Figure 1). The concept of psychological ownership has been examined in many academic fields. These include the adoption of important ideas (Baer and Brown, 2012), consumer behavior (Li and Atkinson, 2020), information systems (Wang et al., 2021), and the management of critical natural resources (She et al., 2022). Based on the above discussion, in summary, psychological ownership relates to individuals' feelings of possession and attachment towards an object, influencing how they perceive and behave towards it. Conversely, psychological barriers represent mental obstacles that impede individuals from adopting new innovations, arising from factors such as image, and tradition. The image and tradition barriers have been detailed before and further elaborated upon in the Discussion section.

2.4.3 Privacy concern. When utilizing truck-sharing, carriers and shippers need to communicate key preferences, such as the maximum acceptable deviation from the main route before picking up products from another shipper. They also need to exchange other information, including the departure and destination locations of each shipper during the trip. Despite submitting this information through online portals or auction-based bilateral exchange systems for collaborative shipping, trust remains a barrier (Zhou and Li, 2014, Gansterer and Hartl, 2020). Therefore, researchers have highlighted concerns regarding "data governance and privacy" (Pan et al., 2019). Previous cases have demonstrated vulnerabilities in freight systems, with instances of compromised security and theft of critical information by fraudsters with database access (Ferrell et al., 2020). These weaknesses can create hesitancy among shippers to embrace truck-sharing. The extent to which this will impact the practice, mostly in the context of truck-sharing (Figure 1), is still uncertain. Privacy concerns are relevant in various domains, including e-commerce (Bandara et al., 2020), healthcare (Abouelmehdi et al., 2018), banking and finance (Lappeman et al., 2022), social networking (Jeong and Kim, 2017), and governance (Königs, 2022).

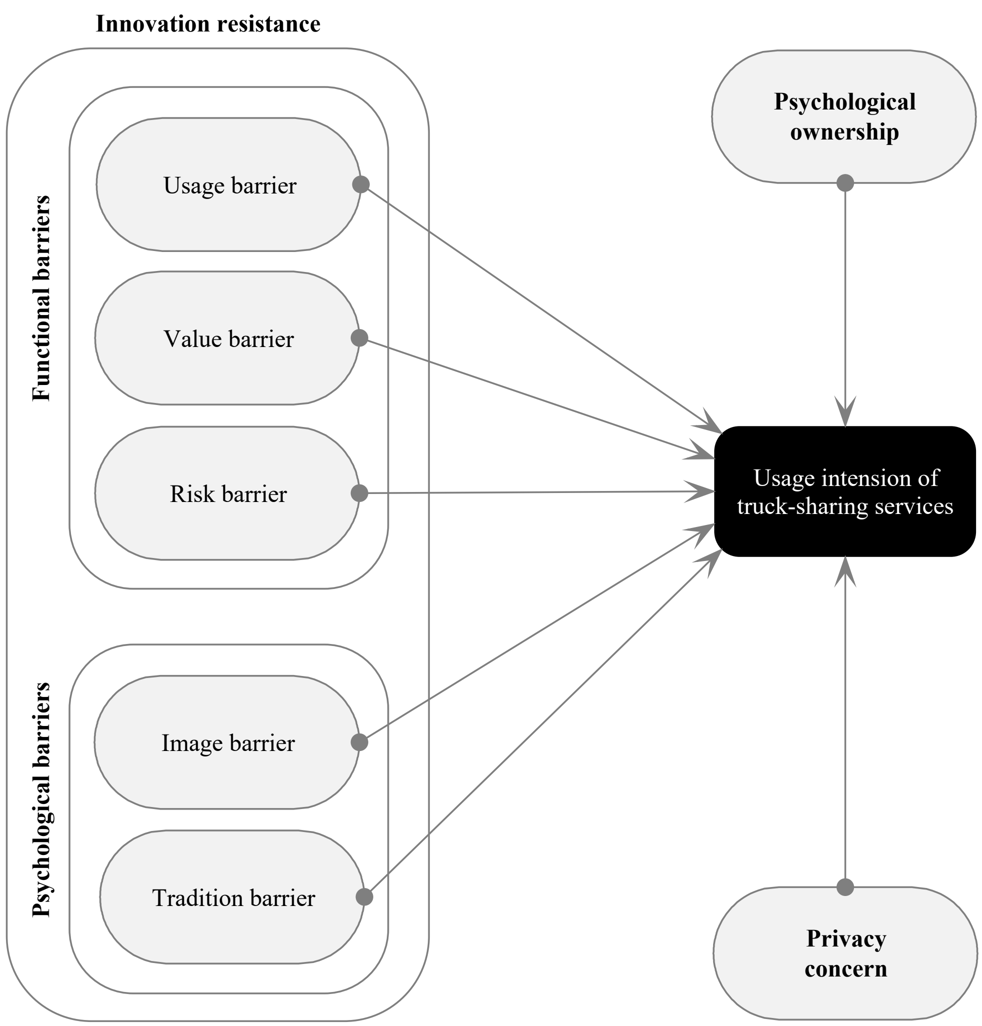

Figure 1. Research model development

3.0 Research methodology

3.1 Research context

The study's background focuses on Bangladesh's freight transport sector, chosen due to its inefficiency compared to other countries like Vietnam. In Bangladesh, the average truck utilization stands at 70%, which is significantly lower than Vietnam's higher utilization rate of almost 80% (Herrera Dappe et al., 2019, Lam et al., 2019). A comparison of truck operating costs between Bangladesh and Vietnam reveals a similar cost structure. Moreover, the expenditure on facilitation payments, fuel, insurance, registration, taxes, and tolls in Bangladesh exceeds that of Vietnam by 2 percentage points. Additionally, expenses related to repair, maintenance, and tires are 5 percentage points higher in Bangladesh compared to Vietnam (Herrera Dappe et al., 2019). Due to these inefficiencies, shipping costs in Bangladesh are three times higher compared to neighboring countries like India and Pakistan (The World Bank, 2018). This inefficiency results in a substantial number of empty trips, which could potentially be reduced by 20-30%, resulting in a significant decrease in ton-kilometers (Gota and Anthapur, 2016). Bangladesh thus offers a suitable setting to explore solutions to these challenges. Crowdsourcing-based truck sharing services are emerging as a potential solution, leveraging technology to optimize truck utilization and reduce empty runs. These services connect truck owners with individuals or businesses in need of transportation, offering a cost-effective and efficient solution to the inefficiencies in Bangladesh's freight transport sector. By tapping into a network of independent truck owners and utilizing smartphone technology for booking and tracking, crowdsourcing platforms have the potential to significantly improve the efficiency of logistics and reduce shipping costs in Bangladesh. As far as the authors are aware, an organization, Truck Lagbe (https://trucklagbe.com/), currently offers crowdsourcing-based truck-sharing services in Bangladesh, albeit to a very limited extent and for a limited number of customers. This limitation is primarily due to various constraints or barriers within the sector. However, Truck Lagbe is planning to expand its services to a larger extent in the future. The existing constraints may include factors such as limited access to technology, lacking infrastructure, regulatory challenges, and a fragmented market (The World Bank, 2018).

3.2 Sampling and survey instrument

Logistics and transport managers, as shippers, bear the responsibility of coordinating and facilitating the transportation of shipments from one location to another. Therefore, this study focuses on logistics and transport managers who possess knowledge of truck-sharing services as the unit of analysis, thereby resulting in an unknown sample frame and population size. To address these barriers, snowball and convenience sampling methods are employed. Previous studies by Zhu et al. (2008b) and Lin and Filieri (2015) utilized nonprobability sampling, specifically convenience sampling, in similar contexts, as it enables data collection in underprivileged countries like Bangladesh where subject databases or records are unavailable or inaccessible in many cases. Consequently, it has been argued that not all information gathering endeavors necessitate a probability sample survey (Fowler, 2009, p. 180). Moreover, the use of nonprobability sampling methods is particularly advantageous for obtaining information from specific industries and firms (Zhu et al., 2008a). For example, in this study, a significant proportion of the respondents work in export-oriented industries such as ready-to-wear clothing and chemicals, which heavily rely on trucks for transporting raw materials and finished goods.

Within the convenience sampling approach, purposive sampling is employed to select participants with specific qualities (Patton, 1990, Daveson et al., 2011). The survey respondents were then chosen based on three criteria: (1) they should have been overseeing transport operations for at least one year; (2) they should have been aware of the benefits associated with truck-sharing; and (3) they should not have previously engaged in truck-sharing to allow for the measurement of resistance behavior. To gather this important information, telephone communications were employed. The total number of respondents in this study is 168. ANNs are generally more flexible regarding sample size than traditional statistical models. While larger sample sizes can improve the generalization and accuracy of the model, ANNs can still perform well with smaller datasets due to their ability to learn complex patterns. This claim is well-supported by Hew et al. (2019), who state, "ANN imposes lenient requirements as it does not require the fulfillment of multivariate assumptions, outliers, and sample size." This quote highlights the flexibility of artificial neural network models, indicating that they are less constrained by sample size compared to other analytical methods. The data collection process involved the administration of a self-completed three-part questionnaire. The first section provided an outline of the research topic, while a confidentiality declaration assured respondents of anonymity while responding to the inquiries. The second part included Table III, which presented the measures that respondents were required to complete. The last part collected information about the respondents and their respective companies. The design of the instrument followed the guidelines of Churchill (1991). No incentives were offered to complete the survey.

Constructs	Items	Details
Image barrier	IB1[a]	I have a very negative image of truck-sharing services.
	IB2[a]	In my opinion, technology-based truck-sharing services are often too complicated to be useful.
	IB3[a]	I have such an image that truck-sharing services are difficult to use.
Usage barrier	UB1[a]	In my opinion, truck-sharing services are difficult to use.
	UB2[a]	In my opinion, the use of truck-sharing services is inconvenient.
	UB3[a]	In my opinion, truck-sharing services are slow to use, and take a lot of time.
	UB4[a]	In my opinion, the transport process in truck-sharing services is unclear.
Value barrier	VB1[a]	The use of truck-sharing services is luxurious.
	VB2[a]	In my opinion, truck-sharing services do not offer any advantage.
	VB3[a]	In my opinion, procuring truck-sharing services decrease my ability to control payment details and transport information on my own.
	VB4[a]	In my opinion, truck-sharing initiatives are useless in helping me to procure desired services.
Usage intention	UI1[b]	I plan to use truck-sharing services in the future.
	UI2[b]	It is most likely that I will use truck-sharing services in the future.
	UI3[b]	I think it is better for me to use truck-sharing services.
Privacy concern	PC1[c]	I am concerned that the sensitive company information I submit to truck-sharing services could be misused.
	PC2[c]	I am concerned that a person can find sensitive company information on the Internet.
	PC3[c]	I am concerned about providing sensitive company information to truck-sharing services, because of what others might do with it.
	PC4[c]	I am concerned about providing sensitive company information to truck-sharing services, because it could be used in a way I did not foresee.
Risk barrier	RB1[d]	I fear that while I am using truck-sharing services, lack of coordination in operations will be an issue.
	RB2[d]	I believe that while I am using truck-sharing services, third parties are able to use or see my company's sensitive information.
	RB3[d]	I fear that trust may be an issue with a shipper we do not know.
	RB4[d]	I fear that while I am procuring transportation through truck-sharing services, there might be operational constraints (e.g., truck capacity, the location of the shippers' facilities, and traffic congestion) involved.
Tradition barrier	TB1[d]	I prefer to patronize in traditional transportation procurement process and develop a relationship with a specific truck driver, rather than procuring transportation through truck-sharing services.
	TB2[d]	I find traditional transportation procurement services more pleasant than sharing a truck with another shipper.
	TB3[d]	I am so used to procure transport services through previously known, specific road carriers, and I find it difficult to move to truck-sharing services.
Psychological ownership	PO1[e]	I feel that this is my company's rented-out truck.
	PO2[e]	I sense that a rented-out truck belongs to my company only and nobody else.
	PO3[e]	I feel a high degree of personal ownership (i.e., sense of ownership) for a rented-out truck.
	PO4[e]	I sense that this is my company's truck.
Sources		[a] Items are adapted from Hew et al. (2019)
		[b] Items are adpted from Chemingui and Hajer Ben (2013)
		[c] Items are adapted from Zhou and Li (2014)
		[d] Items are adapted from Islam and Olsen (2014)
		[e] Items are adapted from Van Dyne and Pierce (2004)

Table III. Measurement items of the survey instrument

3.3 Measurement scale and pilot test

In order to enhance reliability, a 7-point Likert scale was utilized to score all items (1 = strongly disagree, 7 = strongly agree) (Yu et al., 2018). The items presented in Table III were derived from a comprehensive review of existing literature on truck-sharing barriers, innovation resistance theory, and related measurement instruments. We also sought feedback from three subject matter experts or researchers with expertise in the field of truck-sharing. Later the items were modified to suit the specific context of truck-sharing in Bangladesh to ensure relevance. For example, all items were adjusted in collaboration with five shipping and transport managers (Table IV) (Saldanha et al., 2014). Thus, the managers provided valuable feedback on a preliminary version of the survey instrument, enabling the refinement of question phrasing to align with local situation. Their input played a crucial role in establishing the face and content validity of the instrument (Leong et al., 2020). Initially, the questionnaire was developed in English and then translated into Bangla, followed by back-translation into English to verify accuracy. The purpose of this process was to identify any potential issues before conducting the pilot survey. Following the approach outlined by Yuen et al. (2019), the questionnaire was pilot-tested on a sample of 50 knowledgeable industry experts from various companies, once its initial development was completed. This pilot test aimed to assess the readability, validity, and reliability of the questionnaire before its implementation in the main survey. The analysis of reliability indicated that all items exhibited substantial alpha values and composite reliability.

Current position in the company	Category of the current organization	Experience in the current position	Experience in the current organization	Total length of job experience	Educational background
Assistant manager (logistics)	Manufacturer	5	7	7	University
Assistant manager (transport)	Manufacturer	3	5	6	University
Manager (administration)	Manufacturer	7	7	9	College
Manager (administration)	Manufacturer	3	6	6	University
Executive (administration)	Manufacturer	2	4	5	University

Table IV. Experts whose answers refine the questionnaire

3.4 Non-response and late response bias

A total of 210 respondents were initially contacted, out of which 110 complete responses were first received. A telephone call was then made to remind the non-respondents, resulting in 58 additional useful responses. Combining both attempts, a total of 168 complete questionnaires were returned, representing an 80 percent response rate in this study. Phone calls were effectively utilized to gather basic data about non-respondents, such as their age and number of years in the workforce. To evaluate non-response bias, the respondents were compared to the non-respondents according to Fawcett and Magnan (2002); no significant difference was found. T-tests, as suggested by Najafi Tavani et al. (2014), were employed to determine the existence of a late response bias; however, no significant difference was found between those two groups.

3.5 Artificial Neural Network (ANN)

In this study, a neural network was employed. This application is justified based on Hew et al. (2019), who elucidated the suitability of ANNs for this kind of investigation. Firstly, ANNs circumvent the need for multivariate assumptions, such as homoscedasticity, multicollinearity, normality of distribution, and linearity in relationships. Secondly, ANNs exhibit resilience in the face of missing, inaccurate, or outlier data (Bag et al., 2022). Thirdly, as an ANN learns, it has the capacity to identify both linear and nonlinear correlations among variables. This confers a distinct advantage to this study compared to alternative methodologies, including sophisticated techniques like Structural Equation Modeling (SEM). Lastly, as posited by Henseler et al. (2009), ANN emerges as the superior method when the research objective entails prediction, such as exploring predictive correlations between variables, which is the focus of this study. Also, ANNs are robust to issues arising from small sample sizes (Leong et al., 2020).

SPSS 20 has been chosen as the tool for implementing the multi-layer perceptron neural network, which employs the feed-forward-backpropagation algorithm to propagate the computed errors backwards, following the methodology or approach outlined by Taneja and Arora (2019). Drawing upon the work of Sharma et al. (2019), the sigmoid activation function has been utilized for the input layer, while the hidden neurons are automatically generated by SPSS. Moreover, in accordance with the approach proposed by Tan et al. (2014), a 10-fold cross-validation procedure has been adopted, with 90% of the data allocated for training purposes and the remaining 10% for testing, to mitigate issues related to overfitting. To assess the model's predictive accuracy, the Root Mean Square Error (RMSE) has been employed as a measure. A sensitivity analysis has been conducted to evaluate the relative importance of the barriers.

4.0 Data analysis and findings

4.1 Demographic profile

Table V presents the demographic characteristics of the respondents. The data reveals that the male population constitutes 85% of the participants, with 70% falling within the age range of 31 to 40. Also, a significant proportion of the respondents possess a university degree, indicating a majority in this educational category. In terms of employment, 71% of the participants work for export-oriented companies engaged in manufacturing activities. The respondents' job titles exhibit diversity, encompassing a wide array of transportation-related tasks. Furthermore, approximately 38% of the research participants possess professional experience of 6-10 years.

		Frequency	Percent
Gender	Male	143	85.1
	Female	25	14.9
Age (years)	Below 20	0	0
	21 - 30	57	33.93
	31 - 40	70	41.67
	41 - 50	33	19.64
	51 and above	8	4.76
Highest education	Primary school	4	2.4
	Secondary school	3	1.8
	College	10	6.0
	University	151	89.9
Company characteristics	Export-oriented	119	70.8
	Import-oriented	10	6.0
	Both	15	8.9
	None	24	14.3
Company characteristics	Manufacturer	117	69.6
	Wholesaler	24	14.3
	Retailer	5	3.0
	Other	22	13.1
Number of employees	<10 employees	4	2.4
	11-20 employees	4	2.4
	21-30 employees	1	.6
	31-40 employees	6	3.6
	41-50 employees	7	4.2
	>50 employees	146	86.9
Position in the company	Assistant Manager	9	5.4
	Deputy General Manager	3	1.8
	Executive	20	11.9
	Manager	29	17.3
	Merchandiser	22	13.1
	Officer	50	29.8
	Senior Executive	3	1.8
	Senior Manager	3	1.8
	Senior Officer	5	3.0
	Others: Assistant General Managers, Assistant Manager (Admin), Assistant Manager (Logistics), Assistant Manager (Transport)	24	14.1
Job experience (years)	<05 years	53	31.55
	6-10 years	64	38.09
	11-15 years	23	13.69
	16-20 years	10	5.92
	>20 years	18	10.71

Table V. Respondents' demographics

4.2 Instrument reliability and validity

The reliability of the construct is assessed using both Cronbach's alpha and composite reliability scores. These measures are commonly employed to evaluate the ability of a set of items to effectively capture a latent variable (Aibinu and Al-Lawati, 2010). Table VI presents the results, indicating that all coefficients surpass the minimum threshold of 0.70, signifying a generally "good" level of consistency for the instrument (Hew et al., 2018). Furthermore, the data in Table VI demonstrates that the "average variance extracted" exceeds 0.50, providing support for the convergence of the items towards the intended constructs. Consequently, convergent validity is established, reflecting the consistency of results across different measurement approaches for the constructs (Nordman and Tolstoy, 2016). In contrast, discriminant validity pertains to the degree of differentiation between a specific construct and its items, as well as those of other constructs and their items (Tan et al., 2014). This assertion is confirmed by applying the Fornell-Larcker criterion. As illustrated in Table VII, the square roots of the average variance extracted (AVE) for each construct exceed the corresponding interconstruct correlations (Zait and Bertea, 2011). The bold diagonal components represent the square roots of the shared variance between the constructs and their respective measurements (i.e., the AVEs), while the elements outside the diagonal represent the correlations between constructs. Assessing the cross-loadings of the items is another method for establishing discriminant validity (Hair et al., 2016). Higher loading scores indicate that an item effectively represents its associated construct, as the loading reflects the contribution of an item to a variable (Yong and Pearce, 2013). As observed in Table VIII, the items show strong loadings on their constructs, proving the validation of discriminant validity.

Construct	Average variance extracted	Composite reliability	Cronbach's alpha
Image barrier	**0.707**	**0.879**	**.883**
Usage barrier	**0.729**	**0.914**	**.882**
Value barrier	**0.810**	**0.945**	**.939**
Usage intention	**0.821**	**0.932**	**.996**
Privacy concern	**0.629**	**0.871**	**.803**
Risk barrier	**0.630**	**0.872**	**.803**
Tradition barrier	**0.698**	**0.873**	**.793**
Psychological ownership	**0.638**	**0.876**	**.819**

Table VI. Construct reliability and convergent validity

	Image barrier	Usage barrier	Value barrier	Usage intention	Privacy concern	Risk barrier	Tradition barrier	Psychological ownership
Image barrier	**0.8408**							
Usage barrier	0.254	**0.8538**						
Value barrier	0.296	-.024	**0.9**					
Usage intention	-0.528	-0.381	-0.314	**0.9060**				
Privacy concern	.065	.086	-.110	-.049	**0.7930**			
Risk barrier	0.163	.088	-.024	-.105	.075	**0.7937**		
Tradition barrier	.062	-.021	.046	-.147	.034	.014	**0.8354**	
Psychological ownership	.006	.037	-.093	-.122	.130	.114	.052	**0.7987**

Table VII. Discriminant validity

		VB	UB	UI	PO	RB	PC	IB	TB
Image barrier (IB)	IB1	.112	.062	-.258	-.028	.052	-.007	**.825**	-.074
	IB2	.141	.174	-.252	.001	.146	.034	**.829**	.089
	IB3	.194	.113	-.160	.015	.039	.070	**.868**	.062
Value barrier (VB)	VB1	**.918**	-.007	-.185	-.032	.012	-.013	.062	.016
	VB2	**.881**	-.077	-.137	-.050	-.012	-.104	.132	.049
	VB3	**.902**	-.039	-.088	-.032	.029	-.093	.165	.028
	VB4	**.899**	.020	-.058	-.054	-.086	.005	.082	-.032
Usage barrier (UB)	UB1	.075	**.929**	-.096	.039	.053	.082	.105	.095
	UB2	.060	**.922**	-.134	.058	.058	.092	.087	.077
	UB3	-.220	**.701**	-.196	-.079	.127	.007	.124	-.061
	UB4	-.053	**.844**	-.148	.006	-.089	-.047	.031	-.200
Usage intention (UI)	UI1	-.198	-.226	**.900**	-.078	-.030	-.022	-.258	-.088
	UI2	-.183	-.217	**.908**	-.071	-.054	-.016	-.258	-.076
	UI3	-.175	-.216	**.910**	-.079	-.056	-.020	-.253	-.079
Privacy concern (PC)	PC1	-.020	.085	.091	.214	-.055	**.702**	-.061	.013
	PC2	-.072	-.079	-.048	-.040	.022	**.843**	.041	.065
	PC3	-.109	.087	-.092	.078	.060	**.834**	.069	-.019
	PC4	.016	.027	.001	-.027	.073	**.785**	.032	-.009
Risk barrier (RB)	RB1	.020	.007	.018	.018	**.803**	.029	.111	-.018
	RB2	-.040	.084	-.086	.151	**.705**	.050	-.147	-.027
	RB3	.022	.012	-.019	.006	**.861**	-.003	.069	.062
	RB4	-.060	.018	-.028	.019	**.799**	.029	.156	.004
Tradition barrier (TB)	TB1	.016	.004	-.101	.030	-.043	-.001	-.084	**.880**
	TB2	.001	-.090	-.018	.021	.052	.022	.170	**.736**
	TB3	.032	.030	-.052	-.001	.006	.025	-.031	**.882**
Psychological ownership (PO)	PO1	-.135	.034	.007	.819	-.039	-.071	-.015	.186
	PO2	-.023	-.076	-.112	**.808**	.080	.060	-.036	-.054
	PO3	-.093	.017	-.121	**.824**	.038	.095	.070	.047
	PO4	.086	.053	.052	**.741**	.109	.109	-.023	-.099

Table VIII. Cross-loading of the items

4.3 Common Method Bias (CMB)

The presence of CMB may pose a concern in this study due to its reliance on a single data source. When estimating the relationships between variables, the potential for bias arises as CMB can lead to an overestimation of these relationships due to shared method variance (Conway and Lance, 2010). While no best technique exists to eliminate or test CMB, various procedural remedies can be employed to mitigate its effects (Nathan and Justin, 2015). For instance, modifications can be made to the scale items to enhance clarity, respondent anonymity can be ensured by keeping their names confidential, and the survey design can be refined through a series of iterative stages. In addition to these measures, statistical methods are employed to investigate CMB. Firstly, Harman's single-factor test is conducted, which explains 19.80% of the variance. Since this percentage is below 50%, it suggests that CMB is not a significant concern (Leong et al., 2020). Another post-hoc approach involves examining the correlation matrix among all constructs to identify any high correlations (above 0.9) as an indication of influence from CMV (Bagozzi et al., 1991). As shown in Table VII, no significant associations are found between any pair of constructs, indicating that CMB does not pose a problem in this study.

4.4 Multivariate assumptions

Neural networks do not rely on assumptions such as homoscedasticity, multicollinearity, normality of distribution, or linearity in relationships (Hew et al., 2019). However, the one-sample Kolmogorov-Smirnov test reveals a departure from normal distribution in the data, except for the variable "psychological ownership." This test result justifies the utilization of a neural network in this study since none of the scale variables meet the normality assumption. Also, examination of the scatter plot reveals evident patterns indicating heteroscedasticity (Gaudart et al., 2004). Thus, the assumption of homoscedasticity is not supported. Additionally, many of the independent and dependent variables exhibit weak correlations (Heiman, 2014). This suggests the potential presence of nonlinear relationships (Table IX) between the independent and dependent variables, providing further rationale for employing an ANN in this study. ANN has the capability to identify both linear and nonlinear correlations. Given the constraints of word count in this study, a presentation of all assumption test findings is omitted.

Barriers	Statistics	Usage intention	Image barrier	Value barrier	Usage barrier	Privacy concern	Risk barrier	Tradition barrier	Psychological ownership
Usage intention	Pearson Correlation	1	-.528**	-.314**	-.381**	-.049	-.105	-.147	-.122
	Sig. (2-tailed)		.000	.000	.000	.524	.174	.057	.114
Image barrier	Pearson Correlation	-.528**	1	.296**	.254**	.065	.163*	.062	.006
	Sig. (2-tailed)	.000		.000	.001	.404	.034	.425	.938
Value barrier	Pearson Correlation	-.314**	.296**	1	-.024	-.110	-.024	.046	-.093
	Sig. (2-tailed)	.000	.000		.761	.154	.756	.551	.231
Usage barrier	Pearson Correlation	-.381**	.254**	-.024	1	.086	.088	-.021	.037
	Sig. (2-tailed)	.000	.001	.761		.267	.259	.788	.634
Privacy concern	Pearson Correlation	-.049	.065	-.110	.086	1	.075	.034	.130
	Sig. (2-tailed)	.524	.404	.154	.267		.337	.660	.094
Risk barrier	Pearson Correlation	-.105	.163*	-.024	.088	.075	1	.014	.114
	Sig. (2-tailed)	.174	.034	.756	.259	.337		.853	.141
Tradition barrier	Pearson Correlation	-.147	.062	.046	-.021	.034	.014	1	.052
	Sig. (2-tailed)	.057	.425	.551	.788	.660	.853		.499
Psychological ownership	Pearson Correlation	-.122	.006	-.093	.037	.130	.114	.052	1
	Sig. (2-tailed)	.114	.938	.231	.634	.094	.141	.499	
**. Correlation is significant at the 0.01 level (2-tailed).									
*. Correlation is significant at the 0.05 level (2-tailed).									

Table IX. Correlation matrix for exploring linear relationships

4.5 Validating the model

An artificial neural network (ANN) model comprising seven input neurons, one output neuron, and four hidden neurons is constructed and depicted in Figure 2. The input neurons represent various barriers, which are connected to the three hidden neurons through non-zero synaptic weights. This substantiates the model's credibility and its ability to provide accurate forecasts (Hew et al., 2019). Moreover, Leong et al. (2020) assert that the model exhibits proficiency in predicting future outcomes, considering the average root mean square errors (RMSEs) during training and testing to be 0.25 and 0.34, respectively, with a small discrepancy between them. The outcomes of the neural network, obtained from ten separate runs, are presented in Table X.

Neural network analysis	Training			Testing		
	Sample	Sum of squares error	Root mean square error	Sample	Sum of squares error	Root mean square error
1	117	6.832	0.242	51	4.521	0.298
2	121	4.118	0.184	47	3.602	0.277
3	113	5.078	0.212	55	9.801	0.422
4	115	5.297	0.215	53	2.763	0.228
5	123	8.715	0.266	45	4.772	0.326
6	120	11.911	0.315	48	1.173	0.156
7	106	3.592	0.184	62	9.286	0.387
8	112	29.334	0.512	56	13.563	0.492
9	121	4.987	0.203	47	10.758	0.478
10	128	3.357	0.162	40	5.405	0.368
			Mean: 0.25 **SD: 0.10**			**Mean: 0.34** **SD: 0.10**

Table X. RMSE during training and testing procedures

According to Figure 2, the lines in the neural network model diagram represent connections between neurons. Each line indicates how one neuron's output contributes to the input of another neuron. In simpler terms, they represent the flow of information between different parts of the neural network. Moreover, synaptic weights represent the strength of connections between neurons. They determine how much influence one neuron has on another. Higher synaptic weights indicate stronger connections, meaning that the output of one neuron has a greater impact on the input of another neuron. Finally, "H (1:1)" refers to hidden layer neurons. In a neural network, the hidden layer(s) process the input data and extract features before passing them to the output layer for prediction. The numbers within parentheses denote the layer and the neuron number. So, "H (1:1)" refers to the first neuron in the first hidden layer. Understanding these neurons helps interpret how the neural network is processing important information.

Lines: Represent connections between neurons, showing how information flows through the neural network. **Bias** in a neural network allows each neuron to adjust its activation threshold independently, enabling the network to better fit the data and make more accurate predictions.

Synaptic Weight: Indicates the strength of connections or relationships. Higher weights mean stronger influences. synaptic weights greater than zero mean a positive influence, where the connected neurons reinforce each other's activation, while synaptic weights less than zero mean a negative influence, where the connected neurons inhibit each other's activation.

H (1:1): Refers to the first neuron in the first hidden layer. **H (1:2):** This denotes the second neuron in the first hidden layer. **H (1:3):** This denotes the third neuron in the first hidden layer. These neurons process the input data and contribute to the network's ability to learn and make predictions. The numbers following the colon indicate the position of the neuron within the layer.

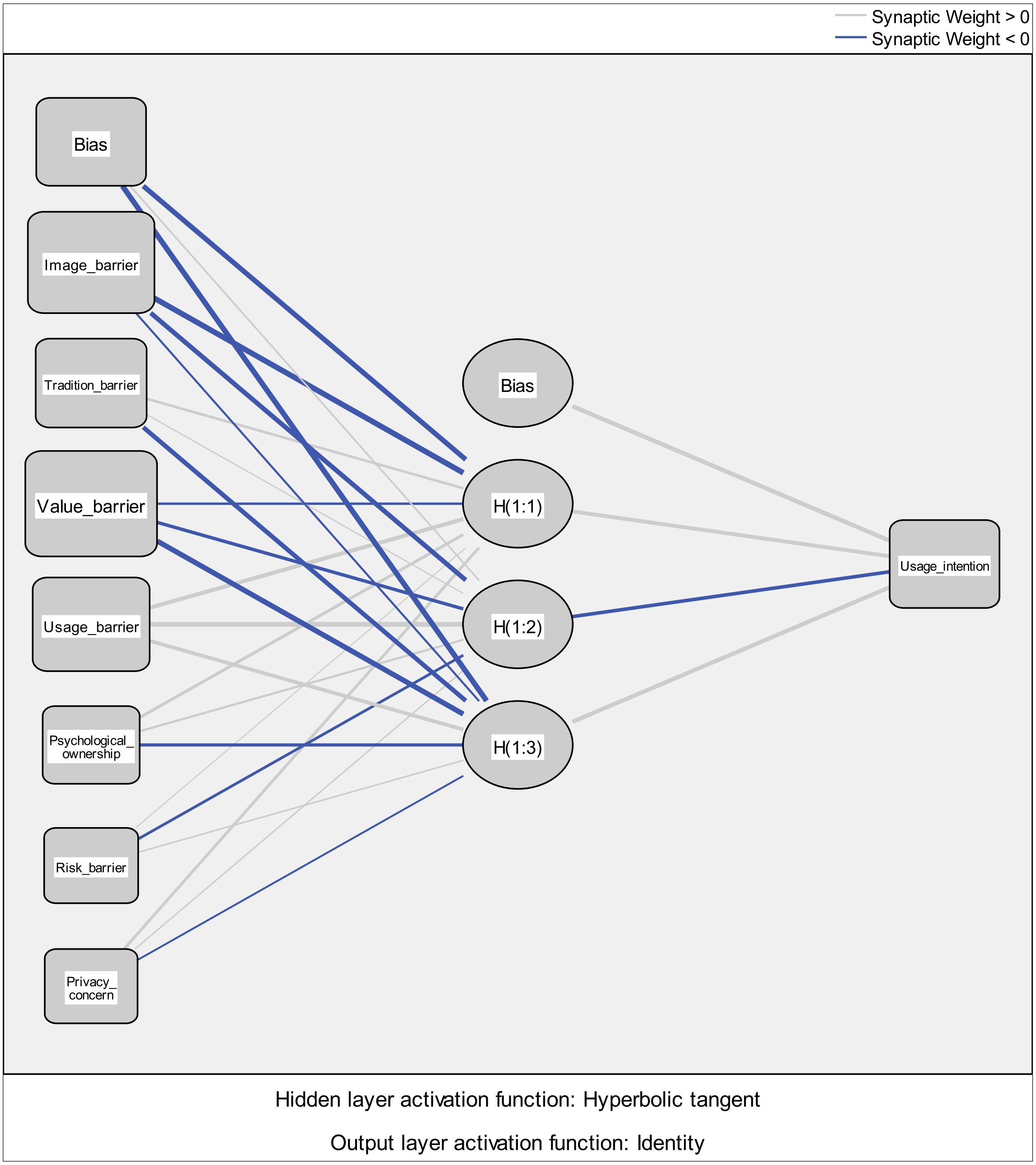

Figure 2. The neural network model

In a neural network, hidden neurons play a crucial role in processing input data by extracting and transforming features before passing them to the output layer. Each hidden neuron can be thought of as a feature detector, learning to recognize different patterns of the input data.

Characteristics of hidden neurons:

- **Activation Function**: Each hidden neuron applies a specific activation function (e.g., ReLU, sigmoid, tanh) to the weighted sum of its inputs. This function introduces non-linearity into the network, allowing it to model complex relationships in the data.
- **Synaptic Weights**: The weights associated with each hidden neuron determine how much influence each input feature has on the neuron's activation. These weights are adjusted during the training process, allowing the network to learn which features are most important for making accurate predictions.
- **Bias Term**: Each hidden neuron includes a bias term that allows it to adjust its activation threshold. This helps the neuron activate in response to inputs even if they are not strong, improving the network's ability to fit the data.
- **Feature Representation**: Different hidden neurons may respond to different aspects of the input data. For example, in an image recognition task, some neurons might become sensitive to edges, while others detect textures or shapes. This diversity in neuron responses contributes to the network's ability to learn complex features.

By understanding these characteristics, we can better interpret how hidden neurons contribute to the network's overall performance and decision-making process.

4.6 Sensitivity analysis

In order to evaluate the significance of barriers in relation to their impact on opposition to truck-sharing, a sensitivity analysis is conducted. This analysis involves determining the normalized relative importance of the barriers. This is calculated by dividing the relative importance of each barrier by the greatest relative importance, and it is expressed as a percentage (Hew et al., 2019). Among the barriers examined, the image barrier is found to have the highest level of significance, as indicated in Table XI. The remaining barriers are ranked as follows: tradition (40.87% normalized importance), value (34.60% normalized importance), usage (33.51% normalized importance), risk (24.79% normalized importance), psychological ownership (20.70% normalized importance), and privacy concerns (17.43% normalized importance).

Neural network analysis	Relative importance						
	Image barrier	Value barrier	Usage barrier	Privacy concern	Psychological ownership	Tradition barrier	Risk barrier
1	.378	.152	.037	.035	.091	.174	.134
2	.227	.079	.278	.073	.079	.119	.145
3	.431	.218	.066	.030	.030	.133	.091
4	.498	.169	.071	.035	.016	.162	.050
6	.268	.102	.173	.105	.102	.129	.121
7	.287	.110	.135	.084	.130	.180	.075
8	.475	.097	.084	.061	.059	.171	.053
9	.345	.099	.203	.079	.057	.131	.085
10	.393	.120	.062	.079	.122	.151	.073
Average relative importance	0.367	0.127	0.123	0.064	0.076	0.15	0.091
Normalized relative importance (in percentage)	**100**	**34.60**	**33.51**	**17.43**	**20.70**	**40.87**	**24.79**

Table XI. Sensitivity analysis

5.0 Discussion

This section initially presents the findings based on the innovation resistance theory, categorized into functional barriers and psychological barriers. Here, the functional barriers include functional barriers such as usage, value, and risk, while the psychological barriers encompass image and tradition. Following this, two additional barriers (psychological ownership and privacy concerns) are discussed along with their findings. Before delving into the details of the findings, it is important to note that this study represents an initial attempt, to the best of our knowledge, to apply the innovation resistance theory in analyzing shippers' resistance behavior towards truck-sharing. This is significant because persuading users, such as shippers in our study, to adopt new services poses a major challenge in the service industry (Mani and Chouk, 2018, Islam et al., 2021). This challenge arises due to the behavioral adjustments required from users to incorporate a new service into their routines (Meuter et al., 2005, Wang et al., 2023). In the realm of transportation, particularly truck-sharing, the validity of this assertion is supported by Vargas et al. (2020), and in Abideen et al. (2023), who emphasized that the freight market remains unprepared for the implementation of collaborative logistics services. This underscores the significance of addressing resistance behaviors in the context of truck-sharing services.

5.1 Psychological barrier

The two major barriers impeding the widespread adoption of truck-sharing are psychological in nature, specifically related to image and tradition. The top barrier influencing decision-making is the "image barrier" which has a 100 percent normalized relative importance. A negative linear relationship exists (Table IX) between the image barrier and the intention to utilize truck-sharing. The presence of image barriers within the realm of truck-sharing may encompass factors that truck-sharing services are negatively perceived, too complicated to be useful due to technology, and difficult to use. The presence of such negative perceptions towards truck-sharing services may arise from various transport issues, including considerations regarding dependability, security, service quality, reputation, trust, and societal stigmatization (Islam, 2017). Tradition ranks as the second most significant barrier, accounting for a relative importance of 40.87 percent. The relationship (Table IX) between tradition barrier and usage intention exhibits a negative association. However, the tradition barrier does not exhibit a linear effect on shippers' willingness to adopt truck-sharing (P value > 0.05). So, the traditional practices stemming from cultural contexts (Talwar et al., 2020). For example, shippers may perceive traditional transport procurement services as more favorable than sharing a truck with another shipper or sender.

5.2 Functional barrier

Functional barriers hold the second position, preceded by psychological barriers. Among the functional barriers, the value barrier emerges as the foremost significant barrier, accounting for 34.60 percent of the normalized relative importance. The value barrier shows (Table IX) a significant linear relationship with usage intention (P value < 0.05). This barrier indicates that shippers perceive truck-sharing as a luxury service and fail to recognize its potential in reducing freight costs compared to traditional transport methods. Despite the proven cost advantages of the truck-sharing service compared to conventional transport methods (Islam et al., 2021), they do not offer any value advantage, decrease shippers' ability to control payment details and transport information on their own, and are useless in helping them to procure desired services.

The usage barrier accounts for about 33.51 percent of the normalized relative importance and exhibits a comparable importance to the value barrier. The usage barrier shows a negative linear relationship with usage intention, as evidenced by a significant P-value (< 0.05). Usage barriers arise when shippers encounter apprehension due to the transition from their current operational approach to a more intricate one associated with increased “difficulty of use” (Kleijnen et al., 2009). Additionally, shippers believe that the use of truck-sharing services is inconvenient, slow to use, and time-consuming, and, most importantly, the transport process in truck-sharing services is unclear. These issues are expected, given the multitude of barriers that need to be addressed, including dissimilar geographical locations of shippers, unsuitable sites for specific activities like cargo pickup and delivery, inadequate transport infrastructure, non-standardized truck sizes, and traffic congestion (Islam, 2017). However, by leveraging the capabilities of a crowdsourcing-based service, truck-sharing can address many of the usage barriers (Zhang et al., 2022). For instance, the truck-sharing service should be capable of providing information, establishing trust, and facilitating communication to promote the acceptance of the service.

Risk emerges as the fifth most prominent barrier with a normalized relative importance of 24.79 percent. The absence of a significant linear relationship between the risk barrier and usage intention is indicated by a P value exceeding 0.05. Shippers encounter several challenges when using truck-sharing services. Firstly, there are concerns about operational coordination, with fears that inadequate organization could lead to delays. Secondly, there is apprehension regarding data security, as shippers worry that third parties may access or use sensitive company information. Thirdly, trust issues arise, particularly with unknown shippers, which can impact the reliability and consistency of service. Lastly, operational constraints such as limited truck capacity, distant shipper facilities, and traffic congestion further complicate the procurement process. These challenges highlight the need for improved coordination, data security measures, trust-building efforts, and solutions to mitigate operational constraints in truck-sharing services. Also, such sources of uncertainty can be alleviated by providing users with adequate information, thus augmenting their level of familiarity with a new service (Ma and Lee, 2019).

5.3 Psychological ownership

Psychological ownership and usage intention display a negative correlation; however, their overall importance is limited, as indicated by a normalized relative importance of merely 20.70 percent. Despite its minor relative importance, the barrier does impact shippers' resistance behavior to some extent. For example, they feel a strong sense of ownership towards the rented-out trucks, perceiving them as belonging exclusively to their company. This feeling of personal ownership leads to a belief that the truck is solely theirs and not shared with others. Consequently, shippers experience a sense of attachment and responsibility towards the truck, treating it as if it were their company's own vehicle. She et al. (2022) propose various strategies to influence psychological ownership, highlighting the effectiveness of a strategy inspired by the "Ant Forest" mobile app which digitizes users' low-carbon actions, converting them into green energy or points. Users can then acquire certificates through the app, serving as reminders of their participation in sustainable actions. Similar innovative applications could be developed for shippers to monitor their daily truck-sharing services, promoting engagement and awareness.

5.4 Privacy concern

Privacy concerns exhibit a minimal significance as a barrier, with a normalized relative relevance of 17.43%. The lack of a negative linear relationship between privacy concerns and usage intention (P value > 0.05) is observed. Yet, privacy concerns do become prominent for a few shippers when they perceive their privacy being violated by others or when they feel a loss of control over their information. These findings align with the conclusions drawn by Pan et al. (2019) and Islam et al. (2017), who assert that privacy concerns and related trust issues among shippers during the information exchange process impact truck-sharing services. However, truck-sharing services can enhance privacy protection for shippers by utilizing blockchain technology (Dadsena, 2023). For example, this technology enables shippers to engage in transactions using a distinct identifier, thereby safeguarding their real identities from being disclosed. This practice serves to protect the confidentiality of shippers, as their sensitive data is not directly associated with the transactions or disclosed to the public. The association between pseudonyms and actual identities can only be verified by authorized parties possessing the requisite decryption keys.

6.0 Managerial implication

The findings presented offer actionable guidance for various stakeholders to facilitate the adoption of truck-sharing services. Managers of truck-sharing services should prioritize targeted awareness campaigns to overcome psychological barriers among potential shippers, using data-driven insights to tailor communication strategies and promotional materials that address concerns like cost, reliability, and ease of use. They should also focus on developing user-centric platforms by conducting comprehensive user research and integrating feedback to refine service features, such as incorporating intuitive interfaces and providing clear user guides to mitigate barriers related to difficulty of use. Additionally, pilot programs or demonstrations could be implemented to showcase the benefits and functionality of truck-sharing services in real-world scenarios. Policymakers, on the other hand, should establish strategic partnerships with logistics service providers, industry associations, and government agencies to address functional barriers and enhance the acceptance of truck-sharing services. These collaborations can help develop and enforce standards that improve service reliability and safety, while supportive regulations and organized industry workshops can facilitate the integration of truck-sharing services into existing logistics frameworks and address regulatory challenges collectively. For shippers, overcoming usage and value barriers requires tailored educational materials and training programs, including how-to guides, video tutorials, and interactive workshops focused on practical aspects like navigating the platform, understanding cost structures, and optimizing usage. Continuous support, such as dedicated customer service and regular feedback sessions, will further assist shippers in adapting to the truck-sharing system, ensuring smooth adoption and effective utilization through training agendas that address common challenges and provide solutions.

7.0 Research implication

The investigation conducted in this study holds crucial research implications. (1) It contributes to the theoretical understanding of innovation resistance theory, particularly within the transport context, with a specific focus on truck-sharing services. This implication holds importance for the academic community as it aligns with the findings of Tsakalidis et al. (2020), emphasizing the presence of substantial barriers that need to be adequately identified before a transformative revolution in transportation innovation can be achieved. By doing so, this study also expands the current body of literature on innovation resistance theory and aids in the advancement of theoretical frameworks related to barriers in the adoption of innovative practices. (2) By explicitly categorizing the barriers, the study contributes to a comprehensive understanding of the collaboration barriers faced by potential shippers. This can serve as a foundation for future studies and inform the development of tailored strategies to address the most important barriers. For example, the research findings highlight the psychological barriers as the most prominent barriers in the adoption of collaborative truck-sharing. Therefore, this study responds to the call for further research made by Vargas et al. (2020), who highlighted the lack of readiness in the freight market for cooperative logistics and transportation. (3) Undertaking this research in a developing country such as Bangladesh offers a valuable viewpoint on the context-specific barriers, which is particularly significant considering the scarcity of studies focused on developing countries within the supply chain literature as noted in the review of Ibrahim et al. (2015). The limited availability of research in this context is anticipated given the barriers associated with data collection in developing countries. These barriers include a lack of awareness among residents regarding the significance of data collection, as well as inadequate infrastructural support such as transport networks, roads, and telecommunication systems (Islam et al., 2021). (4) The use of different research methods beyond conventional Structural Equation Modelling (SEM) to identify complex nonlinear relationships among variables has significant implications for the methodological literature. SEM is widely used for modeling linear relationships, but it may not always capture the intricacies of nonlinear dynamics, especially when studying complex phenomena like barriers to innovation adoption. By exploring alternative methods, such as machine learning techniques, researchers can more effectively uncover the subtle and nonlinear interactions between variables that may be overlooked by traditional methods. This exploration not only broadens the toolkit available to researchers but also provides a more nuanced understanding of how various factors influence innovation adoption.

8.0 Conclusion, limitation, and future study

The findings indicate that the most challenging barriers to truck-sharing are psychological in nature, specifically the image and tradition barriers. Among the functional barriers, the value barrier, risk barrier, and usage barrier are ranked in order of importance. Conversely, the third least significant category of barriers encompasses psychological ownership and privacy concerns. This study also presents a compilation of approaches drawn from existing literature that can be employed to address the identified barriers. This study makes a novel and significant contribution to the existing scholarly literature by applying the innovation resistance theory to the analysis of truck-sharing barriers. Policymakers can now gain a more thorough understanding of the primary barriers that necessitate immediate attention to promote truck-sharing services.

The research has a few limitations. Firstly, incorporating the views of carriers as service providers is crucial to understanding the barriers to truck-sharing from a distinct view. Secondly, the study's applicability is limited to the specific developing country in which it was conducted. Thirdly, the "black box" nature of ANNs poses barriers in terms of providing clear explanations for the model's predictions or decisions. This lack of interpretability may be a limitation in scenarios where understanding the underlying mechanisms of a model is crucial. In contrast to more transparent models (e.g., regression), ANNs lack this level of interpretability. Finally, additional potential barriers could enhance the comprehensiveness of this study in measuring their influence on truck-sharing usage intention. Notably, barriers such as competition or conflicts of interest have not been incorporated into the framework examined in this study. It is also important to acknowledge a limitation related to age categorization. Specifically, the current age brackets in Table 5 create a gap for respondents who are exactly 20 years old, which could potentially leave this group uncategorized. While we have chosen not to revise the existing age categories for this study, recognizing this limitation is crucial for ensuring transparency.

Within the realm of tradition and image barriers, further investigation is required to explore the barriers that impede shippers from embracing truck-sharing services. Thus, the utilization of Interpretive Structural Modeling (ISM) may show promise in unraveling the influential and dependent forces that underlie those barriers. Thus, targeting a few leading barriers associated with image and tradition barriers can yield optimal advantages in fostering shippers' adoption.

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