Journal of Infrastructure, Policy and Development 2024, 8(12), 7920.
https://doi.org/10.24294/jipd.v8i12.7920

Article

Optimization of ride-sharing services: An investigation of the ride-hailing service providers

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CITATION

Al Amin M, Hoque I, Jewel MMH, et al. (2024). Optimization of ride-sharing services: An investigation of the ride-hailing service providers. Journal of Infrastructure, Policy and Development. 8(12): 7920. https://doi.org/10.24294/jipd.v8i12.7920

ARTICLE INFO

Received: 11 July 2024
Accepted: 18 September 2024
Available online: 30 October 2024

Abstract: This study investigates the optimization of ride-sharing services (RSS) on the ride-hailing service (RHS) providers in Bangladesh. This study employed an explanatory sequential mixed method research design- a qualitative study followed by a quantitative one. Qualitative data were collected through focus group discussions and in-depth interviews with twenty (20) riders and drivers in Bangladesh, and quantitative data were collected from 300 respondents consisting of riders and drivers using a convenience sampling technique. Factor analysis and hierarchical cluster analysis were applied to the data analysis. The qualitative analysis reveals several significant factors associated with RSS and RHS, including cost efficiency, fare, fuel consumption, traffic congestion, carbon emissions, environmental pollution, employment opportunities, business growth, and security. The quantitative results indicate that using RSS is associated with more significant benefits than RHS in various aspects, including cost efficiency, fare, fuel consumption, traffic congestion, carbon emissions, environmental pollution, employment opportunities, and expansion of the automobile industry. The findings may assist policymakers in understanding how RSS can yield more incredible economic, environmental, and social benefits than RHS by analyzing fare sharing among passengers, carbon emissions, fuel consumption, and the expansion of the vehicle markets etc. Therefore, the government can formulate distinct policies for RSS holders due to their contributions to economic, social, and environmental concerns. While RHS services are available in many cities in Bangladesh, this study considered only Dhaka and Sylhet cities. Thus, future studies can consider more respondents from other cities for a holistic understanding.

Keywords: sharing economy; ride-hailing services; ride-sharing services; transportation; traffic jam

1. Introduction

Technology has changed many parts of our everyday lives, and the transportation business is no different (Lim and Fernandez, 2022). Ride-sharing services (RSS) manifest the sharing economy, facilitating the connection and accommodation of passengers in vehicles according to their seating capacity to reach a specific destination within a designated timeframe (Akbari et al., 2022; Boateng et al., 2019). One primary benefit of the ride-sharing business model is the reduced requirement for substantial investments in physical infrastructure and fixed assets such as manufacturing factories, automobile garages, and service centers. However, ride-sharing service providers require a shared application that facilitates the connection between riders and drivers, enabling transportation services (Agatz et al., 2012).

Presently, ride-sharing services are not being provided by companies like Uber BD, Pathao, Obhai, and Shohoz in Bangladesh; instead, they are solely engaged in supplying ride-hailing services (Afroj et al., 2022; Tarek et al., 2022). The current study investigates the optimization of ride-sharing services (RSS) for ride-hailing service (RHS) providers in Bangladesh.

Like many other cities in developing countries, traffic jams are common in Dhaka (Khan et al., 2022). Dhaka is ranked 8th (18.2 million people currently staying in Dhaka) as the most populated city in the world (Irani, 2017). Along with its vast population, colossal traffic congestion is a common phenomenon, with an average speed of only 07 kmph in Dhaka (Quaium, 2017). These two problems have opened room for increasing popularity of ride-hailing Service (RHS) providers like UBER BD, Pathaoo, and Obhai in Dhaka (Afroj et al., 2022; Islam et al., 2019; Phun et al., 2018). Ride-hailing apps have considerably changed Bangladesh's transportation system, making it easier, safer, and time-saving (Sakib, 2019). According to Zafri et al. (2021), the government of Bangladesh (GoB) imposes a minimum import tax of 300% on vehicles, particularly for acquiring private cars. Hence, it is quite improbable that households belonging to the middle class will possess personal automobiles. Middle-class and upper-class families may lack personal vehicles due to the application of elevated import taxes (minimum 300% tax). Furthermore, persons with private vehicles must incur significant operating expenses, encompassing prices for garage leasing, driver compensation, and other allowances. As a result, middle-income and high-income families rely on RSS and RHS platforms rather than purchasing personal vehicles.

Consequently, most individuals believe that utilizing RHS is superior to owning a personal vehicle due to its cost-effectiveness and convenience (Zuo et al., 2019). Bangladesh is home to approximately 24 ride-hailing firms, which encounter many obstacles, including accidents, appropriate government legislation, access to training facilities, effective monitoring mechanisms, and the cultivation of positive attitudes toward female consumers (Hoqu and Saumi, 2022). To address these difficulties, both RHS providers and passengers must participate actively. In light of the above circumstances, the objective of this study is to ascertain the optimal advantages of RSS in the context of Bangladesh, specifically in transitioning from RHS to RSS. Furthermore, the study aims to identify the key determinants influencing RHS and to elucidate the ramifications of RSS.

A gap between ride-sharing and ride-hailing services has been identified through a critical examination of relevant literature and interaction with a focus group, and it has been found that nobody shares rides in Bangladesh. Thus, it is imperative to transform ride-hailing into ride-sharing by filling up empty seats on trips. Converting ride-hailing services into RSS is one of the main goals of this study's proposed conceptual model, which would have several beneficial effects on national development, including eliminating traffic congestion and lessening environmental pollutants such as, air and noise pollution (Amin et al., 2024; Islam et al., 2024). Following a quantitative research approach and designing a survey questionnaire, this study analyzed collected data using qualitative and quantitative techniques (Karim et al., 2023; Rahman et al., 2024; Mustafi et al., 2024). This study's results demonstrate that using RSS significantly mitigates traffic congestion and environmental pollution

by effectively managing air and noise pollution, reducing the need for new parking spaces, and minimizing fuel usage (Amin and Oláh, 2024). Furthermore, this research presents a dynamic model founded on the service gap between RSS and RHS to transform the RHS into the RSS.

The rest of the paper has been structured into four sections. The second section presents a detailed literature review. The third section describes the methodology of the study. The fourth section is about results and analysis, followed by discussions. The final section concludes the study with limitations, contributions, and future research avenues.

2. Literature review

2.1. Sharing economy and its significance in developing countries

The term "sharing economy" encompasses a variety of business models that are transforming urban settings by enabling individuals to share, trade, rent, or lease products, services, and spaces (Berg and Fitter, 2015; Mont et al., 2020). The sharing economy is an economic model that includes community-driven online platforms for exchanging products and services between individuals (Baptista and Oliveira, 2015; Hamari et al., 2016; Liang et al., 2021). The sharing economy is also called the platform-based economy, the access economy, and collaborative consumption (Yaraghi and Ravaghi, 2017). Globally, sharing economy tools have altered the production and consumption of products (May et al., 2017; Zvolska et al., 2020). This is because digitalization is happening faster, and more people have smartphones (Mollah et al., 2024). Furthermore, the sharing economy is an internet-based business model in which individuals exchange resources and skills (Elmeguid et al., 2018). Ride-sharing is a contemporary service that prioritizes convenience and punctuality. It utilizes secure and user-friendly mobile phone technology for seamless transportation, connecting drivers and riders in various locations (Feeney, 2015; Qing et al., 2023; Gazi et al., 2024). Ride-sharing has become an increasingly prevalent mode of transportation (Akbari et al., 2021). Developing countries can benefit more from the idea of a sharing economy. Closed car-sharing services are becoming increasingly common among city dwellers living in public housing (Byun et al., 2017). By encouraging individuals to lease, share, trade, or donate unused products instead of purchasing them (Chatterjee, 2020), the shared economy maximizes resource utilization and reduces overconsumption in developing nations. As car-sharing evolves from an ecological lifestyle to an innovative economic model, Uber, DidiChuxing, and KakaoT disrupt traditional businesses worldwide (Cannon and Summers, 2014).

2.2. Ride-sharing services (RSS) as sharing economy vs. ride-hailing services (RHS)

Ride-sharing services (RSS) refer to a sort of transportation service wherein numerous individuals with comparable destinations are picked up and transported together in a single vehicle (Nabil et al., 2019). In contrast, trip-sourcing service/ride-hailing service (RHS) refers to the provision of dependable service at a reduced cost

of transportation compared to traditional taxicabs. In this RHS, passengers don't share their rides with other unknown passengers. This service is accessed by customers using their smartphones, allowing them to request a trip on demand (Dias et al., 2017). On the other side, the primary aim of RSS is to provide passengers with the opportunity to access various advantages of car usage without the need for personal vehicle ownership while also promoting economic effectiveness and environmental sustainability (Dias et al., 2017; Shaheen et al., 2016). RSS pertains to implementing the sharing economy, not RHS, because RSS emphasizes the coordination of riders heading in the same route, generally involving cost-sharing (Nabil et al., 2019).

In contrast, RHS pertains to drivers providing a paid service to an individual rider or group. Ride-sharing emphasizes communal, cost-effective transportation, whereas ride-hailing prioritizes convenience, practicality, and individualized transport. In the ride-sharing business model, RSS providers are not required to invest substantially in physical infrastructure or traditional assets. Furthermore, the organizations above do not employ individuals, specifically drivers, but rather function as platforms for generating cash through ride-sharing services (Moushi, 2018). Nabil et al. (2019) identified three primary advantages of RSS: the ability to mitigate air pollution, the potential for cost-sharing among passengers, and the capacity to alleviate traffic congestion. Khan et al. (2019) underscored that over 50% of individuals who own private cars use app-based travel network services, generating supplementary income. Moreover, individuals from various educational backgrounds, such as students, are increasingly opting for this service as a part-time employment opportunity. According to Baptista et al. (2014), car-sharing programs have been found to have significant benefits in reducing parking demand, decreasing vehicle purchases, and facilitating a transition from higher levels to lower levels of car ownership. According to Efthymiou et al. (2013), those aware of environmental issues and earning a moderate to low income are more likely to engage in responsible, sustainable behavior. This is achieved by providing cost-effective ride services and ensuring safer journeys, reducing the number of private cars on the road. Uber and Lyft are prominent ride-hailing firms in the United States, while DidiChuxing holds a significant market share in China. Similarly, Ola is a prominent player in India's ride-hailing industry. In Bangladesh, Uber BD and Pathaoo are the biggest ride-hailing companies. Conversely, Zipcar and car2go are well-known providers of ride-sharing services.

2.3. Factors affecting RSS in developing countries

Consumers' decisions for ride-sharing services in developing nations are influenced by socio-demographic parameters, cab service characteristics, company marketing techniques, access to mobile phones and trust, and car ownership (Lim and Fernandez, 2022; Rabbi et al., 2024). Dias et al. (2017) also mentioned that as people get older, they are less inclined to take advantage of a ride-hailing service. Clewlow and Mishra (2017) also identified a big difference between how often younger and older people use ride-hailing services. Under socio-demographics, age is an essential factor that affects how people choose ride-hailing services. Income and educational attainment also significantly affect whether people in developing countries choose ride-sharing services (Nistal and Regidor, 2016). Dias et al. (2017) factored in

smartphone ownership and concluded that those who own smartphones are likelier to utilize these RSS apps. According to Lagadic et al. (2019), affordability, ease of access, time savings, and a wide variety of vehicles are all factors found to influence people's decisions to join car-sharing programs significantly.

Moreover, car-sharing programs have been considered an efficient strategy to address social problems such as air pollution, traffic jams, and the number of automobiles on the road, particularly in undeveloped and developing nations (Sprei, 2018). The results of a stated-choice experiment conducted by Tian et al. (2021) show that time savings are more highly valued than monetary and societal advantages (**Table 1**). This could be due to the high cost and limited availability of parking spots in urban areas. Furthermore, Baptista et al. (2014) argue that car sharing enhances mobility by decreasing the need for parking and the cost of buying and maintaining cars. Significant factors influence consumers' decisions to use ride-sharing services in developing countries. Moreover, Hoque and Saumi (2022) mentioned that women are primarily concerned with scheduling routes, consistency, and timeliness regarding ride-sharing services. Lastly, vehicle-sharing participation is heavily influenced by psychological factors like drivers' intentions and passengers' impressions of the service (Chun et al., 2019; Shahneaz et al., 2020, Mahmud et al., 2023).

Table 1. Sustainable value creation potential of car sharing model.

Values	Dimensions	Car Sharing Model
Environmental	Enhance resource efficiency and the utilization of resources responsibly.	Fewer people owning cars means less need for parking space, less overproduction, and less use of natural resources. It may induce people to give up public transport, making it environmentally preferable.
Social	Protecting safety and health while observing laws, rules, rights, Respecting workers, stakeholders, and consumer rights, and expanding consumers' access to cars by ethical principles and without negative social impacts.	The service provider is responsible for vehicle maintenance, and travelling safety may be enhanced. Countries must establish policies for the sharing economy as a whole. Increase consumer access to automobiles. Must protect the interests of traditional taxi drivers. Promote shared consumer culture.
Economic	Improving affordability Boosting earnings and enterprise Stability of operations and risk reduction Boosting aesthetic appeal Enhancing economic prosperity	Consumers save money by sharing cars. The model creates a new commercial possibility. Offers consumers ease and affordability in today's flexible society, with frequently changing locations. New sharing platforms inspire all stakeholders. This new paradigm boosts firm earnings and consumer happiness.

Source: Adopted from Chaudhuri et al. (2022).

2.4. Challenges of RHS and RSS in Bangladesh

People living in underprivileged areas are prevented from using shared mobility initiatives due to various constraints, including financial, technical, skill-based, informational, and social obstacles (Yu and Shen, 2020; Islam et al., 2023). Fewer drivers and higher service charges exist for those living in low-income and high-crime

neighborhoods (Thebault-Spieker et al., 2015). Meanwhile, the inhabitants of low-income regions face barriers to entering the ride-hailing industry due to a shortage of personal vehicles (Kueider et al., 2012). Sonet et al. (2019) discovered that a significant proportion of the population, around 83%, does not possess any personal means of transportation. Conversely, approximately 75% of individuals rely on public buses as their primary mode of transportation in Bangladesh.

On the contrary, private autos account for 5% of passenger transportation while occupying 29% of the road space. Dhaka in Bangladesh is home to 26,756 registered public buses and 237,180 registered private cars, as reported by the Bangladesh Road Transport Authority (BRTA). These vehicles serve as means of transportation, facilitating the movement of individuals within the city. If Bangladesh can leverage RSS, it will alleviate the burden on public transportation and enhance the economic advantages for 237,180 car owners. Implementing seat or car-sharing services can effectively address the transportation scarcity in Dhaka city by facilitating efficient utilization of resources among individuals travelling to the same destination. This approach offers mutual benefits to both passengers and drivers. However, the significant challenges in this sector are gaining trust, weak communication facilities, improper road lanes with networks, and so on. Ullah and Islam (2017) mentioned that social values, norms, and religious considerations prevented women from utilizing and participating in these services. Moreover, He et al. (2018) demonstrated their concern regarding data privacy and passengers' safety, which are the primary challenges for these service providers. Consumers' concerns about utilizing mobile ride-hailing services are influenced by privacy and conflict risks (Wang et al., 2019). As a result, these concerns limit their subsequent buying patterns and purchase intention.

3. Research methodology

3.1. Research design

The present study will employ a hybrid research method, integrating quantitative and qualitative methodologies to comprehend ride-sharing services fully. The endeavor was undertaken to differentiate between ride-sharing and ride-hailing services. The designated participants were provided with a self-administered structured questionnaire to collect primary data from them. Secondary data was collected from scholarly research articles and academic books to conduct the literature review.

3.2. Sampling plan and technique

The study focused on the respondents who are riders and drivers involved in ride-hailing services in Bangladesh. The sample units consisted of individuals who directly utilized ride-sharing and ride-hailing services. The researchers employed the nonprobability sampling technique of convenience sampling to choose the sample. The total sample consisted of 300 individuals, encompassing drivers and passengers, with diverse demographic characteristics.

3.3. Demographic profile of respondents

Details of participating respondents are presented below in **Table 2**:

Table 2. Demographic profile of respondents.

	Categories	Percent
Gender	Male	75%
	Female	25%
	Total	100%
Age	Below 18 years	8%
	18–30 years	45%
	31–40 years	25%
	41–50 years	12%
	50 above	10%
	Total	100%
Occupation	Service holders	40.7%
	Entrepreneurs/ Businessman	35.3%
	Housewife	8%
	Students	15%
	Others	2%
	Total	100%
Education	SSC	15%
	HSC	18%
	Graduation	42%
	Post-Graduation	25%
	Total	100%

Table 2 presents the demographic breakdown of the participants. Among the 300 responders, 225 were male, constituting 75% of the total, while 75 were female, accounting for 25%. The primary age category of the participants indicates that 135 individuals are within the 18–30 age group, constituting around 45% of the total respondents, while 75 individuals are within the 31–40 age group, representing 25% of the overall participants. Of the respondents, 122 are service holders, constituting 40.7%, while 106 are employed as entrepreneurs or business people, representing 35.3% of the total sample size. Finally, among the respondents, 75 possess a post-graduate degree, representing 25% of the total, and 126 hold a graduate degree, comprising 42%.

3.4. Data collection and analysis technique

A meticulously designed questionnaire was distributed to the intended participants to gather data. The researchers personally obtained primary data from the cities of Dhaka and Sylhet. Primary data was collected by surveying employees from both Uber BD and Pathaoo offices in Dhaka city. Various sources, including books, articles, daily newspapers, and websites, were utilized to fulfill the need for secondary data. The statistical software package SPSS 20.0 was used for data analysis. This study

employed factor and cluster analysis as analytical techniques to provide empirical support for the suggested model.

3.5. Variables

The researchers found 15 variables through a focus group discussion, listed below (**Table 3**). Furthermore, these variables and items have been derived from other study studies.

Table 3. Research questions, variables, and sources.

Variables	Sources	Research Questions
V1. Cost efficiency	(Nabil et al., 2019)	RQ1: RSS saves my money more than RHS; RQ2: I pay less in RSS than RHS; RQ3: RHS charges surge pricing, while RSS charges fare pricing.
V2. Ensuring security	(Shabur and Ali, 2024)	RQ4: RSS has greater security than RHS; RQ5: I feel comfortable using RSS rather than RHS; RQ6: RSS has no hassle from other passengers.
V3. Promo code	(Chaudhuri et al., 2022)	RQ7: RSS has more promo codes than RHS; RQ8: RSS has more discounts than RHS
V4. Safe service for female	(Chaudhuri et al., 2022)	RQ9: Female users prefer RSS rather than RHS; RQ10: RSS less sexual harassment than RHS for female passengers
V5. Sharing cost	(Taylor, 2024).	RQ11: RSS splits the total fare among the passengers; RQ12: I pay based on the distance of travel in RSS rather than RHS; RQ6: RSS is cheaper than RHS
V6. Privacy of data	(Agatz et al., 2012)	RQ13: RSS ensures the privacy of data more than RHS; RQ14: I feel secure in the case of RSS; RQ15: My data will not be shared by RSS
V7. Reducing carbon footprint.	(Afsari et al., 2024); (de Palma et al., 2024)	RQ16: RSS reduces CO2 more than RHS; RQ17: RSS requires less cars than RHS;
V8. Reducing traffic jam	(de Palma et al., 2024); (Chan and Shaheen, 2012)	RQ18: More cars create more traffic jams; RQ19: RSS can reduce traffic congestion in Dhaka city than RHS; RQ20: We face more traffic jams due to RHS rather than RSS
V9. Reducing environment pollution	(Shabur and Ali, 2024)	RQ21: RSS reduces air pollution more than RHS; RQ22: RSS reduces sound pollution more than RHS
V10. Technical personnel	(Chaudhuri et al., 2022)	RQ23: RSS requires more technical personnel for operating Apps than RHS; RQ24: RSS Apps have complex algorithms instead of RHS Apps
V11. Reducing fuel consumption	(de Palma et al., 2024); (Agatz et al., 2012)	RQ25: Multiple people visit RSS rather than RHS; RQ26: RSS has less fuel consumption than RHS
V12. Expanding car business.	(Khan et al., 2029)	RQ27: Car dealers import more cars due to RSS business model; RQ28: Drivers purchase new cars to start RSS
V13. Employment Opportunity	(Chaudhuri et al., 2022)	RQ29: RSS creates more part-time employment than RHS; RQ30: Students work more in RHS rather than RHS; RQ31: RSS also creates full-time jobs more than RHS.
V14. Declining number of personal cars	(Afsari et al., 2024)	RQ32: RSS carries multiple passengers together than RHS; RQ33: RSS reduces the number of personal vehicles than RHS
V15. Lack of parking demand	(Lokhandwala and Cai, 2018); (Furuhata et al., 2013)	RQ34: RSS requires less parking demand than RHS; RQ35: Cars in RSS travel more than cars in RHS

4. Results and analysis

4.1. Factor analysis

4.1.1. Define the problem and formulate the hypothesis

This study is intended to know whether Ride Sharing Services offer more significant benefits than Ride Hailing services. To achieve this objective, 300 respondents were questioned to verify this statement based on 15 variables. These variables are considered when forming the null and alternative hypotheses. The hypothesis is:

- Ho: Ride Sharing Service (RSS) has no more merits than Ride-Hailing Service (RHS).

- H1: Ride Sharing Service (RSS) has more merits than Ride-Hailing Service (RHS).

4.1.2. Test hypothesis

Bartlett's Test of Sphericity is used to make judgments about hypotheses, while the KMO test is used to evaluate sampling efficiency (**Table 4**).

Bartlett's Sphericity Test indicates a 0.00 significance level (less than 0.05), with an estimated chi-square value of 11,022.458 and 105 degrees of freedom. Therefore, we reject the null hypothesis and conclude that Ride Sharing Services (RSS) are superior to Ride-Hailing Services (RHS) since the p-value is less than 0.05. In addition, the KMO test value must be greater than 0.5 to ensure sufficient sampling. The KMO value here is 0.917, which is statistically significant (p. 05).

Table 4. KMO and bartlett's test.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		**0.917**
Bartlett's Test of Sphericity	Approx. Chi-Square	11022.458
	Df	105
	Sig.	0.000

4.1.3. Determine the number of factors

Table 5. Number of factors from total variance explained.

Total Variance Explained									
Component	**Initial Eigenvalues**			**Extraction Sums of Squared Loadings**			**Rotation Sums of Squared Loadings**		
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	11.911	79.408	79.408	11.911	79.408	79.408	9.678	64.520	64.520
2	1.728	11.519	90.927	1.728	11.519	90.927	3.961	26.407	90.927
3	0.705	4.702	95.629						
4	0.203	1.350	96.980						
5	0.128	0.854	97.833						
6	0.084	0.562	98.395						
7	0.065	0.432	98.828						
8	0.042	0.277	99.104						
9	0.034	0.224	99.329						
10	0.024	0.157	99.485						
11	0.021	0.137	99.622						
12	0.020	0.134	99.757						
13	0.015	0.099	99.856						
14	0.013	0.085	99.941						
15	0.009	0.059	100.000						

Extraction Method: Principal component analysis.

The benefits of RSS and RHS can be distinguished using the total variance technique derived from principal component analysis. Both initial eigenvalues must exceed a value of one (1), and the cumulative sum of squared loadings for rotation must surpass a threshold of 60% to meet the criteria for a valid analysis. Based on the

above data, the rotation sums of squared loadings for factor 1 and factor 2 are 64.52 and 90.93, respectively. Hence, it is apparent that our inquiry encompasses two distinct components. The eigenvalue for factor 1 is 9.68, while the eigenvalue for factor 2 is 3.96. Both eigenvalues exceed the value of 1 (**Table 5**).

4.1.4. Interpret the results

Rotated Component Matrix segregates variables into components/factors. The Rotated Component Matrix reveals that the following variables are highly correlated with factor 1: Cost Efficiency (r = 0.872), Promo Code (r = 0.869), Sharing cost (r = 0.870), Reduce Carbon Footprint (r =0.842), Reduce Traffic Jam (r = 0.927), Reduce Environment Pollution (r = 0.841), Technical Personnel (r = 0.895), Reduce Fuel Cost (r = 0.853), Expand Car Business (r = 0.866), Employment Opportunities (r = 0.892), Decrease Number of Private Car (r = 0.957), and Reduce parking (r = 0.935). These elements could be profiled as Merits of RSS over RHS (**Table 6**).

While security (r = 0.937), user safety for women (r = 0.940), and data privacy (r = 0.939) have strong correlations with factor 2; these elements could be profiled as Demerits of RSS over RHS. The component plot rotated space is shown in the following **Figure 1**:

Additionally, the values from rotated component matrix are represents in the following **Table 6**:

Table 6. Rotated component matrix.

Rotated Component Matrix		
	Component	
	1	**2**
Cost Efficiency	0.872	0.403
Security	0.288	0.937
Promo Code	0.869	0.397
Female Users Safety	0.302	0.940
Sharing Cost	0.870	0.407
Data Privacy	0.305	0.939
Reduce Carbon Footprint	0.842	0.398
Reduce Traffic Jam	0.927	0.220
Reduce Environment Pollution	0.841	0.403
Technical Personnel	0.895	0.267
Reduce Fuel Cost	0.853	0.390
Expand Car Business	0.866	0.276
Employment Opportunities	0.892	0.283
Decrease Private Car	0.957	0.177
Reduce Parking Demand	0.935	0.228

Extraction Method: Principal component analysis.
Rotation Method: Varimax with kaiser normalization.

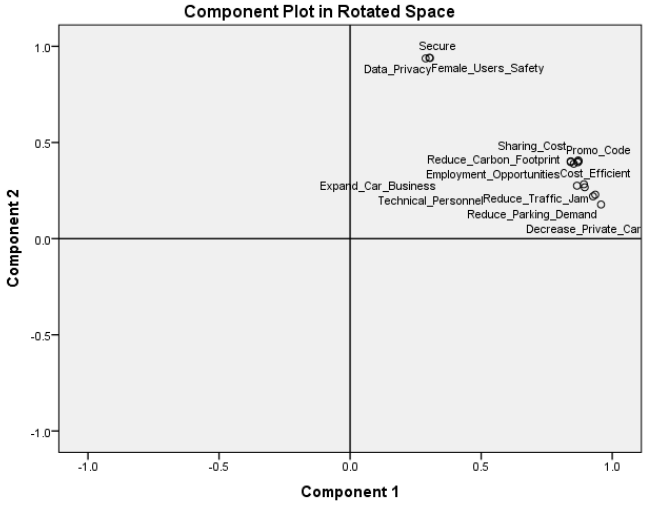

Figure 1. Component plot rotated space.

4.2. Hierarchical cluster analysis and interpretation

Hierarchical cluster analysis was investigated to understand the findings better. According to the agglomeration schedule (**Table 7**), cluster 1 has a strong correlation with the following variables: V1 (Cost Efficiency), V3 (Promo Code), V5 (Sharing Cost), V7 (Reduce Carbon Footprint), V8 (Reduce Traffic Jam), V9 (Reduce Environment Pollution), V10 (Technical Personnel), V11 (Reduce Fuel Cost), V12 (Expand Car Business), V13 (Employment Opportunities), V14 (Decrease Private Car) and V15 (Reduce Parking Demand). On the other hand, Cluster 2 exhibits excellent combinations with V2 (Security), V4 (Female User's Safety), and V6 (Data Privacy). The agglomeration schedules for clustering variables are shown in the following **Table 7**:

Table 7. Agglomeration schedules for clustering variables.

Agglomeration Schedule						
Stage	**Cluster Combined**		**Coefficients**	**Stage Cluster First Appears**		**Next Stage**
	Cluster 1	**Cluster 2**		**Cluster 1**	**Cluster 2**	
1	1	5	11.000	0	0	6
2	7	9	13.000	0	0	4
3	4	6	15.000	0	0	10
4	7	11	15.500	2	0	11
5	10	13	17.000	0	0	9
6	1	3	19.500	1	0	11
7	8	15	20.000	0	0	8
8	8	14	21.000	7	0	12
9	10	12	23.500	5	0	13
10	2	4	24.500	0	3	14
11	1	7	46.444	6	4	12
12	1	8	141.000	11	8	13
13	1	10	195.296	12	9	14
14	1	2	1697.417	13	10	0

As per Dendrogram chart (see **Figure 2**) below, Custer 1 is grouped by Cost Efficiency, Promo Code, Sharing Cost, Reducing Carbon Footprint, Reducing Traffic, Reducing Environment Pollution, Technical Personnel, Reducing Fuel Cost, Reducing Environment Pollution, Expanding Car Business, Employment Opportunities, Reducing Number of Private Car, and Reducing Parking Demand. In addition, Cluster 2 is divided into security, female user safety, and data privacy groups. The two clusters—Cluster 1 and Cluster 2—can be differentiated by the criteria they encompass as output, which signify the distinctive components of a comparative analysis of transportation services, potentially between RSS and RHS. Cluster 1 highlights the economic, environmental, and social benefits of RSS. The economic advantages of RSS encompass cost efficiency, promotional codes, cost sharing, technical personnel requirements, and the expansion of the automobile industry, whilst the environmental benefits include a reduction in carbon footprint, pollution mitigation, and decreased fuel expenses. Traffic mitigation, employment opportunities, reduced private vehicle usage, and decreased parking demand might be considered social benefits of RSS.

In contrast, Cluster 2 addresses potential security and privacy concerns, including security issues, safety measures for female passengers, and data privacy. These factors are the demerits of RSS. These findings align with the research purpose of differentiating RSS from RHS by elucidating the pros and cons of RSS compared to RHS. However, the **Figure 2** is demonstrating below:

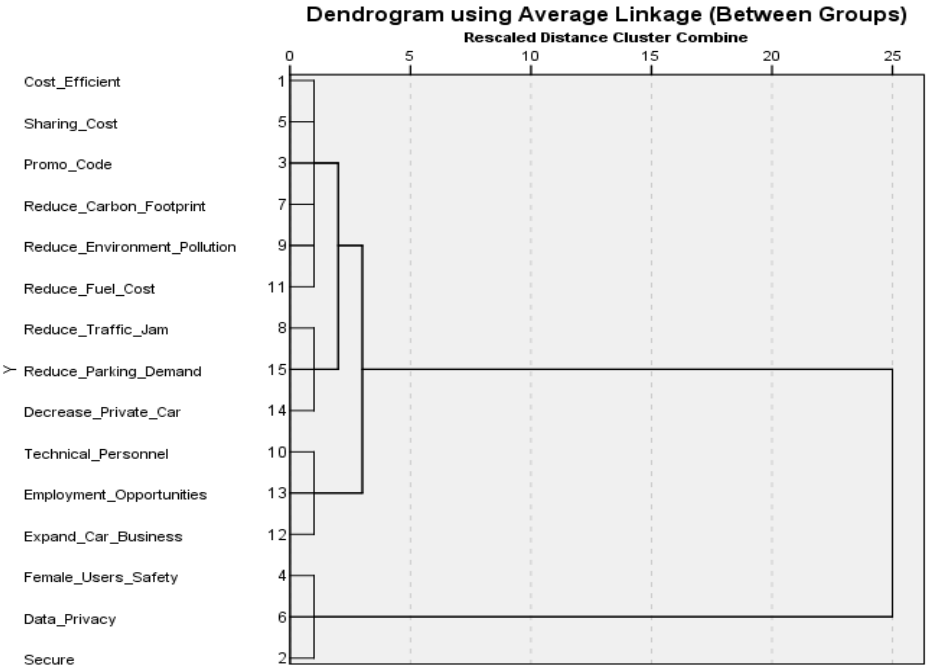

Figure 2. Dendrogram using average linkage method.

5. Discussions on findings

Both factor analysis and cluster analysis have demonstrated that Ride Sharing Services (RSS) exhibit advantages and disadvantages compared to Ride-Hailing Services (RHS). Moreover, after data analysis, it has been determined that RSS confers

more significant benefits than RHS. Recent research by Shabur and Ali (2024) indicates that RSS is significantly more cost-effective than ride-hailing services. While using RHS, a single service recipient hires the entire car and is responsible for the total fare. Therefore, at least two or three empty seats are found during the voyage through RHS. However, by providing RSS to travellers with identical travel destinations simultaneously, this issue can be quickly resolved. Moreover, ride-hailing service providers such as Uberbd, Pathao, and Shohoz, among others, employ promotional coupons to offer discounts to enhance the visibility and recognition of their transportation services. If businesses were to implement ride-sharing systems for their clients, they would likely be able to provide more promotional codes. Unlike the RHS, the RSS allows passengers to share financial responsibility collectively. In carpooling, multiple people can jointly use a single vehicle, maximizing its seating capacity (Taylor, 2024). This arrangement allows for the equitable distribution of the fare among the passengers. Due to this factor, the utilization of RSS, rather than RHS, guarantees equitable distribution of costs among passengers.

Ride-sharing services are deemed to possess a higher level of security than ride-hailing services. Most responders disagreed with this statement due to the requirement for travellers to share unoccupied seats with others when utilizing the RSS service. The security concern presents considerable hurdles for RSS owing to the possible presence of individuals with nefarious intentions (Shabur and Ali, 2024). Most participants agreed that RSS can mitigate the atmosphere's carbon footprint more than RHS. The decrease in vehicular traffic resulting from shared trips substantially reduces CO2 emissions (de Palma et al., 2024). Afsari et al. (2024) confirmed that ride-sharing can diminish annual emissions by 35% compared to individual ride-hailing. Two further significant advantages of RSS are the reduction of air pollution and fuel usage, as evidenced by prior studies conducted by de Palma et al. (2024). Afsari et al. (2024) contended that RSS decreases vehicle usage by 52% in New York City by reducing the number of individual trips taken by multiple passengers concurrently travelling to the same destination. Furthermore, it has been noted that it significantly alleviates traffic congestion more effectively than ride-hailing services (de Palma et al., 2024). Moreover, using ride-sharing services can potentially reduce the demand for parking. The riders will be subjected to increased requests if RSS is utilized. In this particular situation, riders are not required to maintain extended periods of vehicle parking.

6. Proposed model/recommendations

Currently, ride-sharing services are unavailable in Bangladesh due to security concerns, insufficient IT infrastructure development, and a lack of trust among passengers (Shabur and Ali, 2024). Notwithstanding their claim of offering ride-sharing, the primary trend in modern transportation services is mainly focused on ride-hailing. This article advocates for RHS providers to shift their services to RSS, as it benefits both customers and service providers. This work aims to present a model for converting RHS into RSS. The proposed model is depicted below in **Figures 3** and **Figure 4**.

6.1. Model of ride-hailing services

Passengers must book the entire vehicle to travel to a particular destination utilizing ride-hailing services. In the given scenario, if only one or two individuals intend to travel, the remaining 2 to 3 seats will stay unoccupied. Consider the scenario where an individual, referred to as Mr. X, wants to go on a journey from a starting point denoted as Destination (A) to a desired endpoint labeled as Destination (B) with a personal automobile. In order to facilitate this transportation arrangement, Mr. X must submit a formal request to the relevant transportation service provider, RHS. The RHS providers retrieve "X" from the designated location, referred to as destination A. Ultimately, Mr. X will fulfill his financial obligation by making the complete payment upon arrival at location B which is shown in the following **Figure 3**:

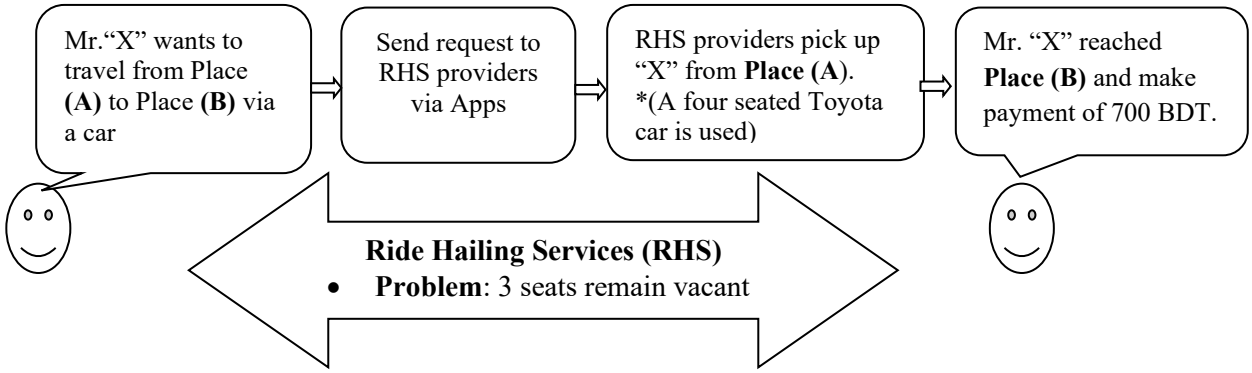

Figure 3. Model of Ride Hailing Services (RHS).

6.2. Proposed model of ride-sharing services

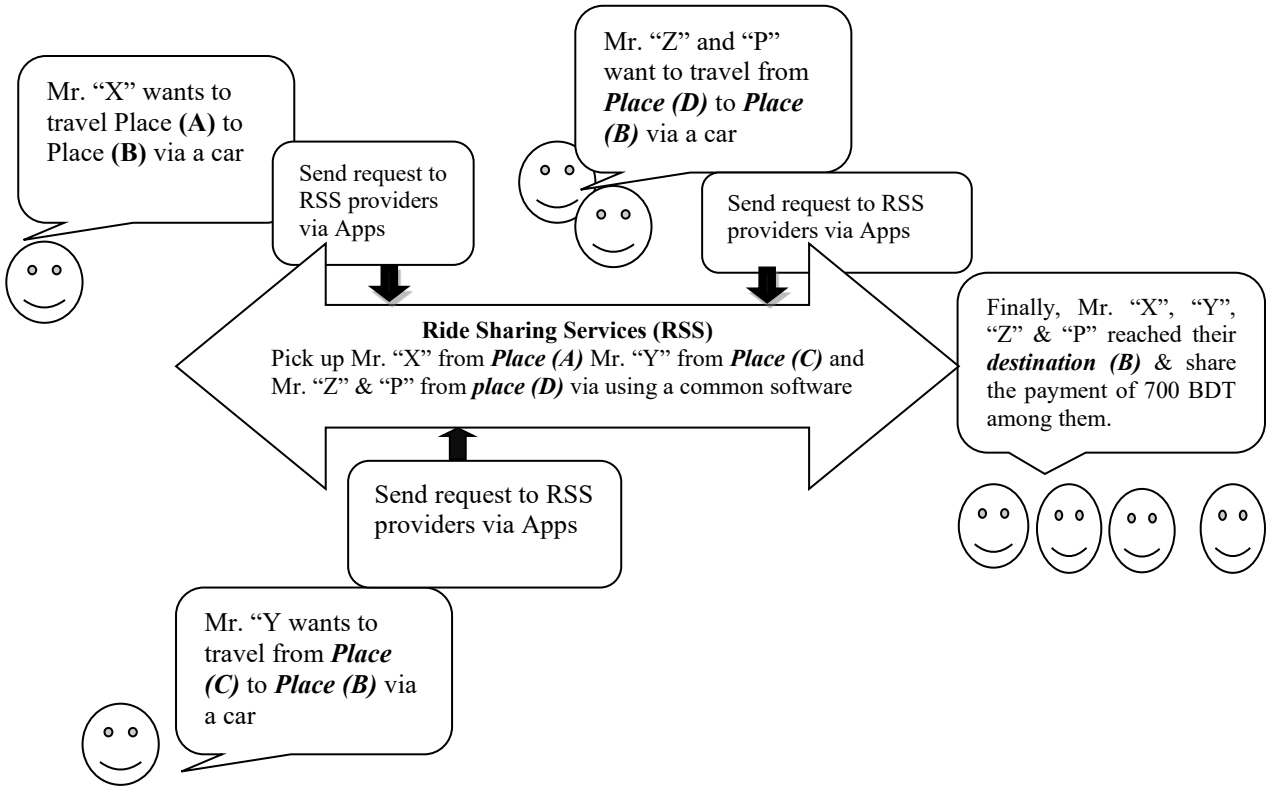

Figure 4. Researchers' proposed model of ride sharing services (RSS).

Multiple individuals can engage in collective travel by utilizing ride-sharing services, provided their planned destinations align. For instance, let us consider the scenario where an individual, referred to as Mr. "X," intends to embark on a journey from point A to point B utilizing a automobile as the mode of transportation. Mr. "Y" desires to go from Destination C to Destination B. Mr. "Z" and "P" have expressed a desire to embark on a journey from Destination D to Destination B. RSS providers retrieve Mr. "X" from Location A. Mr. "Y" from Destination C and Mr. "Z" and "P" from Destination D collaborated by utilizing widely available software. Ultimately, individuals identified as Mr. "X," "Y," "Z," and "P" successfully arrived at their intended destination, denoted as B, and proceeded to distribute a total sum of BDT. 700 amongst themselves (**Figure 4**).

6.3. Critical differences between RSS and RHS algorithm

Ride-sharing algorithms emphasize route optimization, cost-sharing, and the coordination of numerous riders to enhance a more intricate, communal travel experience. On the other hand, ride-hailing algorithms prioritize delivering swift, straight routes and transparent pricing to individual passengers. The primary distinctions are that match riders and route optimization are present in RSS, whereas they are lacking in RHS.

- RSS algorithm: Start → User Inputs Ride Request → Check for Available Drivers → Match Riders? → Yes → Driver Accepts? → Yes → Route Optimization → Ride Begins → Ride Completed? → Yes → Payment Processed → Feedback and Rating → End
- RHS algorithm: Start → User Inputs Ride Request → Check for Available Drivers → Driver Accepts? → Yes → Ride Begins → Ride Completed? → Yes → Payment Processed → Feedback and Rating → End

7. Conclusions

Ride-hailing and ride-sharing services offer a more extraordinary array of benefits compared to the mass transportation system in Bangladesh. The ride-hailing service is experiencing an increase in popularity within the major cities of Bangladesh due to the significant issue of traffic congestion. The study's findings indicate that Ride Sharing Services (RSS) is associated with more significant advantages than Ride-Hailing Services (RHS) in various aspects, including fare rates, fuel consumption, employment opportunities, and the expansion of the vehicle industry. However, it is imperative to acknowledge the presence of security concerns, particularly data privacy that must be effectively resolved when utilizing ride-sharing services. The study additionally suggests that RSS is more cost-effective in distributing costs among passengers than RHS. The utilization of RSS has yielded more significant reductions in traffic congestion, carbon emissions, and environmental pollutants compared to the implementation of RHS. The implementation of RSS has decreased parking demand, specifically in the number of personal vehicles compared to RHS.

Additionally, the utilization of RSS technology has been found to have a beneficial effect on the expansion of the automotive industry. The proposed initiative has the potential to generate a more significant number of employment prospects than

the RHS. Regarding employment opportunities for RSS, ride-sharing promotes the aggregation of several passengers, potentially enabling drivers to optimize their time and vehicle use. The heightened demand for shared trips might provide additional shifts and employment opportunities, particularly for professional or contracted drivers in extensive operations. Furthermore, ride-sharing networks require advanced algorithms to pair riders with analogous routes, increasing demand for technology engineers, data scientists, and support personnel to sustain and enhance these systems.

7.1. Theoretical and practical contributions

This study will contribute to services marketing, consumer behaviour, and transportation services literature, demonstrating how ride-hailing and ride-sharing services can be an excellent transport option besides a traditional transport system and how they can contribute to reducing transport crisis in a developing country. Furthermore, this will show how RSS and RHS services can be optimized by employing a suitable service design and involving all relevant stakeholders. From a practical perspective, this research endeavour can potentially incentivize automobile owners to share vehicles to generate supplementary income, thereby mitigating the difficulties associated with such services. Furthermore, the findings may assist policymakers, particularly in urban development and transportation, in understanding how RSS can yield more economic, environmental, and social advantages than RHS. Governments may implement incentives, such as tax reductions, subsidies, or toll waivers for ride-sharing platforms, to promote cost efficiency, diminish carbon emissions, and alleviate traffic congestion. Moreover, urban planning policies must integrate ride-sharing systems into comprehensive city development schemes. Decreasing dependence on private vehicles can enhance land utilization, especially in densely populated urban areas like Dhaka, where parking availability is constrained. Therefore, ride-sharing would be a good option for urban and environmental planning policy. Furthermore, policies that deter private vehicle ownership via congestion charges or elevated parking prices might encourage shared transportation, alleviating pressure on urban infrastructure. Finally, laws that guarantee rider safety, especially for women, alongside data privacy measures and incentives for electric vehicle integration in ride-sharing fleets, might mitigate significant issues while fostering sustainability and economic advancement.

7.2. Study limitations and future research avenues

While RSS (Ride-Sharing Services) and RHS (Ride-Hailing Services) are widely implemented across many cities in Bangladesh, this study specifically focused on two cities within the country, namely Dhaka and Sylhet. Therefore, the generalizability of the findings may be subject to scrutiny. Moreover, future research endeavours are recommended to encompass a broader range of cities to cultivate a comprehensive and all-encompassing comprehension. Furthermore, measures might be implemented to establish RSS and RHS services in all prominent urban canters inside Bangladesh. In order to address the constraint of limited sample size, future research initiatives can employ a cluster or quota sampling technique. Future research attempts may benefit from doing additional qualitative investigations to validate the conclusions of this

study. Given the paramount importance of security for RSS and RHS, it is imperative to conduct more investigations into the underlying security concerns and the associated reasons.

Author contributions: Conceptualization, MAA and IH; methodology, IH; software, MAA; validation, MBA, MMHJ and ED; formal analysis, MAA; investigation, EM; resources, ED; data curation, MBA; writing—original draft preparation, MAA; writing—review and editing, MBA; visualization, MMHJ; supervision, IH; project administration, ED; funding acquisition, EM. All authors have read and agreed to the published version of the manuscript.

Acknowledgments: This research was supported by the "University of Debrecen Program for Scientific Publication".

Conflict of interest: The authors declare no conflict of interest

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