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Willingness to Consider Pooled Rideshare? An Exploratory Study on Influential Factors

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Abstract

Rideshare use has grown significantly, beginning with solo riders and evolving to pooled rideshare. Pooled rideshare involves sharing a ride with stranger(s). Despite the growth in rideshare services worldwide, the use of pooled rideshare in the U.S. is relatively low within all rideshare trips and compared to other forms of transportation, e.g., driving one's personal vehicle. A national survey of 5,385 individuals was conducted to identify factors influencing riders' willingness to consider pooled rideshare. Exploratory and confirmatory factor analyses were performed. The survey results indicated five factors: *service experience, time/cost, traffic/environment, privacy*, and *safety*. Understanding these factors is crucial for the future of dynamic ridesharing services in the U.S.

Keywords

Pooled rideshare, Dynamic rideshare system, Factor analysis, Transportation network companies, User acceptance, Ride-hailing

Introduction

Ridesharing is an emerging form of transit. Two types of rideshare services are generally provided by transportation network companies (TNCs) such as Uber and Lyft, i.e., personal and pooled rideshare services. In a personal rideshare trip, the user is typically the only passenger in the vehicle but can be accompanied by other people that passenger already knows. In a pooled rideshare trip, the user shares the vehicle with passengers who are strangers using similar travel routes. Pooled rideshare has the potential advantage to reduce energy consumption and traffic congestion (Ke et al., 2020). However, user acceptance of pooled rideshare is lower than that of personal rideshare (Malokin et al., 2019). Understanding the factors limiting user acceptance of pooled rideshare is critical for its success.

Time and cost are typically the primary two factors studied in transportation mode choice studies. In a rideshare context, travel time includes the waiting time between requesting the ride, being picked up by the ride, the in-vehicle travel time through arriving at the destination. Due to the nature of pooled rideshare, where multiple passengers share the ride, the user of pooled rideshare inevitably experiences an increase in their in-vehicle travel time because of the detours needed to pick-up additional passengers. The increased travel time is a primary factor of lower user acceptance rates of pooled rideshare Chen (2017). TNCs usually set lower fare rates for pooled rideshare compared to personal rideshare on a given trip to promote the use of pooled rideshare (Sarriera et al., 2017). Despite the longer duration, the reduced pricing can attract users to pooled rideshare, however, the cost savings associated with pooled rideshare are insufficient to persuade all users to choose the service (Morris et al., 2019).

Traveling with strangers can pose safety concerns for users of pooled rideshare. Several survey studies have suggested that riding with strangers is considered unsafe, with the potential physical risk being a significant factor impacting trust toward all rideshare services (Chaube et al., 2010; Sarriera et al., 2017). Several crimes have taken place during rideshare trips in different countries that have added to the suspicion of safety issues with rideshare (Ma et al., 2019; Marotti, 2017).

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Previous ride experience is another important factor in user acceptance of pooled rideshare. There are multiple aspects of the ride experience including privacy, flexibility, and accessibility. Some riders view pooled rideshare positively because it allows riders to socialize (Bucher et al., 2016). However, most users prioritize privacy over socializing during their commute, and these users prefer personal rideshare more than pooled rideshare (Malokin et al., 2019). Compared to public transportation, pooled rideshare often has more flexible schedules and provides a better environment for multi-tasking during the ride at a modest cost (Morris et al., 2019; Sarriera et al., 2017; Spurlock et al., 2019). These ride experience factors are critical to the user acceptance of pooled rideshare.

A systematic understanding of additional influential factors on the user acceptance of pooled rideshare is needed. Therefore, besides the conventional factors such as time, cost, safety, and ride experience, this study also focuses on underexplored factors, including environmental consciousness, flexibility of service, congestion relief, and the broader societal benefits of pooled rideshare. This paper describes a national survey study aimed at exploring these contributing factors to the user acceptance of pooled rideshare. A series of topics related to the willingness to utilize pooled rideshare services were surveyed, and a factor analysis was conducted on the responses. This comprehensive approach helps to identify key groupings of these topical areas, enabling us to better understand what factors predict one's willingness to consider using pooled rideshare. The outcome of this study is intended to assist researchers and policymakers in developing strategies to improve the user acceptance of pooled rideshare, providing a more nuanced understanding of the barriers and drivers towards its adoption.

Method

Participants

The Institutional Review Board at Clemson University approved this study. The online survey was conducted between July to August 2021. All participants completed two screener questions relative to their age and rideshare experience in the last five years. Participants had to be at least 18 years of age. Potential participants who identified as working as a driver for a rideshare company but who had no rideshare experience as a passenger were excluded from the study. The total number of participants in the study was 5,385. Two thousand participants were recruited across the U.S., and the remaining 3,385 participants were recruited from target locations, including Atlanta, Austin, Chicago, Detroit, New York City, San Francisco, and the Upstate of South Carolina. Participants' age ranged from 18 to 95 years, with a mean of 46.5 years (SD = 17.5). Among the 5,385 participants, 2,803 self-identified as female and 2,545 as male.

Online Survey

After the two screener questions described above, and providing consent, each participant completed five sections:

- Section I: Your transportation needs. This section asked questions to understand the participant's typical modes of transportation and reasons for using personal and pooled rideshare services.
- Section II: Willingness to consider pooled rideshare (PR). This section assessed the participant's readiness to use PR.
- Section III.a and III.b: Would/Would not consider PR. This section investigated topics that may attribute to the participant's willingness or unwillingness to consider using pooled rideshare.
- Section IV: Optimizing rideshare experience. This section examined topics related to user-centered topics and service-related needs.
- Section V: Demographics. This section gathered information about the participant and their household.

Though the study consists of five sections, this paper focuses on questions in Sections III.a and III.b of the survey. In Section II (willingness to consider PR), one key question required participants to respond 'Yes', 'No', or 'Don't know' to describe the overall willingness to consider using PR. Participants who responded 'Yes' were directed to Section III.a, which investigated the importance of a series of items related to their willingness to consider PR while those who responded 'No' or 'Don't know' were directed to Section III.b, which investigated the importance of those same items related to their unwillingness to consider PR. Sections III.a and III.b consisted of 25 identical survey items. The design allowed the proper wording to be used for participants who would and would not consider PR, allowing a similar survey experience for all participants.

For the Section III.a and III.b, while designing the survey, the research team grouped the questions into six categories including Time & cost, Environmental, Social, Personal Safety, Reliability & Accessibility, and Convenience for a total of 25 survey items. Participants rated the importance of each item using a four-point Likert scale: 'Not at all important', 'Not very important', 'Important', and 'Very important'. Each survey topic was assigned a shorter item name for simplicity of representation, see Table 1.

Data Analysis

Because Sections III.a and III.b consisted of identical items, responses to these two sections were combined for statistical analysis. A factor analysis was conducted to identify the underlying latent dimensions, i.e., factors. Though the items were initially grouped into six categories, items in one

Table 1. Original category and survey items from Section III.a and Section III.b.

Original category	Survey item	Item name
Time & cost	Travel time from door to door	Time_Door2Door
Time & cost	Wait time	Time_Wait
Time & cost	Cost savings/incentives received for pooling the ride	Cost_Savings
Time & cost	Cost of driving my personal vehicle	Cost_DrivingSelf
Time & cost	On-time likelihood	Time_OnTime
Environmental	Help to improve the environment	Env_Improve
Environmental	Help to reduce traffic congestion	Env_ReduceTraffic
Social	Chance to meet new people	Social_MeetOthers
Social	Prefer to travel alone	Social_TravelAlone
Personal safety	Traveling during the day	Safe_DayTravel
Personal safety	Traveling at night	Safe_NightTravel
Personal safety	Familiarity with travel vicinity	Safe_Vicinity
Personal safety	Desire for privacy	Safe_Privacy
Personal safety	Trust in the driver	Safe_TrustDriver
Personal safety	Trust in other passengers	Safe_TrustRiders
Personal safety	I am with another person I know	Safe_KnownRider
Reliability & accessibility	Other public transportation options are available	Rel_OtherTransport
Reliability & accessibility	Trust that the rideshare will get me to my destination when I need to be there	Rel_TrustReachDest
Reliability & accessibility	Previous rideshare experience	Rel_RideExperience
Reliability & accessibility	Accessibility needs for passengers with disabilities	Acc_DisabilityNeeds
Reliability & accessibility	I don't have access to other public transportation options	Acc_OtherTransport
Convenience	Convenience of driving my personal vehicle	Conv_DrivingSelf
Convenience	Rideshare App ease of use to request a pooled ride	Conv_EaseOfApp
Convenience	Ability to do other things during the ride	Conv_Multitask
Convenience	Other public transportation options are convenient	Conv_OtherTransport

category may be more correlated to items from another category. An exploratory factor analysis (EFA) determined whether items were more strongly correlated to items from different or new categories (Hayton et al., 2004). A factor model with grouping information about the survey items was generated after the EFA. A confirmatory factor analysis (CFA) was conducted to assess the validity of the factor model (Brown & Moore, 2012). A holdout validation approach was used with an 80/20 split. When the data were processed, 80% of the total sample (N = 4,296) was selected for the EFA model fitting, and 20% of the total sample (N = 1,089) was selected for the CFA model fitting. The two sample sets were generated by stratified sampling. The total sample set was grouped according to the regions of participants (national sample and 7 different cities), and the willingness to consider using pooled rideshare ('Yes', 'No', and 'Don't know' responses). In each sample group, 80% of the samples were randomly selected for the EFA sample set, and 20% of the samples were randomly selected for the CFA sample set.

Results

Descriptive Statistics

For the total sample, combining those who are and are not willing to consider PR, 24 out of the 25 survey items were rated as 'Important' or 'Very important' by more than 50% of the participants. The one exception was the '*Chance to meet new people*,' which was categorized as a social-related variable, with only 31.7% reporting this item as 'Important' or 'Very important'. Items categorized as or related to personal safety were rated by greater than 70% of participants as either 'Important' or 'Very important'. The two items related to personal safety with the greatest percentage of participants rating the items as 'Important' or 'Very important' were '*Trust in the driver*' (87.1%) and '*Trust in other passengers*' (86.3%). Similarly, the percentage of participants who rated 'Important' or 'Very important' for '*Travel time from door to door*', '*Wait time*', and '*On-time likelihood*' were 79.9%, 81.2%, and 80.9% respectively, suggesting that the time-related items were important in the decision to utilize pooled rideshare. Other notable results were that over 80% of participants considered '*Trust that the rideshare will get me to my destination when I need to be there*' (83.5%) and '*Convenience of driving my personal vehicle*' (81.7%) as 'Important' or 'Very important'. A descriptive summary of the responses from the total sample is shown in Table 2.

Exploratory Factor Analysis

Appropriateness of the data. Bartlett's test of sphericity was statistically significant, $\chi 2(300) = 47{,}084.22$, $p < .001$, indicating that there were significant correlations between

Table 2. Summary responses to the survey items from the total sample (N = 5,385).

Item name	Not at all important	Not very important	Important	Very important
Time_Door2Door	7.9%	12.1%	47.9%	32.0%
Time_Wait	7.4%	11.4%	45.6%	35.7%
Cost_Savings	12.6%	20.0%	39.8%	27.5%
Cost_DrivingSelf	13.7%	20.3%	40.5%	25.5%
Time_OnTime	7.8%	11.3%	44.8%	36.1%
Env_Improve	14.7%	19.9%	43.3%	22.1%
Env_ReduceTraffic	14.8%	21.0%	43.3%	20.9%
Social_MeetOthers	36.8%	31.6%	21.2%	10.5%
Social_TravelAlone	6.9%	20.3%	38.8%	34.1%
Safe_DayTravel	9.2%	19.9%	44.7%	26.3%
Safe_NightTravel	10.3%	19.3%	36.3%	34.1%
Safe_Vicinity	6.7%	14.4%	47.7%	31.2%
Safe_Privacy	5.4%	16.1%	42.6%	35.9%
Safe_TrustDriver	5.5%	7.4%	39.5%	47.7%
Safe_TrustRiders	5.4%	8.4%	39.3%	46.9%
Safe_KnownRider	7.3%	17.8%	41.4%	33.5%
Rel_OtherTransport	15.4%	24.3%	42.1%	18.3%
Rel_TrustReachDest	8.4%	8.2%	41.0%	42.5%
Rel_RideExperience	20.7%	20.3%	39.7%	19.3%
Acc_DisabilityNeeds	23.1%	22.4%	32.7%	21.8%
Acc_OtherTransport	20.8%	23.1%	36.5%	19.6%
Conv_DrivingSelf	7.1%	11.2%	39.2%	42.5%
Conv_EaseOfApp	18.1%	20.9%	40.4%	20.6%
Conv_Multitask	16.3%	26.5%	37.1%	20.1%
Conv_OtherTransport	17.7%	24.4%	41.3%	16.6%

survey items. The Kaiser–Meyer–Olkin test was used to assess the measure of sampling adequacy for each of the survey items and for the entire survey resulting in individual measure of sampling adequacy (MSA) values and an overall MSA value, respectively. The MSA values for all individual survey items were .88 or greater, with an overall MSA value of .93. Since the overall MSA was greater than .88, this suggests that the correlation matrix among the items was sufficiently large enough and appropriate for an EFA.

Exploratory factor analysis model. Several EFA models with different numbers of factors were fit and compared. Based on multiple criteria, e.g., Kaiser's rule (Kaiser, 1960), parallel analysis (Horn, 1965), and reasoning based on the item topic, the number of factors were finalized. The strongest and final solution suggested that 23 survey items contributed to five factors. Two survey items ('*Cost of driving my personal vehicle*' and '*Ability to do other things during the ride*') failed to satisfy the factor loading threshold of .35 and were dropped from the model. These variables explained 59.03% of the total variance. Table 3 displays the full pattern loading matrix from the results of the rotated five-factor solution. The factor labels appear as column headings in Table 3. For each survey item, a higher factor loading value indicates a higher contribution to the factor.

The five factors can be explained as follows:

a) The first factor was labeled as 'Safety'. Six variables were clustered under this factor and explained 19.57% of the total variance. Under this factor, '*Trust in the driver*' (.83), '*Trust in other passengers*' (.80), and '*Familiarity with travel vicinity*' (.78) had the highest factor loadings, which indicates a high contribution to this factor.
b) The second factor was labeled as 'Service experience'. Seven variables related to the convenience and experience of using pooled rideshare services were included in this factor. The 'Service experience' factor explained 15.77% of the total variance. Among the eight variables, '*Other public transportation options are available*' and '*Other public transportation options are convenient*' had the highest factor loadings, i.e., .93 and .78 respectively.
c) The third factor was labeled as 'Time/cost'. Five variables were allocated to this factor and explained 11.39% of the total variance. Variables with the highest factor loadings under this factor were '*Wait time*', '*On-time likelihood*', and '*Travel time from door to door*'. Factor loadings for these variables were .88, .82, and .81 respectively.
d) The fourth factor was labeled as 'Traffic/environment'. Two variables were included in this factor and explained 7.97% of the total variance. Both variables had high

Table 3. Standardized loadings (pattern matrix) of the 23 survey items on the five factors.

	Safety	Service experience	Time/cost	Traffic/ environment	Privacy
Safe_TrustDriver	**.83**	−.20	.15	.02	−.09
Safe_TrustRiders	**.80**	−.20	.17	.00	−.01
Safe_Vicinity	**.78**	.04	−.05	.04	.00
Safe_NightTravel	**.75**	.11	−.08	−.05	−.05
Safe_DayTravel	**.73**	.17	−.11	.01	−.02
Safe_KnownRider	**.67**	.08	−.10	−.02	.20
Rel_OtherTransport	−.06	**.93**	−.06	−.13	.16
Conv_OtherTransport	−.02	**.78**	.01	−.07	.06
Acc_OtherTransport	−.03	**.71**	.06	−.07	.04
Rel_RideExperience	.06	**.66**	.08	.01	−.06
Acc_DisabilityNeeds	.07	**.58**	−.10	.20	.09
Conv_EaseOfApp	−.08	**.48**	−.14	.35	−.07
Social_MeetOthers	.04	**.47**	.23	.10	−.19
Time_Wait	−.05	−.02	**.88**	.00	.09
Time_OnTime	−.03	.00	**.82**	−.02	.11
Time_Door2Door	−.05	.04	**.81**	.02	.09
Rel_TrustReachDest	.22	.21	**.49**	−.10	−.08
Cost_Savings	.04	.31	**.38**	.13	−.19
Env_ReduceTraffic	.00	.06	.01	**.88**	.03
Env_Improve	.02	.06	.00	**.84**	.06
Social_TravelAlone	−.04	.11	.02	−.03	**.75**
Safe_Privacy	.42	.00	.01	.04	**.52**
Conv_DrivingSelf	.04	−.07	.22	.09	**.42**
Cronbach's alpha	.85	.84	.83	.87	.63

factor loadings, with .88 for '*Help to reduce traffic congestion*' and .84 for '*Help to improve the environment*'.
e) The fifth factor was labeled as 'Privacy'. Three variables were clubbed under this factor and explained 4.33% of the total variance. The variable with the highest factor loading under this factor was '*Prefer to travel alone*' (.75).

Confirmatory Factor Analysis

Based on the structure suggested by the EFA results, a CFA was conducted using the maximum likelihood method. A measurement model was constructed based on the pattern matrix obtained during the EFA. The goodness of fit chi-square test was evaluated. The model fit yielded $\chi 2(220) = 1{,}487.81$, $p < .0001$. The Root Mean Square Error of Approximation of the model fit was .072, which fell between .05 and .08 and indicated a reasonable approximate fit. Both the Comparative Fit Index and Tucker-Lewis Index of the model fit were slightly under the recommended cut-off value of .9, with .884 and .866, respectively. The Goodness-of-fit Index was .887, which was also slightly under the generally accepted .9 cut-off value. Integrating suggestions from multiple indices, we determined that the results from the CFA indicated that the structure given by the EFA was a good approach to grouping the factors.

Discussion

This study sought to understand barriers to user acceptance of pooled rideshare. The online survey was deployed nationwide, and responses were collected from 5,385 participants. The data were divided into two datasets, one for an EFA model fitting and the other for a CFA validation, respectively. The EFA explored factors that influenced participants' willingness to consider pooled rideshare. Then, the CFA was performed using the holdout sample method, to establish the measurement model describing the relationships between factors and survey items. Five factors were extracted after the factor analyses, and 23 survey items were retained. The factors were named 'Safety', explaining 19.57% of the total variance; 'Service experience', explaining 15.77% of the total variance; 'Time/cost', explaining 11.39% of the total variance; 'Traffic/environment', explaining 7.97% of the total variance; 'Privacy', explaining 4.33% of the total variance.

'Safety' was a high-impact factor and survey items related to safety received high proportions of participants considering them 'Important' or 'Very important', with '*Trust in the driver*' receiving 'Important' or 'Very important' from 87.1% of participants and '*Trust in other passengers*' from 86.3% of participants. Trust exhibited a substantial influence on the willingness to consider pooled rideshare. '*Trust in the driver*' and '*Trust in other passengers*' were the survey items with

the highest factor loadings under the 'Safety' variable. The survey was conducted during the COVID-19 pandemic and may have influenced participants' responses, particularly high factor loading for 'Safety' and participants' focus on *'Trust in the driver*' and '*Trust in other passengers*'. This trust items aligns with previous studies suggesting perceived risk during a rideshare trip affects riders' trust and consequently their usage (Ma et al., 2019). Additionally, it confirms that riders' comfort regarding the familiarity of the travel vicinity (Moody et al., 2019) and the travel time (Gurumurthy & Kockelman, 2020; Z. Wang et al., 2019) significantly impact their willingness to consider PR.

Similarly, in the 'Service experience' factor, public transportation options s in participants' willingness to consider pooled rideshare. All three survey items related to public transportation options were indicators of the 'Service experience' factor, including '*Other public transportation options are available*' (60.4%), '*Other public transportation options are convenient*' (57.9%), and '*I don't have access to other public transportation option*' (56.1%). This corroborates existing literature suggesting that the economic benefits of PR compared to public transportation are marginal (Schwieterman & Smith, 2018) and that positive experiences enhance future use of PR (Sarriera et al., 2017; Tao & Wu, 2008).

The time spent on the journey plays a significant role in deciding between PR and personal rideshare (Li et al., 2019; Sarriera et al., 2017), and cost savings encourage consistent use of PR (Morris et al., 2019). Time is undoubtedly a crucial factor in individuals' willingness to consider pooled rideshare (Amirkiaee & Evangelopoulos, 2018). Survey items related to time received high proportions of participants considering them 'Important' or 'Very important', with '*Travel time from door to door*', '*Wait time*', and '*On-time likelihood*' receiving 'Important' or 'Very important' from 79.9%, 81.2%, and 80.9% of participants respectively. Besides time, '*Cost savings/incentives received for pooling the ride*' is another factor in willingness to consider pooled rideshare. Unexpectedly, only one cost-related factor was retained in the 'Time/cost' variable, and the factor loading was low compared to the loadings of the time-related factors. This might suggest that people's consideration leans more toward time than cost when considering pooled rideshare.

The 'Traffic/environment' factor covered congestion relief and environmental improvement perspectives. Compared to other high-importance items, proportions of participants considering '*Help to improve the environment*' and '*Help to reduce traffic congestion*' as 'Important' or 'Very important' were moderate, with 65.4% and 64.2%, respectively. Interestingly, the findings align with previous studies suggesting environmental consciousness is not a primary motivator for choosing PR (Amirkiaee & Evangelopoulos, 2018; Morris et al., 2019).

The 'Privacy' factor combined survey items from three categories: 'Social', 'Personal safety', and 'Convenience'. Survey items related to privacy received high proportions of participants considering them 'Important' or 'Very important', with '*Convenience of driving my personal vehicle*', and "*Prefer to travel alone*' receiving 'Important' or 'Very important' from 81.7%, and 78.5% of participants respectively. Privacy concerns arise from both a social interaction perspective and safety considerations, echoing previous studies (Malokin et al., 2019).

Conclusion

A nationwide online survey was conducted with 5,385 participants, with 2,000 recruited as a national U.S. sample, and the remaining 3,385 gathered from targeted locations including Atlanta, Austin, Chicago, Detroit, New York City, San Francisco, and the Upstate of South Carolina. The analyses identified service experience, time/cost, traffic/environment, privacy, and safety as significant factors associated with the 23 survey items' contribution on participants' willingness to consider pooled rideshare. Among these factors, safety was of the highest importance according to the factor analysis. Additionally, trust was rated as highly important by participants when considering the use of pooled rideshare services, underlining the critical role of trust in the adoption of PR services. In this research, the choice of survey items was made with the objective of creating a well-rounded and systematic comprehension of the factors that influence the acceptance of pooled rideshare services. The investigation into these factors aims to yield significant insights that will be important to policymakers and the transportation sector, thereby improving pooled rideshare (PR) as an effective and environmentally friendly alternative. In future research, a binomial logistic regression will be conducted where the five factors are predictors to predict the participants' willingness to consider PR.

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