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The Development of the Pooled Rideshare Acceptance Model (PRAM)

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Abstract: Due to the advancements in real-time information communication technologies and sharing economies, rideshare services have gained significant momentum by offering dynamic and/or on-demand services. Rideshare service companies evolved from personal rideshare, where riders traveled solo or with known individuals, into pooled rideshare (PR), where riders can travel with one to multiple unknown riders. Similar to other shared economy services, pooled rideshare is beneficial as it efficiently utilizes resources, resulting in reduced energy usage, as well as reduced costs for the riders. However, previous research has demonstrated that riders have concerns about using pooled rideshare, especially regarding personal safety. A U.S. national survey with 5385 participants was used to understand human factor-related barriers and user preferences to develop a novel Pooled Rideshare Acceptance Model (PRAM). This model used a covariance-based structural equation model (CB-SEM) to identify the relationships between willingness to consider PR factors (*time/cost*, *privacy*, *safety*, *service experience*, and *traffic/environment*) and optimizing one's experience of PR factors (*vehicle technology/accessibility*, *convenience*, *comfort/ease of use*, and *passenger safety*), resulting in the higher-order factor *trust service*. We examined the factors' relative contribution to one's *willingness/attitude towards PR* and *user acceptance of PR*. *Privacy*, *safety*, *trust service*, and *convenience* were statistically significant factors in the model, as were the *comfort/ease of use* factor and the *service experience*, *traffic/environment*, and *passenger safety* factors. The only two non-significant factors in the model were *time/cost* and *vehicle technology/accessibility*; it is only when a rider feels safe that individuals then consider the additional non-significant variables of time, cost, technology, and accessibility. *Privacy*, *safety*, and *service experience* were factors that discouraged the use of PR, whereas the *convenience* factor greatly encouraged the acceptance of PR. Despite the *time/cost* factor's lack of significance, individual items related to time and cost were crucial when viewed within the context of convenience. This highlights that while user perceptions of privacy and safety are paramount to their attitude towards PR, once safety concerns are addressed, and services are deemed convenient, time and cost elements significantly enhance their trust in pooled rideshare services. This study provides a comprehensive understanding of user acceptance of PR services and offers actionable insights for policymakers and rideshare companies to improve their services and increase user adoption.

Keywords: user acceptance; structural equation model; transportation network companies; ride-hailing; dynamic rideshare system; sharing economy; user experience

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1. Introduction

Vehicle ridesharing as a service was first documented in the U.S. during World War I (1914–1918) [1]. During WWI, the U.S. was in a recession, and as a result, individuals used jitney. Jitney is an unregulated taxi or bus service that carries travelers over a regular route on a flexible schedule [2]. Jitney's popularity grew because of its affordability, and this mode of transportation was faster than a streetcar [3]. As the number of jitney vehicles increased, there were concerns about overcrowding, safety, volatility of the service, and fares [4]. After WWI, ridesharing lost popularity due to increased personal vehicle availability and growing concerns about sharing a ride. The second noticeable rideshare increase was during World War II (1939–1945). There was a push from the U.S. federal government for citizens to use ridesharing to conserve resources for the war effort [5]. In the workplace, forming ridesharing committees was encouraged, as well as keeping work shifts flexible to allow employees to find and use rideshares to reduce traffic congestion and resources. The government educated carpoolers to be aware of the impact of their individual behaviors, such as being late, poor manners, or a lack of personal hygiene, which could lead to the failure of rideshare [6]. Similar to the period following WWI, rideshare lost its popularity after WWII. For several decades, from the late 1960s to early 1980s, rideshare usage or carpooling was stable due to high fuel price hikes, but by 1990, there was a decline in rideshare usage. The decline was primarily due to a decrease in fuel prices and, consequently, an increase in personal vehicles [7].

Due to advancements in information and communication technologies, rideshare services have become a more reliable form of transportation. During the 1980s and 1990s, there was a rise in the number of personal computers in the U.S. In 1985, about 9% of households had computers, whereas by the year 2000, more than 50% of American families had a computer in their homes [8]. Along with the rise of personal computers, Internet usage also increased. Later, there was an increase in smartphone usage and advancements in GPS services. Apple sold approximately 1.4 million iPhones worldwide in its first year, 2007, and 11.6 million more iPhones were sold in 2008 [9]. By 2018, the percentage of Americans who owned smartphones grew to 81% compared to 35% in 2011 [10]. The technological advancements associated with smartphones and wireless information communication provided the foundation for the transmission of real-time information through smartphones, which had a significant impact in enabling a sharing economy in transportation.

A sharing economy, or collaborative consumption, is "the peer-to-peer-based activity of obtaining, giving, or sharing access to goods and services, coordinated through community-based online services" [11]. According to a comprehensive literature review on sharing economy by Hossain [12], the concept of a sharing economy has received significant attention from scholars, practitioners, and policymakers. A sharing economy helps to efficiently utilize the available resources and therefore improves sustainability. Some of the attributes of a sharing economy are a lack of ownership (in this case, of one's own vehicle), temporary access, and the reallocation of physical goods or tangible assets such as time or money [13]. A Pew Research Center survey of 4787 U.S. participants highlights that 72% of adults have used some form of shared economy service [14]. Sharing economies are made possible through multiple technological developments that have simplified the sharing of both physical and nonphysical goods and services through the availability of various internet-based information systems [11]. For example, for several decades, Blockbuster was known for its movie rental retail operation, where movies were shared by multiple users. However, the rise in shared access using digital media, such as Netflix, has vastly increased the sharing economy [15]. The integration of the sharing economy with information communication technologies created new business opportunities and companies, such as Airbnb and Uber, which are widely used worldwide [12]. Airbnb, which started in 2008, is a digital marketplace in which individuals share rooms in their homes, where Airbnb profits from the brokerage fee [16]. Similarly, in the transportation domain, the integration of the internet, GPS-based location services, and software Apps in smartphones enabled third-party service providers to develop innovative services for transportation options including internet-based, dynamic ridesharing systems (Feldman, 2002).

Using the advancement of information communication technologies and end-users' growing familiarity with smartphone applications, rideshare service companies first started offering on-demand personal rideshare services. Then, pooled rideshare (PR) on-demand services were offered. With a personal rideshare, the user can travel solo or with individuals they know, whereas with pooled rideshare, the user may travel with one or multiple individuals whom they do not know with multiple pick-up and/or drop-off locations. There are numerous rideshare platforms available throughout the world, including, but not limited to, Uber and Lyft in the U.S., DiDi in China [17], Ola cabs in India [18], Grab in Southeast Asia [19], and Chauffeur Privé in France [20]. Uber offers services worldwide and is currently the largest rideshare service provider [21]. According to Uber's 2022 annual report, their services are available in more than 10,000 cities across 72 countries [22]. There was a 31% increase in the number of bookings from 2018 to 2019 [23]. The number of trips increased annually, with the exception of 2020, the year of the onset of the COVID-19 pandemic. There was a 57% increase in Uber's gross bookings in 2021 compared to the year 2020.

User motivation, which includes, but is not limited to, convenience, flexibility, interaction, time, and economic benefits are important for the success and sustained growth of sharing economies such as rideshare services [12,24]. Hossain [12] highlights that other factors can be economic, political, environmental, social, and technological factors, and for the service providers, the motivations are earning profit and, in some instances, contributing to sustainability. Rideshare services can help to reduce traffic congestion and lower the environmental impact; however, there are challenges in ridesharing [25]. Travelers have concerns about using rideshare services due to privacy and safety [26]. Rideshare service providers must ensure that these critical items are prioritized in their service experience. Due to the increase in safety concerns using rideshare, policymakers worldwide are trying to establish proper guidelines for rideshare service companies. For example, in the U.S., Sami's Law was enacted in 2023 [27], which ensures that rideshare service companies follow government safety requirements. The legislation mandates that the Government Accountability Office must provide Congress with a report every two years containing findings from a study on: (1) the occurrence of deadly and non-deadly physical and sexual assaults on rideshare drivers by passengers and on passengers by drivers during the previous two years; (2) the details and scope of the background checks performed on potential rideshare drivers; and (3) the safety measures implemented by ridesharing businesses to ensure the wellbeing of both riders and drivers.

User acceptance of personal rideshare is still lower compared to the use of one's own personal vehicle. According to the 2018 American Community Survey (ACS), 76.3% of Americans used their personal vehicle when commuting to work, in comparison to only 9% who shared a vehicle for their commute [28]. Research has been conducted on users' motivational factors, as well as the barriers, in using pooled rideshare [21,24,29–33].

The purpose of this study was to develop a model to predict the user acceptance of pooled rideshare by understanding users' concerns and preferences. The investigation was based on a national survey, with a robust sample of over 5000 U.S. participants, where the data were analyzed using structural equation modeling. The following sections present the factors influencing the utilization of pooled rideshare (PR) services. The model builds on the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT) models, defining the user trust in service, attitudes, and acceptance of PR. Then, our lab's previous research concerning the factors influencing users' willingness to consider pooled rideshare services and factors that contribute to enhancing users' experiences are described. The following sections will summarize 14 hypotheses that connect these factors to users' trust, attitudes, and acceptance of pooled rideshare, using responses from 5385 participants in a national online survey. This study aims to provide a comprehensive understanding of user acceptance of PR services and to offer actionable insights for policymakers and rideshare companies to improve their services and increase user adoption.

2. Pooled Rideshare Conceptual Model Development

2.1. Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) was initially developed to predict the user adoption and use of desktop computers for a wide range of users [34]. In this model, the perceived usefulness and the perceived ease of use were the core constructs that determined the users' behavioral intention. Behavioral intention measures the attitude of an individual towards the adoption of any new technology or system. Perceived usefulness in the context of using desktop computers was defined as "the degree to which a person believes that using a particular system would enhance his or her job performance", and perceived ease of use was defined as "the degree to which a person believes that using a particular system would be free of effort" [34]. Since the introduction of the TAM, there has been substantial empirical evidence supporting the model's acceptance [35–37]. The TAM consistently explained around 40% of the variance regarding individuals' intention to use information technology and the actual usage, such as software applications used in the computer. Later, researchers adapted the TAM constructs to other domains. The extension of the TAM was largely based on three elements [38]. First, introducing factors from related models such as subjective norm, perceived behavioral control, and self-efficacy. Subjective norm is the perceived social pressure to perform or not perform a particular behavior; perceived behavioral control is the belief in one's ability to execute that behavior; and self-efficacy is the confidence in one's capability to manage challenges and achieve the desired outcomes. Second, introducing additional or alternative belief factors, such as trialability, which refers to the ease of testing a new innovation; compatibility measures its alignment with existing values and practices; visibility signifies the extent to which the innovation is observable; and result demonstrability represents the ability to demonstrate the innovation's tangible outcomes. The third is examining external variables, which are antecedents to or that moderate the influence of the perceived usefulness and perceived ease of use, such as personality traits and demographic characteristics. As a result, the TAM's topical area was broadened from desktop computer usage to cultural differences in technology acceptance [39]. The TAM in transportation research spans from driver assistance research [40–42], to autonomous driving [43–45], to infotainment features [46], to shared mobility [47], etc. The perceived usefulness and perceived ease of use were significant constructs of users' trust and acceptance of autonomous vehicles [45]. Similarly, perceived usefulness and perceived ease of use were significant when evaluating commercial truck drivers' trust and attitude toward an onboard monitoring system in their work vehicle [40].

Various studies have explored the adapted TAM in the context of ridesharing to gain insight into user acceptance. Key constructs, such as perceived usefulness and perceived ease of use, were found to significantly impact users' trust and their propensity to consider ridesharing services [24,32,48,49]. These studies highlight the importance of understanding user perceptions in the adoption of ridesharing platforms. For instance, Amirkiaee and Evangelopoulos [24] conducted an experimental study to identify the factors influencing people's choice to use rideshare, while Ma et al. [32] examined risk perception and its effect on users' intention to discontinue using ridesharing services in China. Furthermore, Moon et al. [48] investigated the acceptance of Uber services using the TAM framework. Zaigham et al. [49] focused on the rideshare drivers' perspective, incorporating governmental regulations into the TAM. Collectively, these studies emphasize the need to address users' concerns and expectations to promote the widespread adoption of ridesharing services.

2.2. Unified Theory of Acceptance and Use of Technology (UTAUT)

The Unified Theory of Acceptance and Use of Technology (UTAUT) model, developed by Venkatesh at al. [37], integrated several existing user acceptance models to provide a comprehensive framework for understanding technology adoption and usage. The UTAUT model combined elements from the following eight user acceptance models: the Technology Acceptance Model (TAM), Theory of Reasoned Action (TRA), Theory of Planned Behavior

(TPB), Motivational Model (MM), Model of PC Utilization (MPCU), Innovation Diffusion Theory (IDT), Social Cognitive Theory (SCT), and the Model of Adoption of Technology in Households (MATH). The UTAUT model synthesized these eight models and identified four factors of technology acceptance and usage: (a) performance expectancy; (b) effort expectancy; (c) social influence; and (d) facilitating conditions. Performance expectancy is the degree to which an individual believes that using a particular technology will help them achieve gains in their job performance or enhance their productivity. Effort expectancy is associated with the ease of using the system. Social influence is where other people's opinions matter along with the individual user's opinion when using a given technology. The fourth factor, facilitating conditions, is associated with technical and service features that help individuals use the technology.

Mutlu and Der [50] found that the UTAUT model has been extensively applied in diverse fields, including healthcare (e.g., electronic health records), education (e.g., e-learning platforms), and business (e.g., enterprise resource planning systems), to understand and predict technology acceptance and adoption. By examining these examples, the model helps researchers and practitioners identify the factors influencing user behavior, enabling the development of strategies to increase technology acceptance and usage across various domains. Additionally, the UTAUT model incorporates four moderating variables—gender, age, experience, and voluntariness of use—which can affect the relationships between the four factors and technology adoption and use. The UTAUT model explained 70% of the variance in the behavioral intention to use technology and actual system use; in other words, it accounts for a significant portion of the factors that influence whether users will adopt and use a given technology (such as new software applications or internet services).

The UTAUT model motivated researchers to develop novel conceptual adaptations. For example, the car technology acceptance model (CTAM) developed by Osswald et al. [42] was based on a survey of 400 respondents. They introduced an additional factor, perceived safety, to the UTAUT as safety is critical for vehicles. The CTAM primarily focused on in-vehicle technologies. Based on a survey of 241 respondents, Hewitt [44] adapted the TAM and CTAM models to create an autonomous vehicle acceptance model (AVAM), where the model focused on the user's perception of the different SAE driving automation levels [51]. A study on rideshare acceptance in India with 287 survey respondents suggested a significant positive relationship between performance expectancy, effort expectancy, social influence, and facilitating conditions with behavioral intention [13]. Social influence was the most significant construct, with $\beta = 0.632$ and a critical ratio = 8.774, indicating a strong influence on ridesharing acceptance.

2.3. Willingness/Attitude towards Pooled Rideshare (PR) and User Acceptance of PR

When there is a new technology available to consumers, the adoption of the technology is largely dependent on the user's acceptance of that technology [52,53]. Users' attitudes play an important role in guiding their decision-making process when it comes to adopting and utilizing technology [44]. An attitude is a judgment based on beliefs that leads someone to form a specific intention [46]. The theory of reasoned action (TRA) aimed to explain the relationship between attitudes and behaviors [54]. The TRA was primarily used to predict how individuals will behave based on their pre-existing attitudes and behavioral intentions. The technology acceptance model (TAM) and several of its adapted versions [34,37,55] suggest that the user's attitude towards a technology predicts their motivation to use the system, which then leads to the acceptance of that technology. The adaptations of the user acceptance model in the 1990s and 2000s were largely related to the increase in adoption of information technology, such as desktop computers and the Internet. The TAM has been applied to different technologies (e.g., word processors, e-mail, world wide web, hospital information systems) under different situations (e.g., time and culture) with different control factors (e.g., gender, organizational type, and size) and different participants (e.g., undergraduate students, MBAs, and experienced workers) [56]. User confidence in technology is important in determining the user's willingness to accept a technology [57].

In the pooled rideshare context, Amirkiaee et al.'s [24] rideshare acceptance model defines attitudes toward ridesharing "as the way of thinking or feeling about ridesharing", which is similar to the theory of reasoned action (TRA), which highlights "an individual's positive or negative feelings (evaluative effect) about performing the target behavior" [58]. Amirkiaee's team used a scenario-based survey with 300 participants and identified that users with a positive attitude towards ridesharing were more willing to use rideshare services than those with a negative attitude, supporting the idea that a favorable attitude correlates with acceptance. In another study regarding the perceived risk of using rideshare, responses were collected from 443 rideshare users. The users who had a negative attitude toward ridesharing were predicted to discontinue using the rideshare service [32]. A study of 412 Uber users found that attitudes towards Uber rideshare services significantly influenced one's willingness to use rideshare [48]. Previous research on user's behavior, the intention of accepting the ride, and attitude led to the first hypothesis:

H1: *A favorable attitude towards PR is positively correlated with the likelihood of accepting the service.*

2.4. Trust Service

A user's degree of trust plays a crucial role in their willingness to adopt and accept any given technology [52,53,59]. Trust is a multi-dimensional factor based on individuals' characteristics, including their motives, intentions, and actions [60]. Trust is an important factor included in the TAM-adapted versions and, furthermore, has been found to be significant in user reliance and the acceptance of different technologies or services. Before deciding to adopt a technology or service, a user's initial trust significantly shapes their attitude and willingness to even consider using that particular technology or service [45]. Hasan et al. [61] explained that trust plays a significant role in helping users to overcome perceptions of risk as well as their own insecurities.

In a pooled rideshare context, Ma et al. [32] found that users who trust the rideshare services are less likely to discontinue using the service. Similarly, in another study, users with higher levels of trust were more likely to use the rideshare service, highlighting the relationship between trust and favorable attitudes [24]. Zhou et al. [30] suggested that trust needs to be established between the users sharing the ride because trust heavily influences rideshare acceptance, demonstrating the relationship between trust and acceptance. However, Amirkiaee et al. [24] noted that users do not need to trust a specific person, but rather trust people in general, and rideshare servicers are responsible for creating a platform that is conducive to building trust. Trust can be assessed based on the functionality, helpfulness, and reliability of the services [61]. Functionality represents the user's expectations about the service organization's capabilities. Helpfulness represents the user's belief that the technology provides adequate, effective, and responsive help. Reliability assumes that the service organizations are consistent, predictable, or reliable in their performance. For pooled rideshare acceptance, it is anticipated that trust will contribute to increasing the user's confidence and their willingness to consider using the service. Thus, the two hypotheses related to trusting the PR service are:

H2: *A stronger level of trust in PR services is associated with more favorable attitudes and willingness to use PR.*

H3: *Greater trust in PR services results in increased adoption and acceptance of PR.*

2.5. National Survey Assessing Reasons for Being Willing or Unwilling to Consider PR

The PRAM models build on the literature described in Sections 2.1–2.4, combined with the factors identified from two independent factor analyses on a sample of U.S. participants, which examined individuals' reasons for being willing or unwilling to consider pooled rideshare [62,63]. The first of the examined factor analysis items relates to one's willingness to consider PR factors, where the participants rated the items on a four-point scale ('Not very important', 'Not important', 'Important', and 'Very important'). An exploratory factor analysis was followed by a confirmatory factor analysis on 25 items. The analyses retained 23 of the 25 items and identified a five-factor model, which were *time/cost*, *privacy*, *safety service experience*, and *traffic/environment.* Then, regression analyses were conducted to identify each factor's contribution to willingness to consider PR [62]. The second study using the same analytic process and examined 23 items related to optimizing individual's pooled rideshare experience, where the participants rated items on a four-point scale ('Strongly disagree', 'Disagree', 'Agree', and 'Strongly agree'). The analyses retained all 23 items and confirmed a four-factor model: *vehicle technology/accessibility*, *convenience*, *comfort/ease of use*, and *passenger safety* [63]. Using the existing literature, the complex relationships of the factors identified by the two factor analyses, along with trust, user attitude, and user acceptance, a comprehensive conceptual model was developed to form hypotheses for user acceptance of PR; see articles 62 and 63 for the individual survey items.

2.6. Willingness to Consider PR Factors

2.6.1. Time/Cost

From the two factor analyses, the five time- and cost-related items accounted for 11.4% of the total variance towards the willingness to consider PR. Three survey items related to time were rated 'Important' or 'Very important' by the majority of the participants, with 'Travel time from door to door', 'Wait time', and 'On-time likelihood' being selected by 79.9%, 81.2%, and 80.9% of the participants, respectively. This implies that users value the efficiency of their travel time. 'Cost savings/incentives received for pooling the ride' is the other item within this factor that influenced the willingness to consider PR. Based on the logistic regression [62], for every unit increase in the *time/cost* factor score, there was a 29.3% increase in the willingness to consider PR, suggesting that if participants were willing to consider PR, the ride needs to be reliable in terms of being time- and cost-effective compared to other transportation options. Based on these findings, the hypothesis for the current study is:

H4: *Users who perceive that PR provides greater time and cost benefits are more likely to exhibit increased trust in PR services.*

2.6.2. Privacy

The *privacy* factor explained 4.3% of the total variance towards the participants' willingness to consider pooled rideshare, containing the survey items: prefer to travel alone, desire for privacy, and convenience of driving my personal vehicle. The participants who prioritized privacy expressed a preference for personal rideshare over pooled rideshare, driven by a desire to maintain personal boundaries and avoid unwanted social interactions [64]. Moreover, privacy concerns were not solely about social interaction; they extended into safety considerations. In the logistic regression analysis [62], an inverse relationship was identified between the *privacy* factor and one's willingness to consider pooled rideshare. Specifically, for every unit increase in the *privacy* factor score, there was a 76.7% decrease in the willingness to consider pooled rideshare. This suggests that the lack of privacy in pooled rideshares could be a significant deterrent for some users. Considering the importance of privacy in the users' decisions to use pooled rideshare, the following hypotheses are proposed for the current study:

H5: *Users who prioritize privacy will have more concerns about safety when sharing rides with unknown riders.*

H6: *Users who prioritize privacy will expect a higher service experience during the ride.*

Hypothesis H5 draws on the observation that privacy and safety are closely intertwined for many participants. Those who prioritize privacy may be more aware of the potential risks involved in sharing rides with unknown riders, thus leading to heightened safety concerns. Hypothesis H6 acknowledges that for privacy-oriented users, the service experience is not just about comfort or convenience, but is also about having personal space that allows them to multitask without interruption. This may include working, making phone calls, or simply having some quiet time, which would be difficult with the potential for interference from other passengers in a pooled rideshare. These users may be more inclined to adopt pooled rideshare if they believe it can provide an environment that allows them to effectively multitask.

2.6.3. Safety

The *Safety* factor was comprised of six survey items (trust in the driver, trust in other passengers, familiarity with travel vicinity, traveling at night, traveling during the day, and I am with another person I know) and explained 19.6% of the total variance. The participants demonstrated high levels of concern for safety, with items relating to trust receiving high proportions of 'Important' or 'Very Important' ratings. The item 'Trust in the driver' was rated as 'Important' or 'Very Important' by 87.1% of the participants, while 'Trust in other passengers' was rated similarly by 86.3% of the participants. The 'Safety' factor was important for all of the participants, regardless of whether they would consider pooled rideshare or not, as it was not statistically significant between the two groups in the subsequent logistic regression analyses [62]. This highlights that safety concerns are universal among users and non-users alike.

Despite the high importance placed on safety, trust—which is closely related to safety—appeared to be a substantial barrier to the acceptance of pooled rideshare. Users find it challenging to establish trust in co-riders, especially when they are unknown individuals [65]. The survey item 'I am with another person I know' was identified as a significant item affecting the willingness to consider pooled rideshare, suggesting that familiarity and trust are interlinked. As the safety of the passengers is a crucial factor influencing trust, users with higher concerns about safety are likely to have lower trust in PR services. Therefore, the following hypothesis is proposed for the current study:

H7: *Users with higher concerns about safety will have lower trust in PR services.*

2.6.4. Service Experience

The *service experience* factor was found to significantly influence individuals' willingness to consider PR and explained 15.8% of the total variance. The factor analysis identified eight survey items related to the quality and reliability of rideshare services, public transportation alternatives, and the user's previous experience with rideshares. Descriptive analysis showed that participants who had positive experiences with rideshare services were more likely to consider using pooled rideshare, while those who had negative experiences were less likely to consider it. Moreover, participants who found public transportation options more accessible and convenient were less inclined to consider pooled rideshare.

The logistic regression results indicated that for every unit increase in the *service experience* factor score, there was a 185.1% increased willingness to consider PR [62]. This suggests that the service experience plays a crucial role in users' decision-making process when considering pooled rideshare. Compared to alternative transportation options, a positive service experience with pooled rideshare can lead to increased user acceptance. This aligns with the findings from the previous research, where service experience was shown to be a key determinant in the adoption of new transportation modes [33,66]. Drawing on the insights from the previous study, the following hypothesis is proposed for the current study:

H8: *Higher concerns regarding the service experience of PR compared to alternative transportation options result in a decrease in user acceptance of PR.*

2.6.5. Traffic/Environment

The *traffic/environment* factor was identified as one of the key predictors influencing individuals' willingness to consider using pooled rideshare services. This factor encapsulated the topics of traffic congestion relief and environmental improvement, implying the sustainability objectives of pooled rideshare. Although other literature suggested that environmental consciousness and sustainability concerns might not be paramount in the adoption of pooled rideshare [24,67], the factor analysis [62] showed that these items still held substantial relevance. According to the survey data, 65.4% of the respondents considered 'Help to improve the environment' as 'Important' or 'Very important', while 64.2% considered 'Help to reduce traffic congestion' in the same way. Despite not being the highest-importance items, these items emerged as significant influencers in the context of pooled rideshare acceptance. The logistic regression analysis further reinforced these findings, revealing that for every unit increase in the *traffic/environment* factor score, there was a 45.7% increase in the willingness to consider PR. This indicated that concerns over traffic congestion and environmental impacts could motivate users to consider pooled rideshare as a viable transportation alternative. Based on this evidence, the following hypothesis is proposed for the current study:

H9: *Users with higher concerns for traffic congestion and environmental impact leads to an increased user acceptance of PR.*

2.7. Identifying Optimizing Experience Factors

2.7.1. Vehicle Technology/Accessibility

The *vehicle technology/accessibility* factor accounted for 11.3% of the total variance and included four survey items: the availability of an automated vehicle without a human driver; the vehicle being a battery-electric vehicle; accessibility for passengers with disabilities; and the presence of a subscription service. According to the study [63], 35.1% and 44.9% of the participants 'Agree' or 'Strongly agree' with the importance of a vehicle being automated and a battery-electric vehicle, respectively. These percentages indicate that although these factors might not be perceived as essential by riders, they are still important in their overall experience. Furthermore, 62.2% of the participants rated accessibility for passengers with disabilities and the availability of a subscription service as important items when considering pooled rideshare.

Other research has suggested that shared autonomous vehicles could provide a more convenient mode of transportation for vulnerable populations, including the elderly and individuals with disabilities [68]. Additionally, the environmental benefits of ridesharing services might not be sufficient to encourage users to participate, but offering reliable and satisfactory services could have a significant impact [69]. This is supported by the logistic regression analysis, which revealed that for every unit increase in the *vehicle technology/accessibility* factor score, there was a 201.6% increase in the willingness to consider PR. Considering these findings, the following hypothesis is proposed for the current study:

H10: *The optimized vehicle technology/accessibility experience leads to an increased user acceptance of PR.*

2.7.2. Convenience

The *convenience* factor accounted for 18.8% of the total variance and was comprised of six survey items. These items focused on multiple topics, such as the ability to run errands during a commute, privacy, availability of the service when needed, cost, and travel time. Among these items, 'The cost to share a ride is more affordable than other transportation', 'There is clear information about the ride (e.g., cost, route, time) before I book it', and 'I won't be delayed by long detours' had the highest factor loadings. Notably, 84% and 81.5% of the participants either 'Agree' or 'Strongly agree' with the latter two items, indicating their willingness to consider pooled rideshare services.

Other research suggests that lower trip costs compared to other transportation options play a crucial role in considering the use of pooled rideshare services [70]. Additionally, convenience items such as reduced waiting times and increased accessibility contribute to the overall user experience [25,33,64]. Transparent communication about the ride and reliable services have also been found to be influential in increasing the willingness to share a ride [25,68]. The logistic regression analysis conducted in the previous study [63] revealed a 156.2% increase in the willingness to consider pooled rideshare for every unit increase in the *convenience* factor score. Building on these understandings, it is reasonable to theorize that optimizing the convenience experience could lead to increased trust in pooled rideshare services and increased user acceptance. As such, the following hypotheses are proposed in the current study:

H11: *The optimized convenience experience leads to an increased trust in PR service.*

H12: *The optimized convenience experience leads to an increased user acceptance of PR.*

2.7.3. Comfort/Ease of Use

The *comfort/ease of use* factor encompasses various aspects of the user experience, accounting for 26% of the total variance, with a significant influence on the willingness to consider pooled rideshare. The survey items related to comfort, such as adjusting seats, sitting where desired, and adjusting the temperature in the vehicle had the highest factor loadings. For instance, 79.1% of the participants either 'Agree' or 'Strongly agree' that having sufficient storage in the vehicle for their belongings was important for their willingness to utilize pooled rideshare. In addition to comfort, ease of use also played a significant role, with 78.9% of the participants stating that they either 'Agree' or 'Strongly agree' that an easy-to-use rideshare service app is essential for their willingness to utilize pooled rideshare. A user-friendly app has been found to influence rider behavior and the intention to use rideshare services [71]. Furthermore, the perceived ease of use directly correlates with the adoption of new technologies or services [72]. It was observed that for every unit increase in the *comfort/ease of use* factor score, there was a 16% decrease in the willingness to consider pooled rideshare, suggesting that comfort/ease of use is important in an individual's willingness to consider pooled rideshare, where the user's perceived comfort needs to be improved [63]. Based on these findings, the following hypothesis is proposed in the current study:

H13: *The optimized comfort/ease of use experience leads to an increased user acceptance of PR.*

2.7.4. Passenger Safety

The *passenger safety* factor consisted of three survey items that accounted for 8.1% of the total variance: 'the other passenger is pre-screened by the rideshare service' (76.4%) and 'the vehicle is cleaned/disinfected in between rides' (82.1%) received the highest factor loadings. The high percentage of 'Agree' or 'Strongly agree' answers showed the importance of having a vehicle cleaned/disinfected between rides to their willingness to utilize pooled rideshare. This finding indicates that maintaining a safe and clean environment during the ride is a priority for passengers and can significantly influence their willingness to consider pooled rideshare services.

The binomial logistic regression analysis [63] revealed that for every unit increase in the *passenger safety* factor score, there was a 46.8% decrease in the willingness to consider pooled rideshare. This highlights the importance of ensuring passenger safety in promoting user acceptance of pooled rideshare services. Several incidents involving safety hazards in ridesharing services have led to a demand for increased safety measures from the U.S. public and legislators [73]. With the impact of the COVID-19 pandemic, the need for a clean and safe environment during rides has become even more crucial for the sustained growth of rideshare services [74].

Considering the strong relationship between the *passenger safety* factor and the willingness to utilize pooled rideshare services, it is reasonable to theorize that optimizing the passenger safety experience will lead to increased user acceptance of pooled rideshare. Therefore, the following hypothesis is proposed for the current study:

H14: *The optimized passenger safety experience leads to an increased user acceptance of PR.*

The path diagram of the conceptual model for the user acceptance of PR is shown in Figure 1. The hypotheses of the willingness to consider PR factors were theorized based on the perceived usefulness and the perceived ease of use constructs of the TAM and UTAUT models. The hypotheses of the optimizing experience factors were theorized based on the facilitating conditions and perceived safety constructs of the UTAUT, CTAM, and AVAM models. *Trust service* is theorized as the higher-order (hierarchical-order) factor, which is a factor formed from a group of factors (*time/cost*, *safety*, and *convenience*). The *willingness/attitude towards PR* and *user acceptance of PR* are the response variables, where participants gave responses to a single survey question. The *willingness/attitude towards PR* response variable is the user's opinion or feeling about ridesharing, obtained from their response to the question: "Regardless of your past experience, would you be willing to consider utilizing a pooled rideshare, one in which you share the ride with people you don't know who may join from multiple locations during the trip and drop off at different locations?" The *user acceptance of PR* response variable gives an indication of a user's readiness to participate in a rideshare; the survey question was: "Assuming a pooled rideshare service meets all of your needs mentioned above, how willing are you to use a pooled rideshare when it is available to you?" Table 1 lists the definitions of all the constructs. See Appendix A for the survey questions used for the data analysis described in this publication.

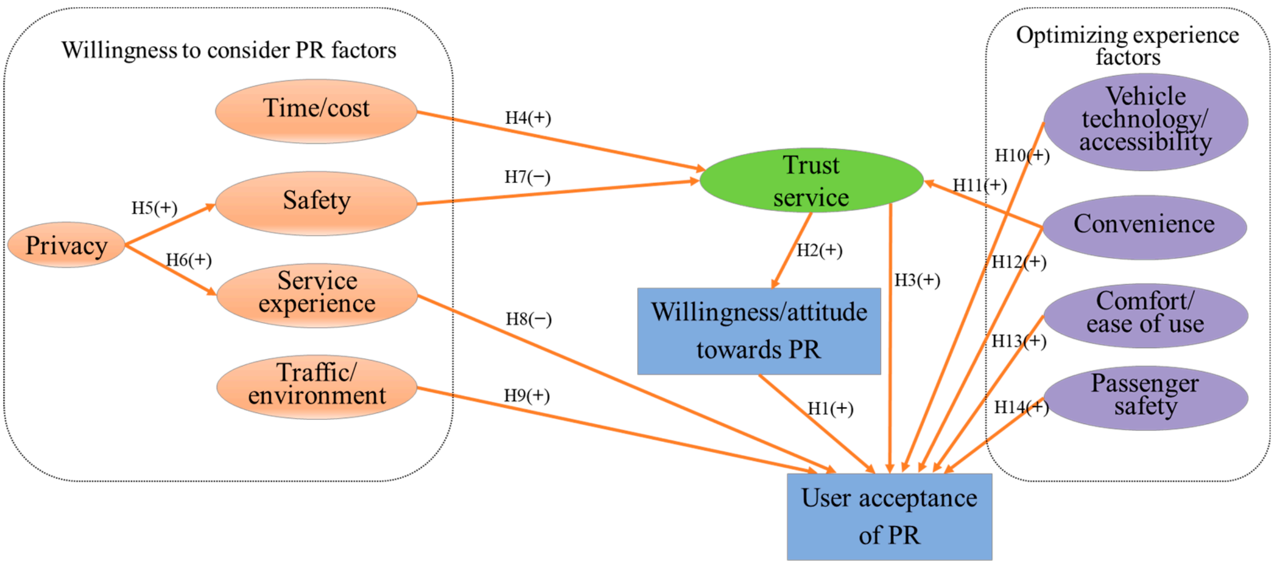

Figure 1. The conceptual path diagram of the pooled rideshare (PR) model. The orange ovals are the willingness to consider PR factors, the purple ovals represent the optimizing experience factors, the green oval is a higher-order factor, and the blue rectangles are response variables.

Table 1. Construct definitions.

Construct		Definition	Definitions Adapted Based Upon the Factor Analyses of Willingness to Consider PR [62] and Optimizing Experience [63] Factors
Response variable	Willingness/attitude towards PR	The user's way of thinking about PR or their willingness to consider PR [24].	NA
Response variable	User acceptance of PR	The user's willingness to use rideshare [48]. It gives an indication of users' readiness to use PR.	NA
Higher- order factor	Trust service	The degree of confidence in the rideshare service that riding with unknown riders has no physical, time, financial or psychological risks [24,32].	NA
Willingness to consider PR factors	Time/cost	NA	Time is perceived as the amount of time spent commuting after the user decides to commute from the source location to the destination. The cost is considered a monetary benefit by commuting at a cheaper cost for spending extra time compared to other modes of transportation [62].
	Privacy	NA	Privacy is a user preference for commuting in an isolated space and not being disturbed by others. Privacy is also related to personal safety, where users want to avoid contact with unknown riders [62].
	Safety	NA	The user perception of safety during the commute without any risks or physical harm considering trust in people, time of the travel and familiarity with the locations and people [62].
	Service experience	NA	The service experience can be user's prior experience of rideshare and the other transport option availability, such as public transit. The services can be for the general public or the focused group such as people with disabilities [62].
	Traffic/environment	NA	PR can help to mitigate the continuous increase in traffic volume. Traffic is still a major cause of pollution in cities, and major roads are congested in densely populated areas [62].

Table 1. *Cont.*

Construct		Definition	Definitions Adapted Based Upon the Factor Analyses of Willingness to Consider PR [62] and Optimizing Experience [63] Factors
Optimizing experience factors	Vehicle technology/accessibility	NA	Vehicle technology is the advancement of vehicle development to make safer travel and build clean energy vehicles. Accessibility is to make the service easy to access for a wide range of users [63].
	Convenience	NA	A convenient ride is a reliable ride in which the vehicle taken is suitable to the users' needs or purpose of the commute [63].
	Comfort/ease of use	NA	Comfort is the state of ease or well-being of a user during the commute. It can be user interactions with the vehicle's features and services [63].
	Passenger safety	NA	Services offered to ensure user safety is taken care of during the commute [63].

3. Methods

3.1. Survey Design

This study was part of a larger U.S. Department of Energy survey study. The online survey was conducted across the U.S., with seven targeted cities plus a national sample. The total number of participants was 5385. There were 2000 participants' data collected from the national sample, and 3385 participants' data obtained from Atlanta (500), Austin (501), Chicago (500), Detroit (500), New York City (500), San Francisco (500), and Upstate of South Carolina (384). As shown in Figure 2, in the survey's design, screening questions ensured that potential participants were 18 years of age or older and their consent was obtained. A baseline of their experience of using rideshare services was recorded. Data were collected from participants who have ridden with individuals they know (46.6%), ridden with individuals whom they do not know (14.1%), or have never used rideshare services (39.3%) in the last 5 years.

The your transportation needs section of the survey explored participants' needs, as well as their experiences with various transportation services, including personal and pooled rideshares. Then, participants reported their willingness to consider utilizing a pooled rideshare in the willingness to consider PR section. Participants determined which factors influence their decisions to utilize or not utilize pooled rideshare. Then, questions about optimizing one's experience were completed in the optimizing experience section to provide insight into which factors will influence their decisions to utilize pooled rideshare in the future. The final section related to demographics. See Figure 2 an overview of the survey structure, and for more detailed information on the survey, see [62,63].

This study focuses on structural equation model (SEM) analysis, where the inputs were extracted from two sections of the survey, as shown in Figure 2. The willingness to consider PR and optimizing experience sections were used to develop the SEM's conceptual model. Based on our team's previous research [62], from the willingness to consider PR section, the 23 items that were included in the factor analyses were used for the current SEM analysis, and 1 question was used as a response variable. Similarly, from the optimizing experience section [63], all 23 items included in the factor analyses were used for the current SEM analysis, and 1 question was used as a response variable.

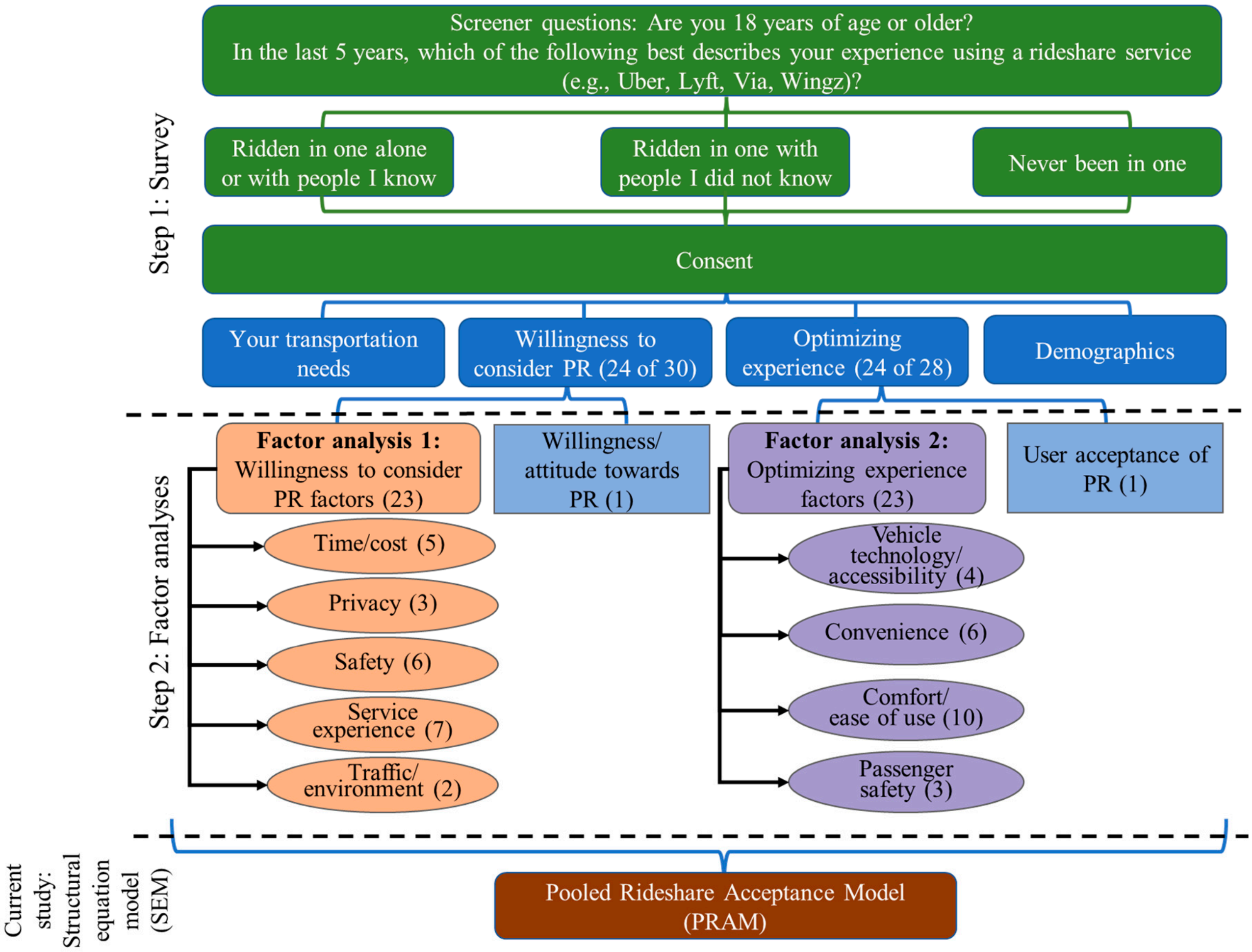

Figure 2. Step 1 displays the structure of the survey. The numbers in parentheses are the number of survey items used in each section of the Structural Equation Model (SEM). Step 2 shows the factors identified from the two factor analyses and the two items (*willingness/attitude towards PR* and *user acceptance of PR*) used as response variables in the SEM. The SEM analysis led to the creation of the Pooled Rideshare Acceptance Model (PRAM).

3.2. Data Analysis Process

Structural equation modeling (SEM) includes various statistical methodologies that aim to estimate a network of causal relationships among latent variables/factors and response variables [75]. The analysis for this study is based on covariance-based (CB) SEM, using maximum likelihood estimation. Maximum likelihood is a method of estimating the parameters of the model based on the probability distribution of the given data. CB-SEM is appropriate when the goal is theory-based hypotheses exploration, theory confirmation, or comparison of alternative theories [76,77]. Given the large sample size and based on the central limit theorem, where the distribution of sample means is close to a normal distribution, univariate and multivariate normality may be less of a concern [78,79]. However, to be conservative, we used the bootstrapping technique with 1000 random samples for the maximum likelihood estimation. Bootstrap sampling is a technique that involves drawing sample data repeatedly [80].

SEM is a two-step process consisting of a measurement model and a structural model [81]. The measurement model examines the relationship between factors and their measures. The structural model examines the relationship between the different factors and response variables. The measurement model was analyzed before proceeding to the structural model. This study focuses on the structural model, which makes use of measurement models that have already been examined in the previous two factor analysis papers [62,63]. The previous measurement models used covariance-based techniques, so it was logical to use a covariance-based technique for the additional SEM analysis.

The CB-SEM analysis was conducted in R, a statistical computing platform, using the *lavaan* package [82,83]. To evaluate the model fit, various goodness-of-fit indices were used. Based on the existing literature, the goodness-of-fit indices should meet the following criteria: Comparative Fit Index (CFI) > 0.8 [48], Root Mean Square Error of Approximation ($RMSEA$) < 0.08 [84], Standardized Root Mean Square Residual ($SRMR$) < 0.08 [85], Goodness-of-fit Index (GFI) > 0.93 [85], and Tucker-Lewis Index (TLI) > 0.8 [48].

As the study included a large and diverse sample of 5385 participants from across seven targeted cities, plus a national sample, the data set provided a variety of perspectives and backgrounds, thereby ensuring heterogeneity in the responses. This broad scope captured a certain degree of heterogeneity regarding geography, ridesharing experiences, and demographic characteristics. Moreover, applying the CB-SEM technique allowed for the exploration of the complex network of relationships among latent variables, providing a more in-depth understanding of the underlying factors. The bootstrapping technique with 1000 random samples for maximum likelihood estimation added further robustness to the analysis by considering the potential variability within the sample.

4. Results of the Structural Model

4.1. Fitting the Model

The conceptual model, shown in Figure 1, was considered a baseline to conduct exploratory SEM rather than confirming a conceptual model fit. The goal of the SEM was to obtain a model that determined the best model fit indices using the most optimal path relationships. The SEM was conducted using multiple iterations to obtain the best model fit. The SEM fit indices criteria were met after five iterations, at which point the model fit met the goodness-of-fit measurement criterion. The fifth iteration model was statistically significant (χ^2 (1041) = 16347.1, $p < 0.001$, $CFI = 0.893$, $RMSEA = 0.052$, $SRMR = 0.055$, $GFI = 0.946$, $TLI = 0.884$).

As shown in Figure 3, out of the 14 original hypotheses, the optimized model revealed that 11 of the hypothesized paths were supported. The two non-significant factors were *time/cost* and *vehicle technology/accessibility*. The *time/cost* factor from willingness to consider PR and *vehicle technology/accessibility* from optimizing experience factors showed no significance in the model. After observing the insignificance of the *time/cost* factor, different configurations of the model were explored to see whether *time/cost* had a direct/indirect significant influence on either *willingness/attitude towards PR* or *user acceptance of PR*; however, in both of those cases, the overall model did not provide a satisfactory fit.

Table 2 provides the significant regression paths of the final model. First, the significant willingness to consider PR factors were reported. The *privacy* factor had a significant influence on both the *safety* ($\beta = 0.946$, $z = 23.994$, $p < 0.001$) and *service experience* ($\beta = 0.516$, $z = 18.884$, $p < 0.001$) factors, indicating that *privacy* had a positive relationship with both *safety* and *service experience*. The *safety* factor ($\beta = -0.629$, $z = -7.810$, $p < 0.001$) had a significant **negative** influence on *trust service.* The *service experience* ($\beta = -0.055$, $z = -1.977$, $p < 0.05$) and *traffic/environment* ($\beta = 0.055$, $z = 2.753$, $p < 0.01$) factors had a significant influence on *user acceptance of PR.* In addition, *service experience* had a **negative** relationship with *user acceptance of PR,* while *traffic/environment* had a positive relationship with *user acceptance of PR.*

Next, the significant optimizing experience factors were reported. The *convenience* factor ($\beta = 0.646$, $z = 4.250$, $p < 0.001$) had a significant positive influence on *trust service.* The *comfort/ease of use* ($\beta = 0.071$, $z = 2.582$, $p < 0.01$) and *passenger safety* ($\beta = 0.070$, $z = 2.403$, $p < 0.05$) factors had a significant influence on *user acceptance of PR.* The *comfort/ease of use* factor had a positive relationship with *user acceptance of PR,* and *passenger safety* had a positive relationship with *user acceptance of PR.*

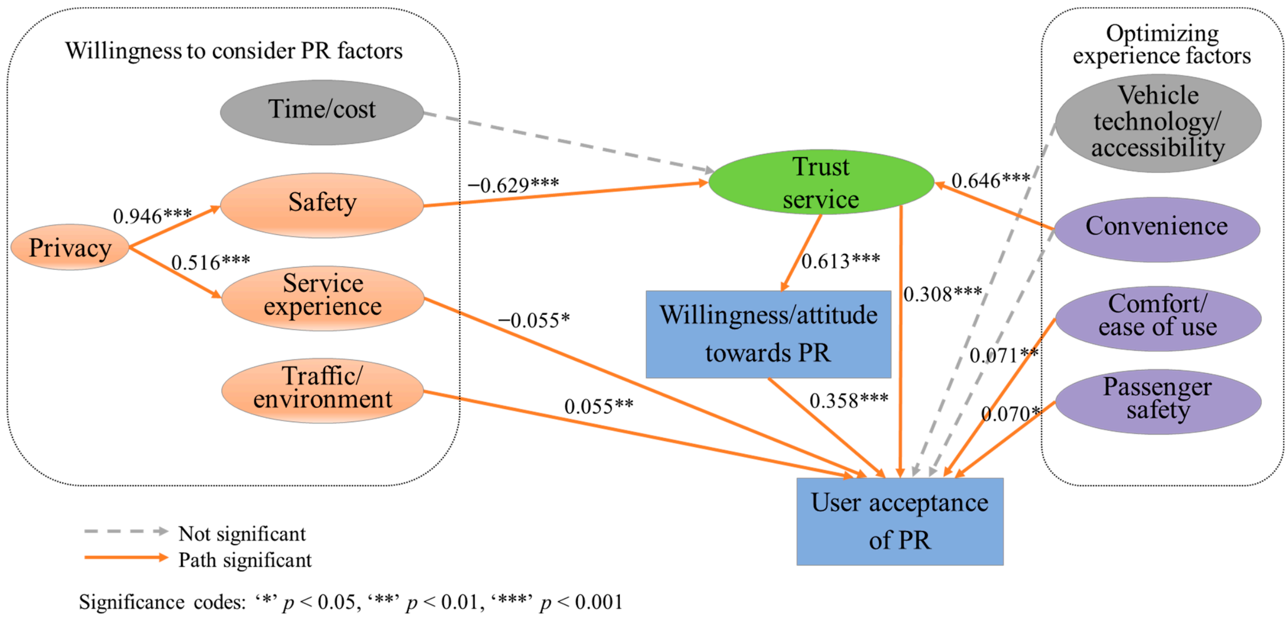

Figure 3. Results of SEM analysis model for user acceptance of PR.

Table 2. List of the SEM's significant regression paths in the order in which they are explained.

Construct Relations (Significant Path)	Direct Effect ^	*z*-Value	Standard Error	Cohen's f^2
H5(+) Privacy → Safety	0.946 ***	23.994	0.048	2.09
H6(+) Privacy → Service experience	0.516 ***	18.884	0.034	8.01
H7(−) Safety → Trust service	−0.629 ***	−7.810	0.047	6.85
H8(−) Service experience → User acceptance of PR	−0.055 *	−1.977	0.023	0.00
H9(+) Traffic/environment → User acceptance of PR	0.055 *	2.753	0.033	0.00
H11(+) Convenience → Trust service	0.646 ***	4.250	0.077	2.54
H13(+) Comfort/ease of use → User acceptance of PR	0.071 **	2.582	0.020	0.00
H14(+) Passenger safety → User acceptance of PR	0.070 *	2.403	0.022	0.00
H2(+) Trust service → Willingness/attitude towards PR	0.613 ***	9.674	0.088	0.60
H3(+) Trust service → User acceptance of PR	0.308 ***	6.909	0.063	0.05
H1(+) Willingness/attitude towards PR → User acceptance of PR	0.358 ***	21.297	0.017	0.14

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; ^ Standardized path co-efficient; Cohen's f^2 values of 0.02, 0.15, and 0.35 indicate the threshold of a small, medium, and large effect.

Finally, the remaining factor, *trust service*, along with the two response variables (*willingness/attitude towards PR* and *user acceptance of PR*) are discussed. The *trust service* factor had a significant positive influence on both *willingness/attitude towards PR* ($\beta = 0.613$, $z = 9.674$, $p < 0.001$) and *user acceptance of PR* ($\beta = 0.308$, $z = 6.909$, $p < 0.001$). The *willingness/attitude towards PR* ($\beta = 0.358$, $z = 21.297$, $p < 0.001$) factor had a significant positive influence on *user acceptance of PR*.

4.2. Effect Size Calculations

After determining the significance of each factor, it is then beneficial to evaluate the model's explanatory power. This is accomplished by evaluating the magnitude of each factor's influence on the next factor on its path; therefore, R^2 values were calculated for the four factors with a predictive variable (*privacy* → *safety*, *privacy* → *service experience*, *safety* → *trust service*, and *convenience* → *trust service*). In addition, R^2 values were calculated for the two response variables (*willingness/attitude towards PR* and *user acceptance of PR*). The objective was to obtain the relationship between the factors and response variable; if a model has an R^2 value greater than 0.3, then that model has good explanatory power [86].

The R^2 value for *safety* was 0.676, where 67.6% of the variability observed in the *safety* factor was explained by the *privacy* factor. The R^2 value for *service experience* was 0.889, where 88.9% of the variability observed in the *service experience* factor was explained by the *privacy* factor. The R^2 value for *trust service* was 0.333, where 33.3% of the variability observed in the *trust service* factor was explained by the combination of the *safety* and *convenience* factors. The R^2 value for *willingness/ attitude towards PR* was 0.375, where 37.5% of the variability was explained by the *trust service* factor. Finally, *user acceptance of PR* had an R^2 value of 0.439, where 43.9% of the variability is explained by five factors (*service experience*, *traffic/environment*, *comfort/ease of use*, *passenger safety*, and *trust service*), as well as one response variable, *willingness/attitude towards PR*. These R^2 values provide additional support for the user acceptance of the PR model.

The R^2 values were then used to calculate the Cohen's f^2 effect sizes, as shown in Table 2. Examining Cohen's f^2 is beneficial when evaluating a model to determine the magnitude of each independent variable's value to the model. *Privacy* had a large effect on *safety* and *service experience*. *Safety* and *convenience* had a large effect on *trust service*. *Trust service*, in turn, had a large effect on *willingness/attitude towards PR*. While there are five factors and one response variable that influence *user acceptance of PR*, the *trust service* factor and the *willingness/attitude towards PR* response variable had a small effect on the *user acceptance of PR*. The remaining four factors had a negligible impact in comparison.

4.3. Mediating (Indirect) Effects

A mediator is a variable in the causal path that helps to explain the relationship between the independent and dependent variables [87–89]. As summarized in Table 3, this full model has four mediators (*safety*, *trust service*, *willingness/attitude towards PR*, and *service experience*), which contributed to 12 paths. The analysis revealed that all of the possible mediated (indirect) effects were significant. The independent variables were *privacy*, *safety*, *convenience*, and *trust service*.

As an independent variable, the *privacy* factor had a negative indirect effect on the dependent variables *trust service*, *willingness/attitude towards PR*, and *user acceptance of PR*. *Privacy* ($\beta = -0.595$, $z = -6.912$, $p < 0.001$) had a negative indirect effect on *trust service*, mediated through *safety*. *Privacy* ($\beta = -0.364$, $z = -13.179$, $p < 0.001$) had a negative indirect effect on *willingness/attitude towards PR*, mediated through *safety* and *trust service*. *Privacy* ($\beta = -0.183$, $z = -10.231$, $p < 0.001$) had a negative indirect effect on *user acceptance of PR*, mediated through *safety* and *trust service*. *Privacy* ($\beta = -0.131$, $z = -11.211$, $p < 0.001$) had a negative indirect effect on *user acceptance of PR*, mediated through *safety*, *trust service*, and *willingness/attitude towards PR*. *Privacy* ($\beta = -0.029$, $z = -2.004$, $p < 0.05$) had a negative indirect effect on *user acceptance of PR*, mediated through *service experience*.

Similar to the *privacy* factor, as an independent variable, the *safety* factor had a negative indirect effect on the dependent variables *willingness/attitude towards PR* and *user acceptance of PR*. *Safety* ($\beta = -0.385$, $z = -14.109$, $p < 0.001$) had a negative indirect effect on *willingness/attitude towards PR*, mediated through *trust service*. *Safety* ($\beta = -0.194$, $z = -9.886$, $p < 0.001$) had a negative indirect effect on *user acceptance of PR*, mediated through *trust service*. *Safety* ($\beta = -0.138$, $z = -11.992$, $p < 0.001$) had a negative indirect effect on *user acceptance of PR*, mediated through *trust service* and *willingness/attitude towards PR*.

In contrast to the *privacy* and *safety* factors, as independent variables, the *convenience* and *trust service* factors had a positive indirect effect on its dependent variables. The *convenience* factor had a positive indirect effect on the dependent variables: *willingness/attitude towards PR* and *user acceptance of PR*. *Convenience* ($\beta = 0.396$, $z = 2.807$, $p < 0.01$) had a positive indirect effect on *willingness/attitude towards PR*, mediated through *trust service*. *Convenience* ($\beta = 0.199$, $z = 2.659$, $p < 0.01$) had a positive indirect effect on *user acceptance of PR*, mediated through *trust service*. *Convenience* ($\beta = 0.142$, $z = 2.809$, $p < 0.01$) had a positive indirect effect on *user acceptance of PR*, mediated through *trust service* and *willingness/attitude towards PR*. Next, as an independent variable, the *trust service* factor had a positive indirect effect on the dependent variable, *user acceptance of PR*. *Trust service* (β = 0.22, z = 8.948, $p < 0.001$) had a positive indirect effect on *user acceptance of PR*, mediated through *willingness/attitude towards PR*.

Table 3. Results of mediating effects organized by each of the four independent variables: *privacy*, *safety*, *convenience*, and *trust service*.

Indirect Path	Mediator(s)	Indirect Effect ^	z-Value	Standard Error
Privacy → Safety → Trust service	Safety	−0.595 ***	−6.912	0.062
Privacy → Safety → Trust service → Willingness/attitude towards PR	Safety and trust service	−0.364 ***	−13.179	0.028
Privacy → Safety → Trust service → User acceptance of PR	Safety and trust service	−0.183 ***	−10.231	0.018
Privacy → Safety → Trust service → Willingness/attitude towards PR → User acceptance of PR	Safety, trust service and willingness/attitude towards PR	−0.131 ***	−11.211	0.012
Privacy → Service experience → User acceptance of PR	Service experience	−0.029 *	−2.004	0.014
Safety → Trust service → Willingness/attitude towards PR	Trust service	−0.385 ***	−14.109	0.022
Safety → Trust service → User acceptance of PR	Trust service	−0.194 ***	−9.886	0.016
Safety → Trust service → Willingness/attitude towards PR → User acceptance of PR	Trust service and willingness/attitude towards PR	−0.138 ***	−11.992	0.01
Convenience → Trust service → Willingness/attitude towards PR	Trust service	0.396 **	2.807	0.099
Convenience → Trust service → User acceptance of PR	Trust service	0.199 **	2.659	0.053
Convenience → Trust service → Willingness/attitude towards PR → User acceptance of PR	Trust service and willingness/attitude towards PR	0.142 **	2.809	0.036
Trust service → Willingness/attitude towards PR → User acceptance of PR	Willingness/attitude towards PR	0.22 ***	8.948	0.034

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; ^ Standardized path co-efficient.

In summary, when the *privacy* and *safety* factors were considered as the independent variables, they had **negative** indirect effects on all their dependent variables, whereas the *convenience* and *trust service* factors had positive indirect effects on their dependent variables.

4.4. Higher-Order Factor (Trust Service) and Multicollinearity Assessment

Trust service was theorized in the conceptual model as a higher-order factor that would be identified during the SEM analysis. The higher-order factor was computed by considering the *time/cost*, *safety*, and *convenience* factors as indicators. As a higher-order factor, *trust service* needed to be treated as a measurement model, and the collinearity validation was conducted before completing the structural analysis, where *trust service* was considered as a dependent variable. A multicollinearity problem occurs when multiple independent variables (predictors) are highly correlated with each other. Table 4 shows the variance inflation factor (VIF) that helped to diagnose whether there were any multicollinearity problems when predicting *trust service*. All of the independent variable VIF values—*time/cost* = 2.7, *safety* = 2.1, and *convenience* = 1.9—were below 5, indicating a low correlation between them [90]. Therefore, *trust service* had no multicollinearity problems amongst its independent variables as a dependent variable.

Table 4. Multicollinearity assessment when predicting *trust service.*

	Independent Variable		
	Time/Cost	**Safety**	**Convenience**
Variance inflation factor (VIF)	2.7	2.1	1.9

Similar to *trust service*, for the dependent variable *user acceptance of PR,* there were multiple independent variables contributing to the regression analysis. Therefore, a multicollinearity assessment was completed for the dependent variable *user acceptance of PR*. The VIF values for the independent variables (Table 5) were *service experience* = 5.6, *traffic/environment* = 2.8, *trust service* = 6.4, *willingness/attitude towards PR* = 1.9, *comfort/ease of use* = 6.4, and *passenger safety* = 6.4. The *traffic/environment* and *willingness/attitude towards PR* VIF values were below 5, indicating a low correlation. The *service experience, trust service, comfort/ease of use,* and *passenger safety* VIF values were below 6.5, which were below the acceptable threshold of 10. As there were seven independent variables, it was important to ensure that there was not a high correlation between these independent variables. If any VIF value were above 10, researchers would consider that to be a high correlation, and as a result, the estimation may not be reliable. That is why researchers recommend a VIF value below 10 [78,91–93]. Our data meet this recommendation.

Table 5. Multicollinearity assessment when predicting *user acceptance of PR.*

	Independent Variable					
	Service Experience	**Traffic/ Environment**	**Trust Service**	**Willingness/ Attitude towards PR**	**Comfort/ Ease of Use**	**Passenger Safety**
Variance inflation factor (VIF)	5.6	2.8	6.4	1.9	6.4	6.4

5. Discussion

The goal of this study was to develop a model to predict U.S. travelers' pooled rideshare (PR) acceptance using human factor considerations. The study surveyed 5385 participants across the U.S., plus seven targeted cities. This study utilized the factors identified from two of our team's previous research papers examining users' willingness to consider PR [62] and optimizing experience of PR [63]. The willingness to consider PR study identified five factors: *time/cost, privacy, safety*, *service experience*, and *traffic/environment*. The optimizing experience study identified four factors: *vehicle technology/accessibility, convenience*, *comfort/ease of use*, and *passenger safety*. In this study, a structural model was created to identify the causal relationships between these factors, resulting in a higher-order factor, *trust service*, and identifying all of the factors' relative contributions to *willingness/attitude towards PR* and *user acceptance of PR*.

A conceptual model was established using the complex relationship between the ten factors/latent variables (time/cost, privacy, safety, service experience, traffic/environment, trust service, vehicle technology/accessibility, convenience, comfort/ease of use, and passenger safety) and two response variables (willingness/attitude towards PR and user acceptance of PR). While 14 potential paths were explored between the variables, the final optimized model identified 11 of the 14 paths as being significant. Further investigation of the model revealed the mediated (indirect) effects, which explain the indirect relationships that exist between the variables. Based on the model's direct and indirect effects, the different factors' relative contribution to the willingness/attitude towards PR and user acceptance of PR can be explained. Privacy, safety, trust service, and convenience factors showed strong significance in the model. The model's only two non-significant factors were time/cost and vehicle technology/accessibility, which suggests that their importance was relatively low compared to the other factors.

The final model explained the 11 hypotheses and met the required goodness-of-fit measurements criterion. The first hypothesis (H1) stated that users with a favorable attitude towards PR are positively correlated with the likelihood of accepting the service. The result suggested a positive direct relationship between the *willingness/attitude towards PR* and *user acceptance of PR*. This finding is consistent with other studies derived from the Technology Acceptance Model, indicating that a user's attitude generally influences their acceptance of a technology/service [32,44,46]. The second hypothesis (H2) stated that a stronger level of trust in PR services is associated with more favorable attitudes and willingness to use PR. The finding demonstrates a positive direct relationship between *trust service* and *willingness/attitude towards PR*. Trust in the rideshare services is important for the users to have a positive belief, which is also highlighted in other rideshare service studies [24,32]. Ma et al. [32] mention that trust in the rideshare service and trust in multiple drivers form a cumulative trust that is significant for the user to continue using the personal rideshare service. For the pooled rideshare service, this study found that the passengers' trust is significant if one is to share a ride with someone they do not know, which is a critical element for pooled rideshare services.

The third hypothesis (H3) stated that greater trust in PR services results in increased adoption and acceptance of PR. The result suggested a positive direct relationship between *trust service* and *user acceptance of PR*. In sharing economy research, trust in unknown persons and services is an essential prerequisite for success in a sharing economy [16,94]. For example, Airbnb acts as a broker and operates an online marketplace focused on short-term homestays between strangers. The research on Airbnb usage suggests that trust in its service platform leads to greater usage of its service [16]. In this study, the results suggest that trusting in the service is important for user acceptance of PR. Along with directly influencing *willingness/attitude towards PR* and *user acceptance of PR*, the *trust service* factor was found to be a significant mediator. With the *trust service* factor as a mediator, the *privacy* and *safety* factors had a negative indirect relationship with *willingness/attitude towards PR* and *user acceptance of PR*. Similarly, with the *trust service* factor as a mediator, the *convenience* factor had a positive indirect relationship with *willingness/attitude towards PR* and *user acceptance of PR*. The acceptance of pooled rideshare relies on the rideshare service platform, which must ensure that riders trust its services with multiple riders and create favorable conditions [95]. If the user does not feel safe during the ride or if any safety or privacy violations occur while using the ride, it will strongly influence users not to use PR.

The next two significant hypotheses (H5 and H6) were related to the *privacy* factor. The fifth hypothesis (H5) stated that users who prioritize privacy will have more concerns about safety when sharing rides with unknown riders. The result suggested a positive direct relationship between the *privacy* and *safety* factors. As pooled ridesharing requires the user to travel with multiple people whom they do not know, privacy inside the vehicle will influence their perception of safety. The user expects the rideshare companies to ensure that there is no harm or danger when sharing a ride [21,32]. The sixth hypothesis (H6) stated that users who prioritize privacy will expect a higher service experience during the ride. The result suggests a positive direct relationship between the *privacy* and *service experience* factors. As the majority of travelers in the U.S. prefer a personal vehicle for commuting, this finding suggests that the user will desire privacy during PR and wants that privacy to be as similar as possible to what they experience in their own private vehicle. Rideshare companies likely need to enhance their service experience by offering better privacy options to increase PR use.

Next, the seventh hypothesis (H7) stated that users with higher concerns about safety will have lower trust in PR services. The result suggests a negative direct relationship between the *safety* and *trust service* factors. This means that safety is the primary concern for users who do not accept the PR concept. As highlighted in several studies [32,33,96–98] as well as in Uber and Lyft's safety reports [99,100], physical and sexual assaults have happened in the past. These incidents tend to cause the user to have reduced trust in the rideshare service, as reflected in this study. When using pooled rideshares, it is likely that a vehicle will detour from their original path to pick up and drop off others; therefore, the user has to travel an extra distance, possibly in an unfamiliar location. With the *safety* factor as a mediator, the *privacy* factor had a negative indirect relationship with *trust service*. Compared to using a personal vehicle, where there is privacy and a preference for traveling alone, the pooled rideshare can create privacy concerns that negatively influence a user's trust in the service. Feeling safe is of the highest importance for the users; therefore, rideshare companies must ensure passengers that there is a level of safety between the users and the service.

In the two subsequent hypotheses, the *service experience* and *traffic/environment* factors directly influenced the *user acceptance of PR*. The eighth hypothesis (H8) stated that the higher concerns regarding the service experience of PR compared to alternative transportation options result in a decrease in the user acceptance of PR. The result suggested a negative direct relationship between *service experience* and *user acceptance of PR*. In the *service experience* factor, the items with the highest factor loadings were related to public transportation availability. This suggests that unless there is a strong justification for the rideshare advantage, the user may still prefer public transportation over pooled rideshare, as reflected in other studies [101,102]. The ninth hypothesis (H9) stated that users with higher concerns for traffic congestion and environmental impact leads to an increase in user acceptance of PR. The result suggested a positive direct relationship between *traffic/environment* and *user acceptance of PR*. The widespread adoption of ridesharing can take vehicles off the road, reduce traffic congestion, protect air quality, lower vehicle emissions, and reduce the need for infrastructure investment [70,101,103,104]. The users' concerns about traffic congestion and thoughts that using rideshare will improve the environment influenced their acceptance of PR directly.

The next significant hypothesis is related to the *convenience* factor. The eleventh hypothesis (H11) stated that the optimized convenience experience will lead to increased trust in the PR service. The result suggested a positive direct relationship between the *convenience* and *trust service* factors. Unlike the *safety* factor, the *convenience* factor can strongly influence the user to gain trust in the PR services. The increase in trust will help users to formulate a positive opinion of PR [46]. Rideshare companies need to carefully focus on the topics that fall within the *convenience* factor, which can increase ridership. In this study, the results suggest that ride affordability and information about the ride (e.g., cost, route, time, service transparency, and user communication with the outside world) were important. Inbar et al. [105] conducted similar research concerning passengers and found that passengers like to have continuous information about their trip as well as continuous communication with the outside world. Similar results were also found in the shared autonomous vehicle research, where multiple users share a ride without a driver [68,106]. The *convenience* factor indirectly influenced both *willingness/attitude towards PR* and *user acceptance of PR,* mediated through *trust service,* indicating its influence on users' willingness to use PR. Rideshare companies should incorporate user-centered services that are reliable to provide a convenient ride.

The two remaining significant hypotheses were related to *comfort/ease of use* and *passenger safety* factors. The thirteenth hypothesis (H13) stated that optimized comfort/ease of use experience will lead to increased user acceptance of PR. The result suggested a positive direct relationship between *comfort/ease of use* and *user acceptance of PR*. As Mayr [107] suggested in the traveling comfort theory, the user should have a comfortable experience within the vehicle and a comfortable ease of use experience when scheduling a ride. The user expects a high level of physical comfort for a convenient ride [108]. Rideshare companies should focus on customized heating, ventilation, and air condition (HVAC) systems for each user, enough physical space, ergonomic seats, and in-built infotainment, as well as a better view of the outside environment. The fourteenth hypothesis (H14) stated that the passenger safety experience will lead to increased user acceptance of PR. The result suggested a positive direct relationship between *passenger safety* and *user acceptance of PR*. As seen earlier, the *safety* factor is the greatest priority for the user. Therefore, the safety improvement features in the rideshare service are essential for sustained service growth. Companies such as Uber and Lyft have been consistently incorporating new features to increase the safety of their users. For example, Uber has an emergency assistance button to call authorities if the user needs immediate help. Friends and family can follow the user's route and will know when the user arrives at their destination. In addition, advanced features such as RideCheck use vehicle sensors and GPS data to detect if a trip goes off-course or if a possible crash has occurred [109].

The first non-significant factor in the model was *time/cost*, which is from the willingness to consider PR factors. Some studies suggest that the time and cost items are important for rideshare participation [24,70,104,110–112]. The previous studies have largely focused on time and cost with other factors, such as demographic features, the relationship between cost and time, vehicle automation, etc. This study focused on 46 items that were categorized into nine diverse factors to obtain the comprehensive motives of user willingness to accept PR. Given the *safety* and *convenience* factor's significant contributions to *trust service*, the *time/cost* factor did not significantly influence *trust service* [24]. In this study, only the *trust service* factor influenced positive attitudes towards PR as it acted as a mediator for the *privacy*, *safety*, and *convenience* factors, which the users considered more important than the *time/cost* factor.

However, the survey items on the *convenience* factor focused on cost, travel time, wait time, and information about the ride. From the previous factor analysis, it is important to note that the items 'The cost to share a ride is more affordable than other transportation', 'There is clear information about the ride (e.g., cost, route, time) before I book it', and 'I won't be delayed by long detours' had the highest factor loadings [63]. Specifically, 84% and 81.5% of the participants either 'Agree' or 'Strongly agree' with the latter two items, indicating their willingness to consider pooled rideshare services. Despite the *time/cost* factor's lack of significance, the individual items related to time and cost were crucial when viewed within the context of convenience. This highlights that while users' perceptions of privacy and safety are paramount for their attitude towards PR, once the safety concerns are addressed and the services are deemed convenient, time and cost elements significantly enhance their trust in pooled rideshare services. The findings complement the other research, which indicates that factors like reduced trip costs compared to alternatives are important in opting for pooled rideshare services [70]. Moreover, convenience features like shorter wait times and accessibility all the time, along with transparent communication and reliable services, further influence users' decisions to share rides [25,33,64,68]. Amirkiaee et al.'s [24] rideshare acceptance model highlights that, along with trust, time and cost benefits significantly influence positive attitudes toward rideshare.

The second non-significant factor in the model was *vehicle technology/accessibility*, which is from the optimizing experience PR factors. This complements the findings in Amirkiaee et al.'s [24] rideshare acceptance model that the user may not be concerned about the vehicle's energy source, whether it is propelled by electricity, gasoline, or another energy source. Regarding the automation of the vehicle, shared autonomous vehicles have found significance in autonomous vehicle development [106,110,111,113]; however, from the users' point of view, it does not influence their acceptance of PR. Finally, after reviewing all of the hypotheses' significances obtained from the analysis, the user acceptance pooled rideshare model using the human factors perspective, which is Pooled Rideshare Acceptance Model (PRAM), is shown in Figure 4.

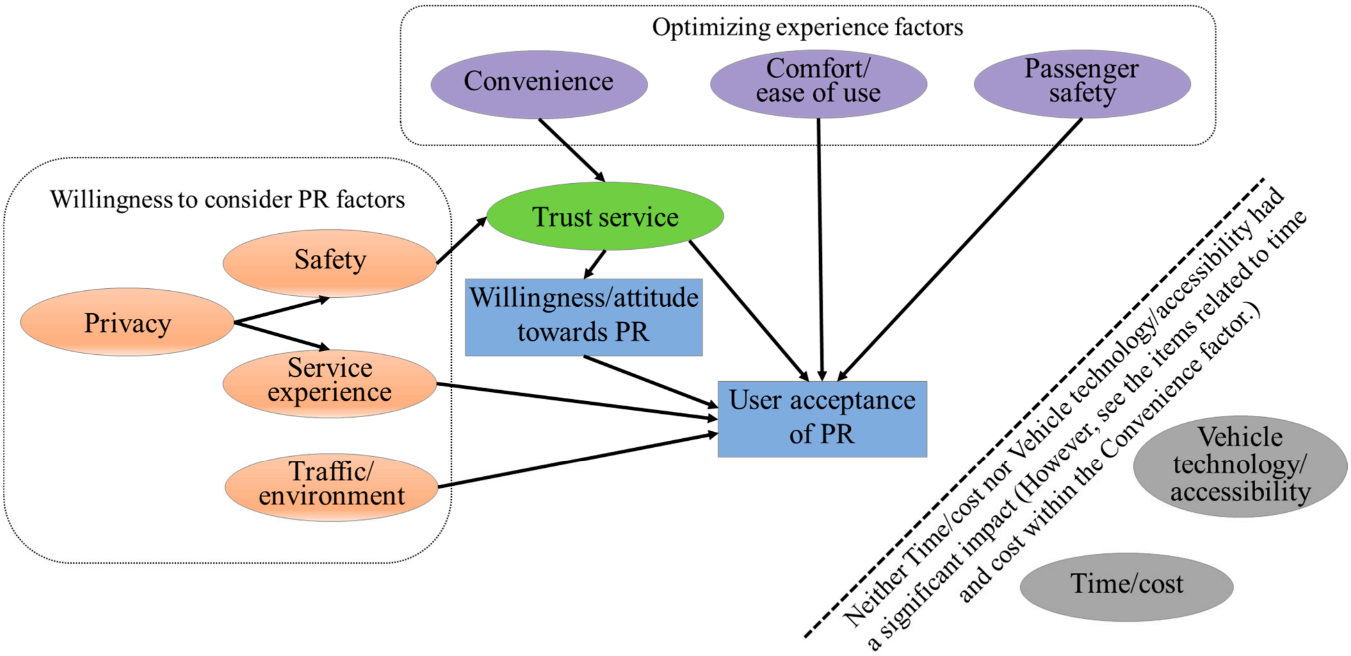

Figure 4. Pooled Rideshare Acceptance Model (PRAM): showing significant paths, with 10 factors (privacy, time/cost, safety, service experience, traffic/environment, vehicle technology/accessibility, convenience, comfort/ease of use, and passenger safety) and 2 response variables (willingness/attitude towards PR and user acceptance of PR). Time/cost and vehicle technology/accessibility factors were not significant compared to the relative contribution of other factors.

6. Conclusions

This study was designed based on an online national survey in the U.S. with 5385 participants to increase the understanding of human factor- barriers and user preferences, which will provide foundational knowledge of the factors that affect individuals' acceptance of pooled rideshare (PR). The covariance-based structural equation model (CB-SEM) was used to identify the causal relationship between the willingness to consider PR factors (*time/cost*, *privacy*, *safety*, *service experience*, and *traffic/environment*) and optimizing experience of PR factors (*vehicle technology/accessibility*, *convenience*, *comfort/ease of use*, and *passenger safety*), resulting in a higher-order factor, *trust service*, and eventually finding all of the factors' relative contribution to *willingness/attitude towards PR* and *user acceptance of PR*, thereby developing a Pooled Rideshare Acceptance Model (PRAM). In the PRAM, the *privacy*, *safety*, *trust service*, and *convenience* factors showed significance, along with the *comfort/ease of use*, *service experience*, *traffic/environment*, and *passenger safety* factors. The only two non-significant factors in the model were (1) *time/cost* and (2) *vehicle technology/accessibility*, suggesting that users only consider the time, cost, technology, and accessibility variables when they feel safe in using it. Despite the *time/cost* factor's lack of significance, individual items related to time and cost were crucial when viewed within the convenience factor [63]. This highlights that while user perceptions of privacy and safety are critical towards their attitude towards PR, once the safety concerns are addressed and the services are deemed convenient, time and cost elements significantly enhance users' trust in pooled rideshare services. This is an important and consistent finding in the study, which makes a valuable contribution to the design of pooled rideshare services.

Privacy had a negative indirect influence on willingness/attitude towards PR and user acceptance of PR, mediated through safety and trust service. Privacy had a negative indirect influence on willingness/attitude towards PR and user acceptance of PR, mediated through service experience. Safety had a negative indirect influence on willingness/attitude towards PR and user acceptance of PR, mediated through trust service. The trust service factor had a positive direct influence on user acceptance of PR and a positive indirect influence, mediated through willingness/attitude towards PR. Convenience had a positive indirect influence on willingness/attitude towards PR and user acceptance of PR, mediated through trust service. The other factors from willingness to consider PR, such as service experience, had a negative direct influence on user acceptance of PR, and traffic/environment had a positive direct influence on user acceptance of PR. Similarly, the factors from optimizing experience, such as comfort/ease of use, had a positive direct influence on user acceptance of PR, and passenger safety had a positive direct influence on user acceptance of PR. In summary, the information about the ride (e.g., cost, route, time), service transparency, and user communication with the outside world greatly influence the acceptance of PR. The individual considers privacy, safety, and service experience as deterrent factors in using PR when compared with other modes of transportation. Rideshare service companies and policymakers must consider these factors as the highest priority in their policy to increase user acceptance of PR.

7. Recommendations to Policymakers and Rideshare Companies

Based on the findings of this extensive study on U.S. travelers' acceptance of pooled ridesharing (PR), several policy implications and recommendations for policymakers and rideshare companies can be derived. The Pooled Rideshare Acceptance Model (PRAM) reveals that privacy, safety, trust in the service, and convenience factors are paramount to influencing user acceptance of PR.

Enhance User Trust: Rideshare companies should invest in measures that boost user trust in their services. This can be achieved by ensuring transparency in operations, offering reliable services, and ensuring proper communication with users about their ride information and any changes that might occur.

Prioritize Safety: Policies should be enacted that mandate strict safety measures in PR services as safety has been identified as a primary concern for users. This could include rigorous background checks for drivers, robust processes for handling complaints, and advanced safety features like emergency assistance buttons and ride tracking.

Privacy Measures: PR services should pay special attention to the privacy concerns of users, particularly as users are often sharing rides with strangers. Privacy in this context could extend to both physical and data privacy. Measures could include strict data privacy policies and practices. Future vehicle designs, including those of autonomous vehicles, might consider the integration of privacy pods as a potential opportunity considering the growing emphasis on privacy among users.

Improve Service Experience: Rideshare companies should strive to enhance the service experience by mimicking the privacy and comfort that users experience in their personal vehicles. This could involve offering personalized climate control, spacious and ergonomic seating, and onboard infotainment options.

Promote Environmental Benefits: Policymakers should promote the environmental benefits of PR, such as reduced traffic congestion and lower emissions, to encourage more users to consider this mode of transportation. This could include public awareness campaigns and incentives for users choosing more sustainable travel options.

Improve Convenience: Efforts should be made to make PR as convenient as possible. This might include minimizing wait times, providing accurate arrival times, and making the process of booking and paying for rides seamless.

While this study did not identify time/cost and vehicle technology/accessibility as significant factors, it did highlight the importance of time- and cost-related items when viewed through the prism of convenience. Therefore, the importance of shaping users' perceptions needs to address the problem using a user-centered design, and service providers need to prioritize safety initiatives and address travel time and pricing from a user convenience perspective. As future policies and practices evolve, there is a clear need to offer competitive prices, efficient travel times, reliable services, and to integrate user-friendly technologies, while prioritizing the pivotal factors identified in this study. It is predicted that adhering to these recommendations will substantially amplify the acceptance and adoption of PR services in the U.S.

8. Future Research

In this study, the impact of the different moderators, such as gender, age, cities, educational background, prior rideshare experience, and employment status, are not considered in the pooled rideshare acceptance model. Further analysis will be conducted for these moderators' influence on various factors contributing to the user acceptance of PR. One example of the need for this more comprehensive data analysis is the importance of examining the impact of previous rideshare experiences. Future research will examine potential variations in attitudes and acceptance levels between different groups (including but not limited to previous rideshare use, gender, age, income, location, employment status, and education) as moderators for the pooled rideshare acceptance model (PRAM). These future results may be able to highlight interventions aimed at promoting shared modes of mobility, particularly focusing on strategies to engage users who have never utilized a PR service. In particular, examining each of these groups of participants through a targeted approach will help to determine how each of the factors influence rideshare acceptance.

The model is developed based on a U.S. sample. The factors contributing to the user acceptance of PR can vary in different regions of the world. Therefore, the model can be used to further explore user acceptance of PR in different geographic areas. While this study focused on user willingness to accept pooled rideshare services, when considering different populations and ridesharing modes, governmental regulations may play a vital role in shaping perceptions and attitudes. The inclusion of such a factor in future research may offer a deeper understanding of pooled rideshare acceptance, especially considering diverse regulatory environments, the aftermath of COVID-19, and socio-economic contexts, along with the global efforts by policymakers to establish guidelines for global rideshare service companies. Given that the study employed a non-experimental design, future research may benefit from exploring alternative causal sequences and mechanisms. Such investigations could provide a deeper understanding of the dynamics influencing pooled rideshare acceptance [89,114].

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Appendix A

This appendix provides a list of the survey questions developed in collaboration with J.D. Power that allowed for the development of the Pooled Rideshare Acceptance Model (PRAM). The following survey questions are a subset of the larger survey.

Willingness/attitude towards PR question

1. Regardless of your past experience, would you be willing to consider utilizing a **pooled rideshare**, one in which you share the ride with people you don't know who may join from multiple locations during the trip and drop off at different locations? (e.g., UberPool, Lyft Shared) ___Yes, ___No, ___Don't know

Willingness to consider PR factor questions

(If item 1 was "Yes", the following question was used) We would like to understand more of the reasons why you are willing to consider **pooled rideshare**. How important are each of the following **travel time and cost** factors in determining your willingness to utilize a **pooled rideshare**?
(If item 1 was "No" or "Don't know", the following question was used) We would like to understand more of the reasons why you are not willing to consider **pooled rideshare**. How important are each of the following **travel time and cost** factors in determining your unwillingness to utilize a **pooled rideshare**?

Rating Scale: 1 = Not at all important, 2 = Not very important, 3 = Important, 4 = Very important

2. Travel time from door to door (e.g., in car travel time to destination)	1	2	3	4
3. Wait time (e.g., waiting for ride to arrive, another passenger pick up)	1	2	3	4
4. Cost savings/incentives received for pooling the ride	1	2	3	4
5. Cost of driving my personal vehicle (e.g., gas, maintenance, parking)	1	2	3	4
6. On-time likelihood (e.g., risk of picking up others along the route that may modify your original arrival time)	1	2	3	4

(If item 1 was "Yes", the following question was used) How important are each of the following **environmental** factors in determining your willingness to utilize a **pooled rideshare**?

(If item 1 was "No" or "Don't know", the following question was used) How important are each of the following **environmental** factors in determining your unwillingness to utilize a **pooled rideshare**?

Rating Scale: 1 = Not at all important, 2 = Not very important, 3 = Important, 4 = Very important

7. Help to improve the environment (e.g., reduce pollution, reduce energy consumption)	1	2	3	4
8. Help to reduce traffic congestion	1	2	3	4

(If item 1 was "Yes", the following question was used) How important are each of the following **social** factors in determining your willingness to utilize a **pooled rideshare**?

(If item 1 was "No" or "Don't know", the following question was used) How important are each of the following **social** factors in determining your unwillingness to utilize a **pooled rideshare**?

Rating Scale: 1 = Not at all important, 2 = Not very important, 3 = Important, 4 = Very important

9. Chance to meet new people	1	2	3	4
10. Prefer to travel alone	1	2	3	4

(If item 1 was "Yes", the following question was used) How important are each of the following **personal safety** factors in determining your willingness to utilize a **pooled rideshare**?
(If item 1 was "No" or "Don't know", the following question was used) How important are each of the following **personal safety** factors in determining your unwillingness to utilize a **pooled rideshare**?

Rating Scale: 1 = Not at all important, 2 = Not very important, 3 = Important, 4 = Very important

11. Traveling during the day	1	2	3	4
12. Traveling at night	1	2	3	4
13. Familiarity with travel vicinity	1	2	3	4
14. Desire for privacy	1	2	3	4
15. Trust in the driver (e.g., unnecessary detour, theft, skills, physical safety)	1	2	3	4
16. Trust in other passengers (e.g., theft, illness, physical safety)	1	2	3	4
17. I am with another person I know	1	2	3	4

(If item 1 was "Yes", the following question was used) How important are each of the following **reliability and accessibility** factors in determining your <u>willingness</u> to utilize a **pooled rideshare**?
(If item 1 was "No" or "Don't know", the following question was used) How important are each of the following **reliability and accessibility** factors in determining your <u>unwillingness</u> to utilize a **pooled rideshare**?

Rating Scale: 1 = Not at all important, 2 = Not very important, 3 = Important, 4 = Very important

18. Other public transportation options are available	1	2	3	4
19. Trust that the rideshare will get me to my destination when I need to be there	1	2	3	4
20. Previous rideshare experience	1	2	3	4
21. Accessibility needs for passengers with disabilities	1	2	3	4
22. I don't have access to other public transportation options	1	2	3	4

(If item 1 was "Yes", the following question was used) How important are each of the following **convenience** factors in determining your <u>willingness</u> to utilize a **pooled rideshare**?
(If item 1 was "No" or "Don't know", the following question was used) How important are each of the following **convenience** factors in determining your <u>unwillingness</u> to utilize a **pooled rideshare**?

Rating Scale: 1 = Not at all important, 2 = Not very important, 3 = Important, 4 = Very important

23. Convenience of driving my personal vehicle	1	2	3	4
24. Rideshare App ease of use to request a pooled ride	1	2	3	4
25. Ability to do other things during the ride	1	2	3	4
26. Other public transportation options are convenient	1	2	3	4

Optimizing experience factors questions

This next series of questions will help us understand what factors influence your willingness to utilize a **pooled rideshare** in the future.

(MODE) Thinking about certain aspects of the vehicle or other riders using the rideshare service, please state how much you agree or disagree with the following statements: I would be more likely to choose a **pooled rideshare** if. . .

Rating Scale: 1 = Strongly disagree, 2 = Disagree, 3 = Agree, 4 = Strongly agree

27. The vehicle is automated and does not have a human driver.	1	2	3	4
28. The vehicle is a battery-electric vehicle (only runs on electricity).	1	2	3	4
29. The vehicle is cleaned/disinfected in between rides.	1	2	3	4
30. The vehicle is accessible for passengers with disabilities.	1	2	3	4
31. I can ride with a person who is like me.	1	2	3	4
32. The other passenger is pre-screened by the rideshare service.	1	2	3	4
33. A subscription service is available (i.e., fixed monthly cost for unlimited rides).	1	2	3	4

(HMI) Considering how you might interact with the rideshare vehicle or service, please state how much you agree or disagree with the following statements: I would be more likely to choose a **pooled rideshare** if. . .

Rating Scale: 1 = Strongly disagree, 2 = Disagree, 3 = Agree, 4 = Strongly agree

34. The rideshare service app is easy to use.	1	2	3	4
35. I can adjust the temperature in the vehicle to my liking.	1	2	3	4
36. I can see a profile of the other passenger.	1	2	3	4
37. I can adjust the seats in the vehicle for comfort.	1	2	3	4
38. The vehicle design creates private spaces.	1	2	3	4
39. I can call to request a ride instead of using the app.	1	2	3	4
40. There is sufficient storage in the vehicle for all my belongings.	1	2	3	4
41. I can sit where I want in the vehicle.	1	2	3	4
42. The vehicle offers me information and entertainment throughout the experience.	1	2	3	4
43. I had someone to help me with the service during my first time requesting a ride.	1	2	3	4

(ROUTE) Please state how much you agree or disagree with the following statements: I would be more likely to choose a **pooled rideshare** if. . .

Rating Scale: 1 = Strongly disagree, 2 = Disagree, 3 = Agree, 4 = Strongly agree

44. The cost to share a ride is more affordable than other transportation.	1	2	3	4
45. A ride is available 24/7.	1	2	3	4
46. The other passenger is coming from or going to the same event/location as me.	1	2	3	4
47. I can provide information about my trip and location to my family and/or friends.	1	2	3	4
48. There is clear information about the ride (e.g., cost, route, time) before I book it.	1	2	3	4
49. I won't be delayed by long detours.	1	2	3	4

User acceptance of PR question

50. Assuming a **pooled rideshare** service meets all of your needs mentioned above, how willing are you to use a **pooled rideshare** when it is available to you?___Definitely will not, ___Probably will not, ___Probably will, ___Definitely will

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