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Students' Intentions toward Carpooling in Sohar, Oman: Importance of Various Motivating Factors, Incentives, and Barriers

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ABSTRACT: This study explores the carpooling potential among university students considering the various incentives, discounts, motives, and barriers. A questionnaire was designed and conducted with the students of Sohar University, Oman. The analysis of collected 250 samples showed that more than 60% of the students were willing to accept carpooling considering the various benefits and incentives. The ANOVA analysis revealed significant differences in interest in carpooling according to multiple segments of students based on age, marital status, vehicle ownership, driving a car, and study major. Factor analysis yielded four factors of encouraging variables and three factors of discouraging variables. The factors of accessibility, convenience, cost and physical, and incentives are significant predictors of carpooling intentions. Also, the factors of perceived difficulty, freedom, trust, and commitment concerns are significant predictors of intentions. The students' preference for the bus over carpooling negatively affects the intention, whereas, carpooling experience, carpooling for the reduction in traffic congestion, and study major (engineering) positively correlated with carpooling intentions. These findings provide a useful understanding of the significant factors influencing the behavioral intentions of students toward carpooling.

KEYWORDS: Travel demand management; Carpooling, Travel Behaviour, Traffic Congestion, Mode choice

1. INTRODUCTION

The increased use of single-occupancy vehicles leads to traffic congestion on road networks. This congestion results in travel delays and increases the externalities from road transport (Sweet, 2013). Generally, supply is added to meet the increased travel demand; however, in the long run, society does not benefit from it because adding more supply brings more traffic on roads (Noland, 2001). The cities need to look for alternative transport strategies along with supply-side measures to ensure the mobility of people and reduce externalities. This will help to shape the cities sustainably by reducing the economic and environmental impacts of induced traffic (Noland, 2001; Piras et al., 2018).

Various travel demand management (TDM) measures have been implemented in different countries to tackle persistent traffic congestion. These TDM measures influence individual travel behavior and disperse the travel demand in time and space (Ferguson, 1990; Meyer, 1999; Piras et al., 2018). The TDM measures are effective in making modal shifts through behavioral change. Various coercive and non-coercive TDM strategies are available to asses and implement for effective modal shift (Eriksson et al., 2006; Javid et al., 2015). One of the TDM measures is carpooling which tends to reduce the use of single occupancy vehicles and provide an alternative transport mode where people share the ride on mutual consent (Collins, 2013; Horton, 2020; Terrier & Audrin 2022). Carpooling helps travelers to reduce their travel costs, and to reduce traffic congestion on roads (Santi et al., 2014; Zhou et al., 2014). Carpooling has significant potential to provide road users with economic, social, and environmental benefits. It can also address the localized traffic problems in a particular locality.

The recurrent traffic congestion occurs near the Sohar University (SU) campus daily in the morning peak. It has been observed that students and staff sometimes face long delays near the university on service roads. The majority of the students, faculty members, and administrative staff reached the university using their private transport. The university has around 11,000 undergraduate and graduate students. Some of the female students travel by university bus transport. It is not always convenient and affordable for students to travel by private vehicle or use shared taxis or public transport (Thopate et al., 2022). However, the students' excessive use of single-occupancy vehicles has resulted in recurring congestion near the SU campus. The shared mobility among staff and students can help to reduce travel delays and solve the on-campus parking issue for the students. Therefore, this study explores the potential of carpooling among SU students considering various constraints, incentives, and motivational and psychological factors. A questionnaire was designed and conducted with students online using Google Forms. The collected data were analyzed using factor analysis and logistics regression analysis methods to identify the significant correlations among various factors and their influence on carpooling intentions. The findings of this study provide useful insights into the student's intentions with carpooling and significant influencing factors. The remaining of the paper is organized in the following manner. Section 2 analyzes and discusses the relevant literature, and section 3 elaborates on the research methods. Survey and analysis results are presented and interpreted in section 4. Discussion and policy implications of results are presented in section 5. The last section summarizes the key findings and limitations of the study.

2. LITERATURE REVIEW

A study in China shows that the sex and age of students do not significantly impact attitudes toward carpooling, and the most concerning factor in carpooling for students is comfort (Li et al., 2024). The carpooling practices at the University of Wollongong campus are fortified by the factors of emotional control, convenience, and autonomy, rather

than sustainability (Horton, 2020). Security and cost are the main attributes of a carpooling program or club designed by educational institutions (Liakopoulou et al., 2017). Being a female and foreigner, and being a student or faculty member along with a fixed schedule increases the probability of ridesharing among participants in sustainable urban mobility (Alquhtani, 2022). A study showed that the student's intentions to carpool are positively influenced by the perceived benefits of carpooling and parking restrictions, whereas negatively influenced by personal and schedule constraints (Javid & Al-Khayyat, 2021). Gender, hot weather conditions, and vehicle ownership trends influence the students' mode choice behavior in high-income countries (Hamad et al., 2021; Javid & Al-Khayyat, 2024).

The results of a binary Logit model show that occupation, income, marital status, schedule flexibility, trip distance and time, weather conditions, carpooling fee, and profiles of riders and drivers have a significant influence on the demand for carpooling systems (Tahmasseby et al., 2016). It is reported that the relationship between individuals and their organization is an effective way to promote carpooling, and the trust and attitudes of individuals strongly define the carpooling intention (Terrier and Audrin, 2022). The dispositional trust has an indirect impact on carpooling intention via PBC (Bachmann et al., 2018). The people's trust in ridesharing service providers and participants in combination with economic and time benefits strongly influence their intentions to participate in ridesharing (Amirkiaee & Evangelopoulos, 2018). Socio-environmental and economic benefits, preferential parking, disincentives for car use, and convenience and comfort are significant predictors of carpooling potential. However, privacy, restricted freedom, and security negatively influence carpooling likelihood (Javid et al., 2017).

The attitudes and subjective norms have the most significant impact on carpooling intentions which is followed by perceived behavioral control (PBC) and personal norms. Sustainability indicators and economic incentives have shown an influence on attitudes toward carpooling (Abutaleb et al., 2021). Normative beliefs in conjunction with perceived behavioral control are significant in predicting the carpooling intentions of both passengers and drivers (Bachmann et al., 2018). Perceived practical constraints and poor counterparts are the main barriers to incorporating carpooling, and proper matching programs provide a good experience for carpoolers (Adelé & Dionisio, 2020). An application of the Unified Theory of Acceptance and Use of Technology (UTAUT) showed that the trust factor has a significant contribution to the acceptance of ridesharing programs. This study also highlights the significance of price value, habit, and trust in influencing the intentions to use the technology (Stefan et al., 2020). Convenience, privacy, and trust are important attributes for females to participate in carpooling programs and postgraduate students are less likely to carpool (Al-Masaeid et al., 2022).

A review of factors shows that psychological factors are more significant than demographic variables in predicting carpooling intentions including the time benefits and environmental concerns (Olsson et al., 2019). A study found that value beliefs, safety, and platform quality perceptions have a significant and direct influence on the formation of supporting attitudes and intentions to engage in carpooling programs (Dinesh et al., 2021). The intentions to carpool are positively affected by perceived usefulness, environmental awareness, and social pressure, and it is negatively influenced by perceived risks associated with carpooling (Kang et al., 2024). The perceived risks have a negative influence on carpooling intentions, especially in times of crises or pandemics (Terrier & Audrin, 2022). The psychological risks are important as travelers are concerned about their health (Tran, 2020). It is believed that hedonic motivation and social influence play important roles in predicting carpooling behavior and intentions (Lowe & Piantanakulchai, 2023). Another study reports that the socio-economic, cultural, and environmental factors influence the carpooling matching programs (Ballo, 2023). The safety concerns related to carpooling and psychological high costs make a neutral carpooling attitude and comfort the most concerning parameter for college students (Li et al., 2024). The increase in perceived risk during COVID-19 tends to reduce the use of public transport and increase the use of shared bikes and private transport (Wang et al., 2024). It is crucial to reduce the traveler's perceived risk in shared transport (Saha et al., 2024). Sharing personal space with strangers causes discomfort to travelers and special discounts and incentives are needed to enhance the trust among potential carpoolers (Cellina et al., 2024). Social and demographic attributes and built environment settings influence the perceived risks associated with shared mobility (Rahimi et al., 2021). However, a study in Bangkok showed that the perceived risk does not influence the carpooling intention, and trust in using the carpooling has no impact on the perceived risk (Tsai et al., 2021). The influence of perceived risks while sharing public space like sharing a vehicle with strangers might vary from region to region. Also, cultural and social values and individual attitudes influence people's decision to choose a travel mode (Rahimi et. al., 2020; Saha et al., 2024). Social transformation is important to make the significant modal shift from private cars to shared transport services (Vélez et al., 2023).

A review study highlighted the need to explore the influence of cultural differences, dimensions of trust, and various psychological barriers in designing carpooling programs (Julagasigorn et al., 2021). The cost-saving factor in carpooling affects differently to the drivers and passengers' carpooling intentions. The attitudes and intentions toward carpooling need critical evaluation in auto-dependent regions where people's travel decisions are difficult to alter. Special discounts and incentive schemes are required to alter travel behavior and make a modal shift as cost saving may not be effective in this context. The local traffic issues, the needs of the travelers, and cultural and psychological barriers can have a significant impact on the carpooling intentions of a specific segment of the population (Si et al., 2023). The trust and privacy aspects of carpooling and other physical, infrastructural, economic, and psychological barriers need to be explored while designing the carpooling schemes. Further, the use of digital technology can play an important part in ensuring the carpooler's trust in intended carpooling programs (Adele and Dionisio, 2020). Therefore, this study tends to explore the students' intentions and actual use of carpooling as their travel mode considering the various psychological factors, physical, economic, and parking incentives/disincentives, and perceived difficulty and accessibility constraints. Figure 1 presents a hypothetical model of this study. This study selected only some of the carpooling barriers and motives for evaluation in the context of Oman.

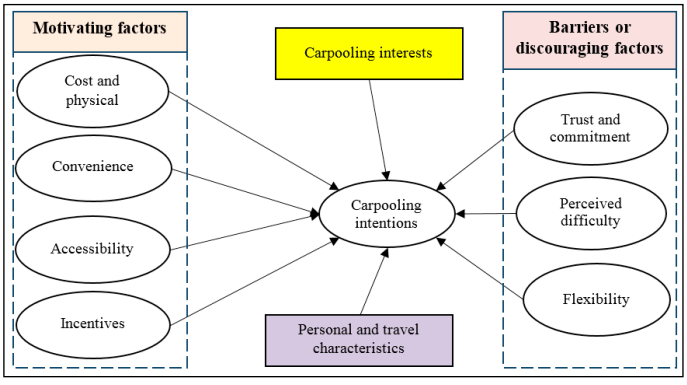

Figure 1. A hypothetical model of study research

3. RESEARCH METHODS

3.1 Survey design and methods

The designed questionnaire consisted of five parts where personal and travel information was asked in part 1. These details include age, gender, marital status, study major, traveling mode to the university, car ownership and driving license, travel time and trip distance, and the number of people to share a ride. The second part consisted of various questions related to carpooling interests as a driver and passenger and preferring the university bus over carpooling. These responses were recorded using a binary scale i.e. Yes or No. In the third part, students' responses were recorded related to carpooling intentions considering various scenarios. These scenarios or incentives included money saving, companionship with others, preferential parking inside the campus for carpoolers, improvement in traffic safety with less traffic, sharing driving tasks with others, same residence place, and presence of high occupancy vehicle lanes (Neoh et al., 2017; Ostrovsky & Schwarz, 2019; Seyedabrishami et al., 2012). These intentions were asked on a five-point ranking scale from never (1) to always (5). The party asked the respondents to record their level of agreement with the factors that might motivate them to carpool. A five-point Likert-type scale for the level of agreement was used i.e. strongly disagree (1) to strongly agree (5). The potential motivating factors included an increase in petrol price, same living place, same major, fixed schedule, limited parking at the campus, same route, discount on tuition fees and traffic fines, and availability of carpooling apps and clubs (Adele & Dionisio, 2020; Si et al., 2023; Tahmasseby et al., 2016). In the last part, responses were asked about the factors that might discourage students from carpooling. The same five-point Likert scale was used for the level of agreement. The discouraging elements included having other plans on the way, traveling with family members, like flexibility and freedom in traveling, difficulty in finding carpooling programs, trust and security concerns, and personality traits (Julagasigorn et al., 2021; Si et al., 2023; Terrier & Audrin, 2022).

This survey was conducted online using Google Forms with Sohar University (SU) students. The main reason behind the selection of SU for this survey was the parking and traffic problems near the campus. It was assumed that the potential carpooling programs would help reduce the traffic congestion near the campus during peak hours and parking requirements as it would reduce the use of single occupancy vehicles and hence parking. Further, it is believed that organizations-based carpooling programs have more potential to be successful (Tahmasseby et al., 2016; Terrier & Audrin, 2022). Therefore, the SU students were selected as participants in this case study. The survey targets the respondents of different study majors at the SU to know the differences in their perceptions. The SU has around 10,000 undergraduate students studying in different faculties. Convenience and purpose-based sampling methods were deployed to ensure a sufficient sample size for analysis. The questionnaire link was sent randomly through emails, WhatsApp, and other sources to achieve the required sample size. The students were approached randomly through various online sources. The target was to get responses from students of different study majors at the university to make a comparison. A low response rate was students observed from students in filling out the responses. The questionnaire link was kept open sufficiently to receive the required responses. The students were reluctant to record their responses, which could be due to personal reasons. With all efforts and frequent reminders, only 250 usable responses were obtained for analysis. These 250 are the valid responses after the elimination of invalid questionnaires. The invalid questionnaires were those where responses were suspected to be not accurate or reliable for data analysis. Researchers have recommended a sample size to be useful for logistics regression analysis is 10 times the number of predictors in the model (Peduzzi et al., 1996). It was assumed that this sample size is sufficient to make a substantial analysis and derive some policy implications for the study area. Some other studies with similar scope have used sample sizes close to the collected responses in this study. The required sample size depends on the number of predictors in the analysis.

3.2 Analysis methods

The analysis was done using the ANOVA, exploratory factor analysis, and ordered logistic regression analysis. The ANOVA method was used to identify the significant differences among various groups of students based on their characteristics for perceptions about their carpooling intentions. The ANOVA helped to understand the differences in carpooling perceptions across various segments of the students based on some characteristics. The collected responses were analyzed using the exploratory factor analysis (EFA) method to extract the appropriate factors for students' intentions to consider carpool, factors encouraging and discouraging carpooling. The EFA is a widely used statistical technique that reduces the dimensions of data and simplifies it by transforming it into a set of uncorrelated factors. The primary goal is to capture the most variance in the data using fewer factors than the original observed variables. It achieves this by linearly combining the observed variables into factors or latent variables, where the first factor captures the maximum variance, and each subsequent factor carries the remaining variance in a decreasing manner. It is widely used in transportation research, for noise reduction, data visualization, pre-processing in machine learning, etc. The rotation of factors is done to obtain more logical and interpretable factors. In this study, principal axis factoring and varimax rotation methods were used. The EFA was used in this study to reduce the observed variable to logical and interpretable latent variables required for further analysis. Reliability analysis was conducted by estimating Cronbach's alpha values for the extracted factors. An alpha value of more than 0.7 indicates good reliability of the collected data and internal consistency among respondents in the evaluation (Tavakol & Dennick, 2011). Logistic regression analysis determined the significant correlations of extracted factors with students' intentions to carpool. Some observed variables of student's personal and travel characteristics were included in the regression analysis. This analysis was deployed as the dependent or objective variables have an ordinal scale and are compatible with the data measurements. The logistic regression analysis provides the likelihood of a particular outcome under the influence of the selected independent variables. The imputation technique was used to handle the outliers in the data analysis while running the ordinal logistics regression analysis. The outliers were substituted with the mean score while conducting the regression analysis.

4. ANALYSIS OF RESULTS

4.1 Descriptive statistics of sample

The descriptive statistics of the sample are presented in Table 1. Almost 65.6% of respondents are female which is consistent with the population of female students at SU campus. The majority of the respondents are Omani and in the age group of 20-25 years. More than 50% of the respondents belong to engineering majors. Private cars, shared modes, and university buses are the dominant modes of traveling for students. More than 50% of the students are willing to carpool with 3 or more people. Details of trip distance and travel time are shown in Table 1.

Characteristics	Categories	Frequency	Percentage (%)
Gender	Male	86	34.4
	Female	164	65.6
Age (years)	Under 20	78	31.2
	20-25	124	49.6
	Above 25	48	19.2
Nationality	Omani	211	84.4
	Non-Omani	39	15.6
Study major	Business	38	15.2
	Engineering	137	54.8
	Computing	32	12.8
	Others	43	17.2
Travel mode	Private car	86	34.4
	Shared taxi	28	11.2
	Sharing a private car	50	20.0
	University bus	56	22.4
	Others	30	12.0
Drive a car	Yes	159	63.6
	No	91	36.4
Number of cars at home	2 or less	61	24.4
	3	78	31.2
	4	55	22.0
	More than 4	56	22.4
Are you married?	Yes	97	38.8
	No	153	61.2
Trip distance	< 10 km	95	38.0
	11 – 20 km	46	18.4
	21 – 30 km	47	18.8
	> 30 km	62	24.8
Number of people to share ride	1	45	18.0
	2	74	29.6
	3	84	33.6
	4	47	18.8

Table 1. Descriptive statistics of the sample

Figure 2 shows the distribution of students' responses about their interests in carpooling. More than 55% of the respondents have heard about the carpooling term and more than 60% of them are willing to participate in carpooling as passengers and/or drivers. Around 48% of students reported that they would prefer university over carpooling, and around 60% of the respondents were willing to make carpooling a commuting mode. About 66% of students believe that the carpooling act can reduce the traffic problem near the campus which is a result of the higher use of single-occupancy vehicles.

4.2 Analysis of Variance (ANOVA)

ANOVA (analysis of variance) was conducted to identify the significant difference between perceptions of different groups based on their personal and travel characteristics. Variables of carpooling interests were used as dependent variables and age, study major, car drive, number of cars in the household, marital status, trip distance, and number of people to ride with were used as factors. The results in Table 2 show that students' age difference and study major are significant in determining their preference for university buses over carpooling and carpooling interests if relevant mobile apps are available. The student's present driving experience is significant in identifying their interests in carpooling for different scenarios. Similarly, the number of cars available at home significantly correlates with carpooling interests as a passenger and preferring the university bus over carpooling. The marital status is significant in carpooling interests as a driver, preferring bus over carpooling and willingness to carpool if mobile apps are available. Trip distance is significant at a 10% level of significance in determining the carpooling interests of a passenger. Carpooling interests as a driver are significantly related to the number of people to share rides with them.

Table 3 presents the results of ANOVA analysis for carpooling propensity with various incentive schemes. The average responses and standard deviation are also presented. Only two factors i.e. study major and 'Do you drive a car?' have significant correlations with carpooling likelihood. There is very strong evidence that differences across study majors exist in carpooling interests for saving money on fuel, companionship with friends on the way, decreasing accidents, and sharing driving tasks with others ($p< 0.001$). Results have shown strong evidence of differences across study groups for less stress during traveling, and the same residence place in the city ($p< 0.01$), whereas there is moderate evidence of differences for preferential parking inside campus for car-poolers and high occupancy vehicles (HOV) lanes existence ($p< 0.05$). Similarly, the likelihood varies between those who drive a car and those who do not. There is very strong evidence for preferential parking inside the campus for car-poolers, strong evidence for saving money on fuel, and moderate evidence for companionship with friends on the way and decreasing accidents. Weak evidence asserted across two groups for Less stress during traveling, sharing driving tasks with others, and same residence place in the city. The results were insignificant for the high occupancy vehicle (HOV) lanes existence scenario ($p< 0.1$). However, the student's intentions to carpool considering existing high occupancy vehicle lanes did not significantly differ across those who drive and those who do not drive.

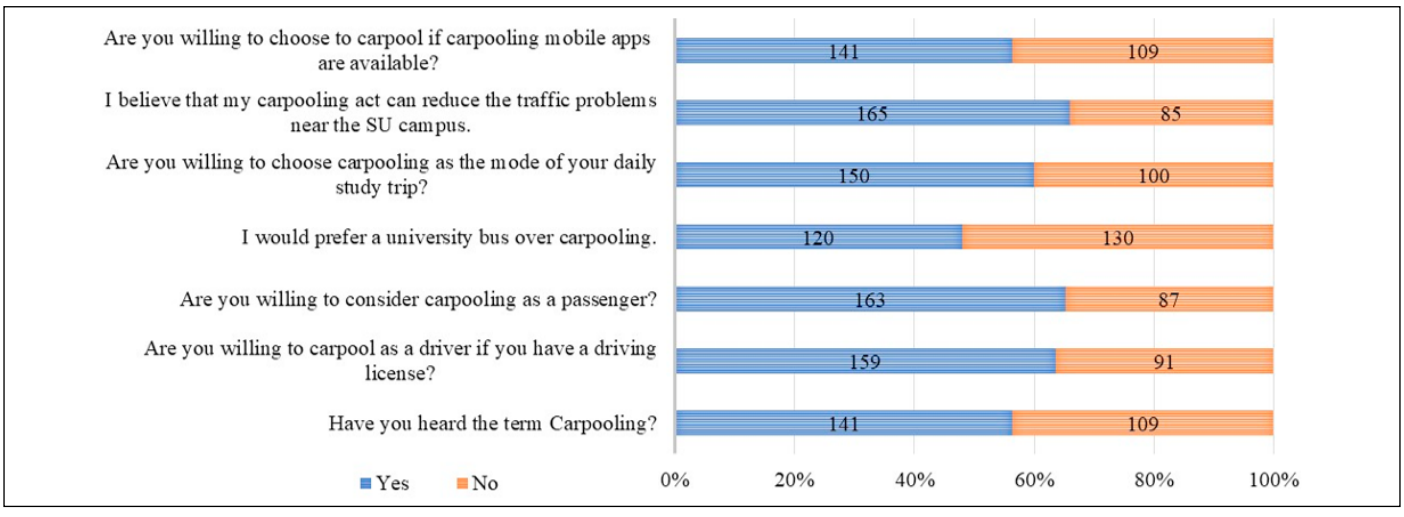

Figure 2. Distribution of responses for various scenarios of carpooling

Dependent variable	Frequency (N)	Age	Study Major	Drive a car	Number of cars	Marital status	Trip distance	Number of people to ride
Are you willing to carpool as a driver if you have a driving license?	Yes: 159 No: 91	F = 1.63 (p = 0.19)	F = 0.33 (p = 0.85)	*F = 10.90 (p< 0.001)*	F = 0.54 (p = 0.701)	*F = 5.08 (p < 0.05)*	F = 1.61 (p = 0.173)	F = 2.36 *(p < 0.10)*
Are you willing to consider carpooling as a passenger?	Yes: 163 No: 87	F = 0.31 (p = 0.733)	F = 0.47 (p = 0.75)	*F = 3.06 (p <0.10)*	*F = 2.12 (p < 0.10)*	F = 0.04 (p = 0.838)	*F = 2.19 (p < 0.10)*	F = 0.92 (p = 0.42)
I would prefer a university bus over carpooling.	Yes: 120 No: 130	*F = 3.62 (p < 0.05)*	*F = 3.06 (p < 0.05)*	*F = 4.12 (p <0.05)*	*F = 2.74 (p < 0.05)*	*F = 2.81 (p < 0.10)*	F = 1.40 (p = 0.235)	F = 1.12 (p = 0.34)
Are you willing to choose to carpool if carpooling mobile apps are available?	Yes: 141 No: 109	*F = 3.133 (p < 0.05)*	*F = 2.178 (p < 0.05)*	*F = 4.926 (p < 0.05)*	F = 1.384 (p = 0.240)	*F = 8.979 (p < 0.01)*	F = 0.301 (p = 0.877)	F = 1.769 (p = 0.154)

Table 2. Results of ANOVA analysis for carpooling interests with various scenarios

4.3 Exploratory Factor Analysis

Table 4 presents the results of exploratory factor analysis for the student's likelihood to carpool. The analysis resulted in only one factor which is named 'students' interests in carpooling'. The factor loadings of all the observed variables are more than 0.7 and Cronbach's alpha value is more than 0.70 which shows good coherence among respondents in the evaluation and reliability of the results. The % of variance explained is 68.955%. The average scores of all variables are more than 3 except one variable which is also near 3.0. These results show that most of the students have the consensus to consider carpooling for some of their trips considering various benefits where less traffic and stress are more prominent.

Second EFA was conducted related to variables or factors that would motivate the students to carpool. This analysis resulted in four factors that explain almost 85% of the total variance. These factors were named (1) cost and physical (CP), (2) Convenience (C), (3) accessibility (A), and (4) incentives (I). The alpha values of all four factors are more than 0.7 which indicates an acceptable level of reliability. The factor loadings are also more than 0.5 which shows good consistency among respondents in the evaluation. The first factor of CP shows that the increase in price, parking shortage at the campus, the same study major, and living place can play a significant role in motivating individuals to carpool. The factor loadings of the convenience variable are more than 0.7 which shows that the students who follow the same route and have fixed study schedules would have more likelihood to make carpool programs. The factor loadings of the accessibility variable depict that the respondents have a good consensus on the availability of carpooling clubs and mobile apps. The availability of clubs and apps will make it easier for the respondents to find the students to share rides. The last factor of the incentive variable shows the significance of discounts on traffic fines and tuition fees on students' interests in carpooling.

Dependent variable	Mean (on a five-point scale)	Standard deviation	Study major	Drive a car
Saving money on fuel	2.940	1.467	*F = 8.978 (p < 0.001)*	*F = 7.177 (p < 0.01)*
Companionship with friends on the way	3.000	1.276	*F = 6.578 (p < 0.001)*	*F = 4.295 (p < 0.05)*
Preferential parking inside campus for car-poolers	3.052	1.277	*F = 3.112 (p < 0.05)*	*F = 14.238 (p < 0.001)*
Decreasing accidents because of less traffic on roads	3.148	1.313	*F = 4.602 (p <0.001)*	*F = 6.120 (p < 0.05)*
Less stress during travelling	3.072	1.324	*F = 4.108 (p < 0.01)*	*F = 3.060 (p <0.10)*
Sharing driving tasks with others	3.036	1.296	*F = 5.377 (p < 0.001)*	*F = 3.466 (p < 0.10)*
Same residence place in the city	3.140	1.335	*F = 4.441 (p < 0.01)*	*F = 3.435 (p < 0.10)*
If high occupancy vehicle (HOV) lanes exist	3.128	1.302	*F = 2.944 (p <0.05)*	F = 0.949 (p = 0.331)

Table 3. Results of ANOVA analysis for carpooling interests with various incentives

Observed variables	Mean	Factor loadings	% of variance explained	Cronbach's alpha
Decreasing accidents because of less traffic on roads	3.248	0.885	68.955	0.945
If high occupancy vehicle (HOV) lanes exist	3.072	0.874		
Same residence place in the city	3.140	0.848		
Less stress during traveling	3.321	0.831		
Sharing driving tasks with others	3.036	0.831		
Companionship with friends on the way	3.150	0.822		
Preferential parking inside the campus for car-poolers	3.252	0.818		
Saving money on fuel	2.940	0.725		

Table 4. Rotated factor loadings and reliability analysis of students' carpooling intentions

Observed variables	Mean	Factors			
		Cost and Physical (CP)	Convenience (C)	Accessibility (A)	Incentives (I)
Increase in petrol price	3.010	0.836			
Shortage of parking on campus for non-car-poolers	3.176	0.706			
Same living place	3.076	0.693			
Same faculty/major of study at the SU	3.184	0.552			
Fixed schedule of people with whom you want to carpool	3.104		0.739		
If someone does not have a car	3.188		0.733		
Same travel route to the campus/home	3.204		0.718		
Carpooling clubs' availability in your area	3.032			0.872	
Carpooling mobile app availability	2.988			0.827	
Discount on traffic fines from ROP for car-poolers	3.137				0.697
Discount on tuition fees for car-poolers	3.172				0.548
% of variance explained		24.913	24.799	20.657	14.909
Cronbach's alpha		0.916	0.902	0.874	0.868

Table 5. Rotated factor loadings and reliability analysis for factors motivating to carpool

Observed variables	Mean	Factors		
		Trust and Commitment (TC)	Perceived Difficulty (PD)	Flexibility (F)
I do not trust the driving ways of others	3.320	0.830		
I am concerned about the security of my belongings	3.160	0.775		
I hate to wait for others	3.248	0.669		
I do not like to be committed to others	3.182	0.614		
I like to travel alone as it gives me freedom	3.088	0.610		
I cannot find a group to carpool with	3.284		0.819	
I like to be flexible in my route	3.224		0.640	
Carpooling does not suit my personality	3.168		0.623	
I may need to travel with other family members	3.296		0.512	
Having other plans to do on the way	3.300			0.876
I like to be flexible in my schedule	3.192			0.730
% of variance explained		31.905	27.029	21.919
Cronbach's alpha		0.933	0.897	0.868

Table 6. Rotated factor loadings and reliability analysis for factors discouraging carpooling

Table 6 presents the results of rotated factor loadings and reliability analysis for the factors that might discourage the students from carpooling. Three possible factors were extracted from factor analysis and were named (1) trust and commitment (TC), (2) Perceived difficulty (PD), and (3) flexibility (F). The alpha values show good reliability of the extracted factors and the % of variance explained by these factors is more than 80%. The factor loadings of the TC factor are more than 0.7 which indicates good mutual consent among respondents in the evaluation related to trust and commitment concerns while considering the carpooling. Most of the students have strong beliefs on perceived difficulty while considering carpooling e.g. difficulty in finding someone to carpool, flexibility in route, personality concerns, and traveling with other family members. The strong beliefs in freedom and flexibility in traveling have a significant influence on students' intentions to carpool.

4.4 Ordinal Logistic Regression Analysis

An ordered logistic regression analysis was performed for students carpooling intentions using the results of factor analysis. Some variables of personal characteristics, carpooling experience, preferring university bus over carpooling, and carpooling intention to reduce traffic congestion were included in the analysis. These variables were coded as binary variables (0, 1), and only significant variables are listed below:

- Study major: 0 if engineering, otherwise 1
- Preferring bus over carpooling: yes: 0, no: 1
- Carpooling to reduce traffic congestion: yes: 0, no: 1
- Have previous experience of carpooling: yes: 0, no: 1

The results of regression analysis are shown in Table 7. The values of the R-square and adjusted R-square for the regression model are 0.734 and 0.721, respectively. Regression analysis showed that the factors of cost and physical, convenience, accessibility, and incentives have positive standardized coefficients with the carpooling intentions factor. These coefficients are highly significant ($p < 0.001$). The students who have positive beliefs about these encouraging factors or motives have more likelihood to carpool. The estimate of trust commitment and flexibility factors with intentions are significant at a 5% level of significance. The estimate of perceived difficulty with intentions variable was significant at a 1% level of significance. These significant and positive estimates show that despite having beliefs on perceived barriers to carpooling, there are students who have positive intentions to carpool. The coefficient of the variable preferring bus over carpooling with intentions is negative and significant at a 5% level of significance. It shows that those students who prefer university buses would have fewer intentions to carpool. They may feel the bus is a more convenient and comfortable mode of traveling instead of sharing a car with others. The estimates of previous carpooling experience and

carpooling for the reduction in traffic congestion are positive with carpooling intentions. These results show that the students with experience of ride-sharing and those who want to reduce the traffic congestion would prefer to carpool. Also, engineering students have more likelihood to carpool as the estimate is positive and significant. The values of Pseudo R square show that all independent variables explain almost 74% of the variance in the dependent variable.

5. DISCUSSION

The analysis showed that the increase in travel cost of car use, same living place, and on-campus parking measures are significant in determining the carpooling intentions with various incentives. Students traveling from the same origin can develop carpooling matching to save travel costs and reduce the use of single-occupancy vehicles. It is believed that the carpooling programs are more favorable for those drivers and passengers who share the same origin and destination (Olsson et al., 2019; Neoh et al., 2018). The parking measures at the campus have a high potential to reduce the use of single-occupancy vehicles among students and promote carpooling. Preferential parking is considered a decent incentive for potential carpoolers (Olsson et al., 2019). The university management car offers special or preferential parking spaces for the carpoolers in the parking lots within the campus. Special access management strategies can be implemented for the carpoolers, e.g. provision of special smart cards for the carpooling students. The convenience and easiness of access in making carpooling programs and incentive schemes have a positive impact on enhancing carpooling intentions. The same schedule and route of potential carpoolers is the encouraging factors. Also, the availability of carpooling clubs and digital apps can influence the student's likelihood of carpooling. The dedicated carpooling clubs and apps make it easier for travelers to access the carpooling programs and find the appropriate ride-mates. Other studies have also reported the importance of fixed routes and schedules (Javid & Al-Khayyat, 2021; Neoh et al., 2017) and carpooling clubs (Correia & Viegas, 2011) in making the carpooling programs successful. Carpooling clubs help to develop trust among carpoolers and ensure privacy for those who work in the same place (Correia & Viegas, 2011). The discount schemes for students on traffic fines and tuition fees from the university can have a positive impact on carpooling intentions. The provision of HOV lanes encourages people to carpool as they save travel time and have broader impacts in terms of travel behavior change (Cohen et al., 2022; Yuan et al., 2024). The integration of various incentives and discounts e.g. preferential and free parking, discounts, and provision of HOV lanes is a strong way to develop and implement carpooling programs for educational institutions.

Trust, privacy, and commitment concerns usually exert a negative impact on the carpooling likelihood of the students. This influence is more significant among male and female students in the Middle East Region (AlQuhtani, 2022; Hamad et al., 2021). The planning of carpooling programs with carpooling clubs and digital apps can help to reduce trust and privacy concerns and ensure the integrity and security of the riders. The students who have strong beliefs in travel flexibility and perceived difficulty in carpooling might not prefer carpooling over their private cars. Other studies have reported the negative influence of freedom and flexibility on carpooling (AlQuhtani, 2022; Horton, 2020) and perceived difficulty (Adelé & Dionisio, 2020; Terrier & Audrin, 2022). Carpooling clubs and apps can help to find the right ride-mates and ease the perceived difficulty. These can make carpooling programs flexible for the students living at the same place and following the same route.

In the same study major, marital status, age, experience of driving a car, and number of cars at home have significant correlations with carpooling intentions. It is well believed that household car ownership, driving experience, and possession of a driver's license play an important role in carpooling formation (Buliung et al., 2009; Javid et al., 2017). The students with more cars at home would have more probability to carpool as a driver with other students who do not have experience of driving or don't own a car. As female students have a major share in the sample, and they have shown a preference for the university over carpooling. Another study reported that female students tend to university buses more than male students (Hamad et al.. 2021). The female students feel it is more convenient to travel on the bus than to share a ride with other students. The students have also shown pro-social behavior to carpool for reducing the traffic congestion. The use of the university bus and this tendency of female students are aligned with sustainable transport alternatives as female students have more likelihood to participate in shared mobility programs (Alquhtani, 2022). Private cars can provide a sustainable and convenient travel alternative in the form of carpooling for other students to reduce traffic congestion and environmental impacts (Asghari et al.. 2022). The students who like to interact with others would have more preference to carpool. However, gender-specific constraints, privacy, and trust play important roles in carpooling matching programs considering the cultural and religious values of various regions (Al-Masaeid & Olaimat, 2023, Ayaz et. al., 2021). The carpooling previous

Independent variables		Estimate	Standard error	p-value
Cost and physical		1.483	0.160	0.000
Convenience		1.377	0.148	0.000
Accessibility		1.186	0.149	0.000
Incentives		1.026	0.132	0.000
Trust and commitment		0.274	0.132	0.038
Perceived Difficulty		0.595	0.139	0.000
Flexibility		0.224	0.140	0.060
Preferring bus over carpooling		-0.480	0.249	0.049
Carpooling to reduce traffic congestion near the campus		0.429	0.276	0.078
Carpooling experience		0.642	0.278	0.062
Study major (engineering)		0.618	0.242	0.011
Pseudo R square	Cox and Snell		0.744	
	Nagelkerke		0.744	

Table 7: Results of ordinal regression model of students carpooling intentions

exposure has a significant impact on students' intentions to carpool. It shows that the awareness about the availability of carpooling programs and potential ride-mates through carpooling clubs, and digital apps have important implications in shaping the carpooling programs. It has also emphasized the importance of students' understanding of the carpooling programs (Madubuike, 2017). Educational institutions facing traffic and parking issues can develop carpooling apps for students and their employees to provide necessary information for potential carpoolers. Potential carpoolers as drivers and/or as a passenger can upload their relevant information on digital apps including the travel schedule, origin, and route. It will make it easy for the carpoolers to connect with other students to find the right match for carpooling. These digital platforms will also help to develop trust among the carpoolers and enhance the perceived safety and security. The educational institutions can dedicate a specific number of parking spaces for the carpoolers to encourage carpooling. Also, the integration of discounts with physical measures would help to promote carpooling among students. The provision of HOV lanes would have a high impact on developing and promoting the carpooling programs.

6. CONCLUSIONS

This study identifies the carpooling potential among students by considering various incentives, motives, and barriers. The required data were collected with the help of an online questionnaire survey. The data were analyzed using the ANOVA, factor analysis, and ordinal regression analysis methods. More than 60% of the students have the intention to carpool for various reasons and incentives. ANOVA results revealed significant differences among various categories of students for carpooling intentions. Four factors of carpooling encouraging variables and three factors of discouraging were identified using exploratory factor analysis. The results of ordinal regression analysis revealed significant correlations of accessibility, cost, physical, incentives, and convenience factors of carpooling motives with intentions. Also, the estimates of discouraging factors such as trust and commitment, flexibility, and perceived difficulty are significant with carpooling intentions. Students' preference for bus over carpooling is negative, and intentions to carpool for traffic reduction, carpooling experience, and study major (engineering) are positive predictors of carpooling intentions.

These findings provide useful insight for developing carpooling programs for university students based on their preferences and characteristics. The carpooling clubs and digital apps have an important part in initiating the carpooling programs. The carpooling clubs and apps can build trust and ensure privacy about the information of carpoolers. The carpooling apps would make it easy for the students to find the right ride-mate as a driver and/or as a passenger (Chang, 2022). These schemes will help to find appropriate ride-mates based on available details of potential carpoolers in apps and relevant clubs. Carpooling clubs can be designed for specific areas where the students share the same living place and the same route. Incentives such as free and preferential parking, and discounts on traffic fines and tuition fees would have a significant influence on students' decision to carpool. Also, the cost savings and traveling with other students can motivate students to carpool instead of traveling alone. The implementation of a carpooling program with an integrated parking system at Monash University helped reduce parking issues and save travel time (Deller, 2023). A web-based carpooling matching has been implemented at two universities of Milano for students and staff (Bruglieri et al., 2011). This program showed some significant results in reducing the use of private vehicles and increasing the share of shared mobility among students. The Karos Mobility platform provided a tailored solution to meet the transportation needs of university students across three countries. The universities opted for Karos Mobility applications to provide convenient carpooling services to the students (Karos Mobility, 2023). The carpooling groups emerged as an efficient travel alternative for the students in Islamabad, Pakistan where registered users can find ride-matches through various carpooling groups (CarpoolWorld, 2024). These carpooling cases indicate that an integrated approach like combining carpooling schemes with parking incentives would make carpooling programs successful. Also, the availability of carpooling mobile applications and web-based systems makes it easier for potential carpoolers. The findings will be useful for the educational institution to focus on important factors while designing the carpooling programs to reduce the traffic problems near the campus.

This study used a small sample size to identify the important factors affecting the carpooling intentions. Further, the majority of the respondents belong to engineering majors; a larger sample size is required from other majors to draw a comprehensive comparison among different student groups. This study did not consider all physiological factors like security, privacy, and safety and perceived risks related to carpooling evaluation. Future studies may also select a specific group of students to understand their carpooling attitudes and preferences in detail considering the various psychological and social barriers. Also, the results are based on the stated preference questionnaire survey; therefore, there is the probability of bias in the reported attitude and intentions as the actual preference of students might be different from the reported responses. This study was conducted with the students of an educational institution in Sohar City Oman and may reflect the perceptions of the whole population in Oman. The extracted results and factors have limitations in their implications considering the geographic aspects of the sample. The generalization of results and their implications may cause some bias in the implementation. Despite limitations of sample size and results, the study elicits some significant implications for transport authorities and planners for the design of carpooling programs.

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