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Analyzing the students' moral obligation considering their carpooling intentions in Oman

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Abstract

The rise in private vehicle use causes traffic congestion on the road network and increases the social costs of the trips. Travel demand management (TDM) strategies are deployed to mitigate traffic congestion sustainably as these strategies spread travel needs in space and time by influencing individual travel behavior. Carpooling is a TDM measure used to decrease the use of single occupancy vehicles and promote shared mobility among travelers sharing the same origin-destination and following the same route. This study attempts to identify the correlations between the socioeconomic demographics of travelers and their carpooling potential considering the moral obligations. A questionnaire survey was conducted with the students of the University of Nizwa, Oman, and a total of 156 samples were collected. The results revealed a high interest of respondents in carpooling as a passenger as well as a driver. The respondent's moral obligations are high to carpool for the reduction in traffic congestion, air pollution, and energy consumption. The category analysis showed some differences in interests among different groups. The ordered regression analysis revealed that variables of gender, present travel mode, trip distance, car driving, and carpooling as passengers are significant in determining the moral obligations of the travelers. These results implicate that specific carpooling programs based on specific market segments have the potential for consideration and implementation.

Keywords: Traffic congestion, Carpooling, Questionnaire survey, Regression analysis, Oman

1. Introduction

Auto-dependent countries need to provide travel alternatives to the people considering the growing demand for sustainable transportation infrastructure development and reduce climatic impacts. The scattered and low-density urban development leads to high usage of private vehicles. Vehicle ownership is increasing at 9-10% per annum in Oman [1]. The public transportation facilities are very limited and only low-income people use them. The increased traffic demand on road networks in the morning peak worsens the traffic situation in major cities [2] which increases the social costs associated with congestion events. The authorities need to look for alternative transport modes to reduce the traffic congestion and externalities.

Fuel prices in Oman in recent years have increased significantly and adjusted every month considering the international market rates. This has increased the travel cost of all available travel alternatives. Young people especially male students have started sharing their private vehicles to share the travel costs. This sharing also helps them to share their driving load [3]. The increased travel demand and costs require looking for alternative transport alternatives that ensure sustainability. The evaluation and implementation of appropriate travel demand management (TDM) policies for modal shifts can help to ensure the mobility needs of travelers. The TDM measures emphasize on influencing the individual's travel behavior for a modal shift towards sustainable travel alternatives [4, 5]. The TDM measures focus on altering behavior change through mode change, route change, changing the time of the trip, improving the occupancy of the vehicles, and sometimes even eliminating the need for travel e.g. tele-working [4]. Carpooling and car sharing are TDM measures that help to alleviate traffic congestion by increasing the occupancy of private vehicles and reducing the use of single-occupancy vehicles. It also reduces the travel cost of the travelers as they can share the cost of travelling.

Three main categories of factors that affect the implementation plan of carpooling schemes include socio-economic characteristics of individuals, spatial factors such as accessibility, and temporal factors [4]. Carpooling helps to reduce travel costs, travel demand, and externalities [6]. The travelers' likelihood to carpool is significantly affected by many motivational factors such as time savings, cost savings, free parking, and taxes on single occupancy vehicles [7-9]. It is believed that the perceived psychological benefits including time and cost saving, reducing traffic congestion and environmental concerns have significant influence on carpooling decisions [10]. Cheaper parking for carpoolers and introducing the high-occupancy vehicle lanes can help to improve carpooling likelihood among travelers [10]. The fixed schedule of university students and staff has impact on increasing their likelihood of ridesharing [11]. Individual's attitudes and trust on others are strongly related to carpooling intentions [12]. The people's decision to carpool is influenced by perceived moral obligations, and their socioeconomic demographics (SEDs) [13, 14]. The factors which influence the decisions to carpool differ across the drivers and passengers, and psychological factors and cultures play important role in this context [15, 16]. Hsieh [17] used Swarm Optimization Algorithm with Six Hybrid Firefly–Differential Evolution Algorithms and an Effective Cost-Saving Allocation Method for stakeholders to determine the optimum ridesharing matching among stakeholders.

Another study reports used an algorithm to improve the performance of the discount-guaranteed ridesharing systems and illustrates that two people working together have more likelihood to correct their ride-sharing or carpooling decision than those who are working alone [18]. Hsieh [19] also highlights the importance of trust in finding the right ride-mate in a ridesharing program while minimizing the costs and respecting other constraints. There are several motivational factors as mentioned earlier which influence the decision to carpool. However, this study only assesses the relationships of travelers' socio-economic demographics and travel characteristics with carpooling likelihood considering the moral obligation. Researchers have found that age and trip distance influence drivers' decisions, whereas gender and income level influence the decisions of passengers to carpool [20, 21]. It is reported that the traveler's occupation, income level, marital status, trips distance and time, rider and driver's profile and carpooling fee significantly influence the market demand of carpooling programs [22]. The carpooling interests and choice are related with commuting distance, university affiliation, marital status, and present travel mode [23]. Comfort is the most concerning factors for college students in carpooling [24]. There are several personal, and trip characteristics of the students which influence their decision to carpool and need to be explored in the context of a specific region. The significance of the correlations between intentions variables and SEDs helps in identifying the transport policies for the target group. This study aims to identify the relationship between SEDs, carpooling intentions, and moral obligations through category analysis and ordered regression analysis. This paper has been arranged in the following order. Data collection and analysis details are discussed in section 2. Results are presented and discussed in section 3. The last section summarizes the key findings and their implications.

2. Data collection and analysis methods

2.1 Questionnaire design and survey

A self-reported questionnaire was designed to gather the responses of target respondents. Respondents' SEDs were asked in the first part of the questionnaire which included gender, age, driving license possession, vehicle ownership, mode of travel, travel cost and time, and trip distance from home to the university. The following categories were used for travel mode questions: bus, pick-up and drop-off by others, traveling with friends, private car, and shared taxi. Students' intentions to carpool were asked as a driver and passenger separately. The moral obligations to carpool for the reduction in congestion, energy consumption, and air pollution were asked on a five-point Likert-type scale from strongly disagree [1] to strongly agree [5].

The target respondents of this survey were the students of the University of Nizwa (UoN), Oman. The majority of the students live in hostels and travel once a week from their homes to the hostel and vice-versa. These students usually walk to the university or use the university to travel from their hostel to the campus [25]. A trial survey was conducted to check the concreteness and readability of the designed statements. The feedback of the trial survey was incorporated in revising the questionnaire. The final questionnaire was distributed randomly to the students to fill out. Ample time was given to the students to record the responses to ensure the reliability of the collected data. The completed questionnaire was collected back after the allocated time. Some of the survey forms were discarded due to incomplete information. Therefore, further analysis was only based on 156 usable samples.

2.2 Analysis methods

The data were analyzed using conventional frequency analysis and ordered regression analysis. The conventional analysis included the frequency distribution and categorical analysis of students' interests in carpooling. Ordered probit regression analysis was conducted to identify the significant correlations of personal and trip characteristics with interest in carpooling considering moral obligations. Factor analysis was conducted to identify the factor of moral obligations. The reliability of the factor was checked using Cronbach's alpha value. The significance of relationships was determined using t-values and p-values.

3. Results and discussion

3.1 Descriptive statistics of SEDs

Table 1 shows the descriptive statistics of respondents' SEDs. The share of female respondents is 72% in the sample. It means that this gender distribution is consistent with female students' proportion in the campus. Most of the targeted respondents are less than 30 years of age. Almost 35% of the students have a personal car and 41% of them have a driving license. A major portion of students is traveled by the university bus and private vehicles. Table 1 also presents the distribution of travel costs, distance, and distance of a commuting trip from home to the university.

Table 1 Sample description

Characteristics	Category	Share (%)	Characteristics	Category	Share (%)
Gender	Male	28.2%	Age	< 20 years	12.2%
	Female	71.8%		> 20 years	87.8%
Personal car ownership	Yes	35.3%	Driving license	Yes	41.0%
	No	64.7%		No	59.0%
Frequent travel mode	Car/taxi	39.7%	Travel time from campus to home	< 30 minutes	68.0%
	Walking	12.8%		31-60 minutes	19.8%
	Bus	33.3%		> 60 minutes	12.2%
	Others	17.3%			
Distance from campus to home	< 5 km	39.1%	Travel cost from campus to home	< 0.5 OR	32.7%
	5-15 km	18.6%		0.5 – 1.0 OR	39.0%
	16-30 km	21.8%		1.0 – 1.5 OR	18.7%
	31-50 km	9.0%		> 1.5 OR	9.6%
	> 50 km	11.5%			

3.2 Interests in carpooling

The results of student's interests to carpool as a passenger and as a driver are shown in Figure 1(a). Almost 68.6% of the students have shown willingness to carpool as a driver, whereas 77% as a passenger. This distribution shows the significance of carpooling policy implications for the students. Figure 1(b) shows that the majority of respondents have intentions to carpool considering their moral obligations for reduction in traffic congestion, energy consumption, and air pollution. Figure 1(c) shows the student's intentions to share a ride with a number of riders.
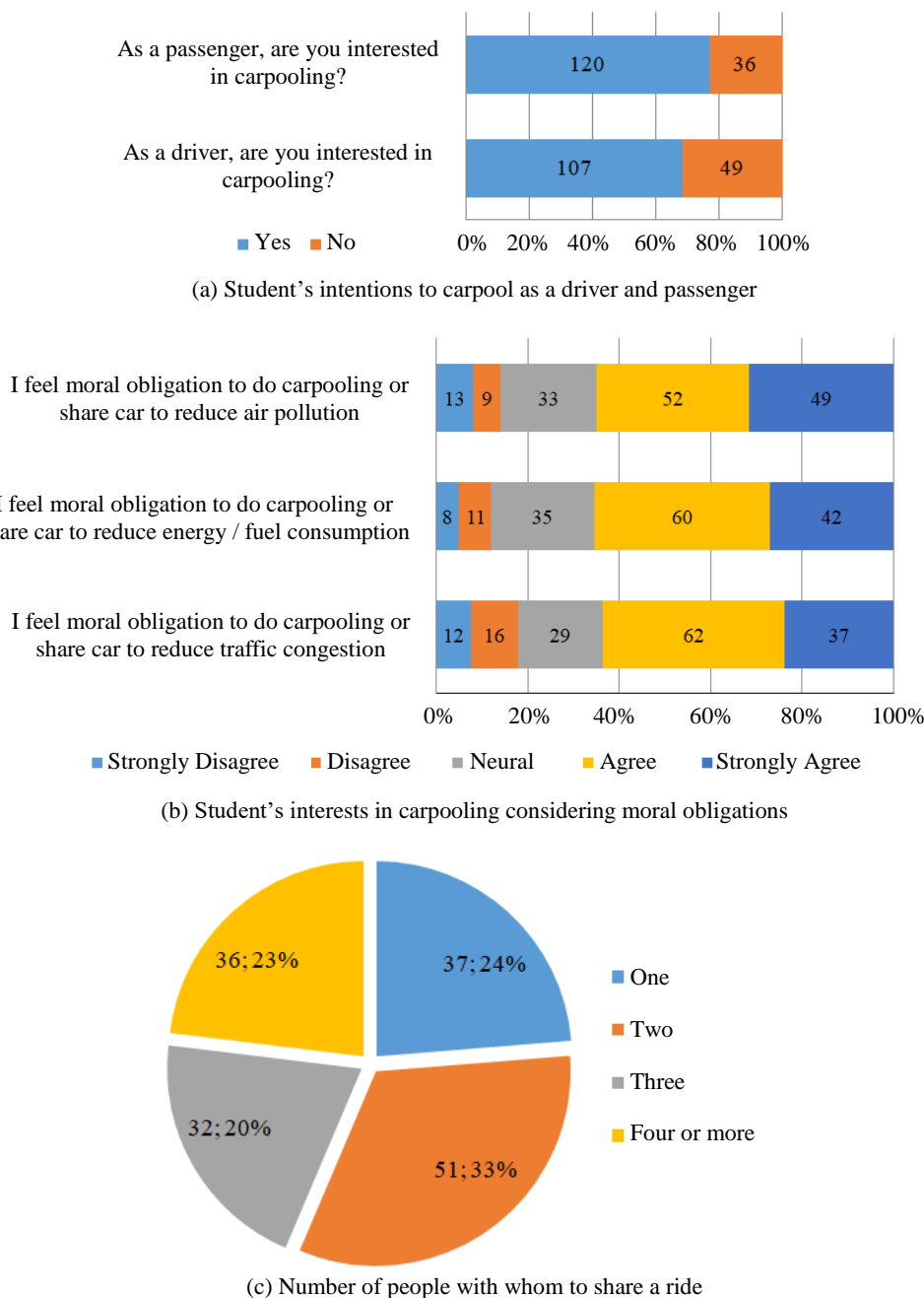

(a) Student's intentions to carpool as a driver and passenger

(b) Student's interests in carpooling considering moral obligations

(c) Number of people with whom to share a ride

Figure 1 Students' interests in carpooling considering various aspects

3.3 Categorical analysis of students' interests in carpooling

Figure 2 presents the categorical analysis of students' interests in carpooling as a driver with their travel and personal characteristics. It shows that the interest level of female students is a little higher than that of male students. The students whose present travel modes are university bus, sharing with others, and pick-up/drop off by others have more interest in carpooling. Also, the students with no driving license and private cars have shown higher interest in carpooling. The students with a lesser number of cars in their households are more inclined towards carpooling. Figure 3 also predicts similar trends of carpooling interests as passengers considering various demographic characteristics. The students who currently use shared modes and public transport have more potential to carpool as compared to current car users.
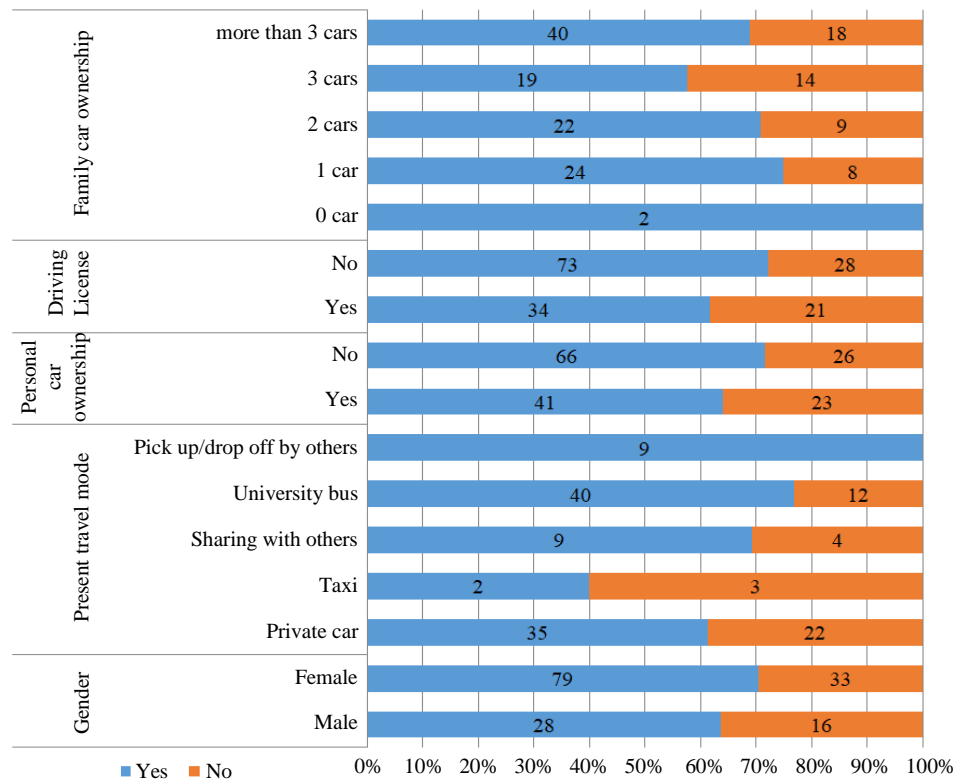
Figure 2 Carpooling interests as a driver versus personal characteristics
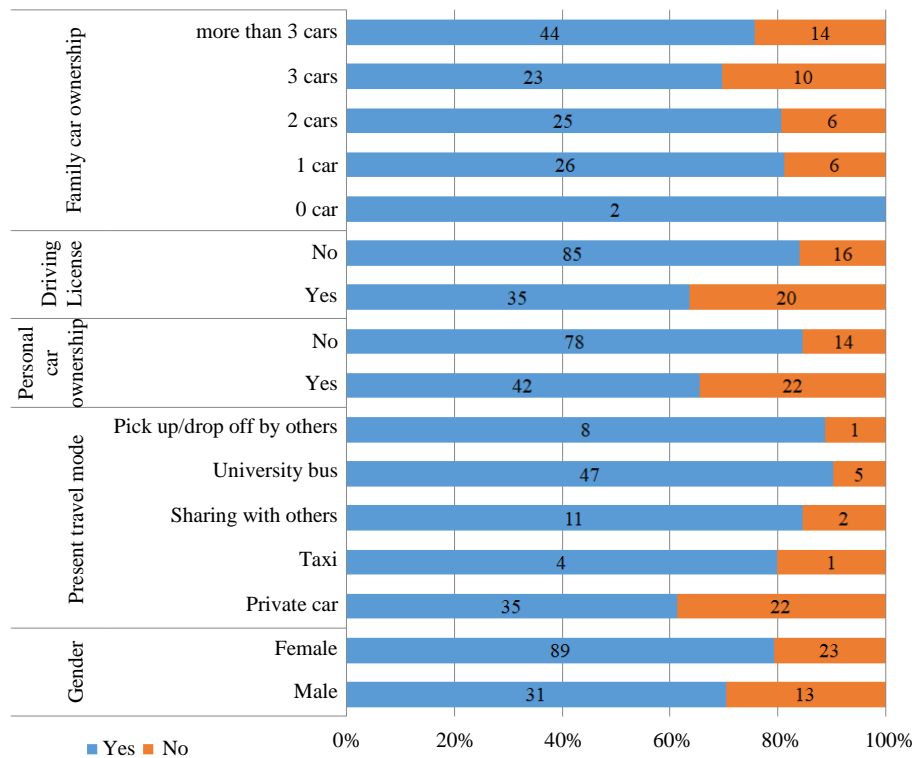

Figure 3 Carpooling interests as a passenger versus personal characteristics

Figures 4 and 5 show that there is an increase in carpooling interest with the increases of trip distance. However, at trip distance of more than 50 km, a lower intention is observed. Lower travel costs have shown a positive impact on students' interest in carpooling. Other studies have also shown the impact of trip distance on carpooling intentions [26]. Some odd results are shown at higher costs and long trip distances. As the sample size is small in each category, it is difficult to predict the exact trend of change in travel behavior with carpooling scenarios.
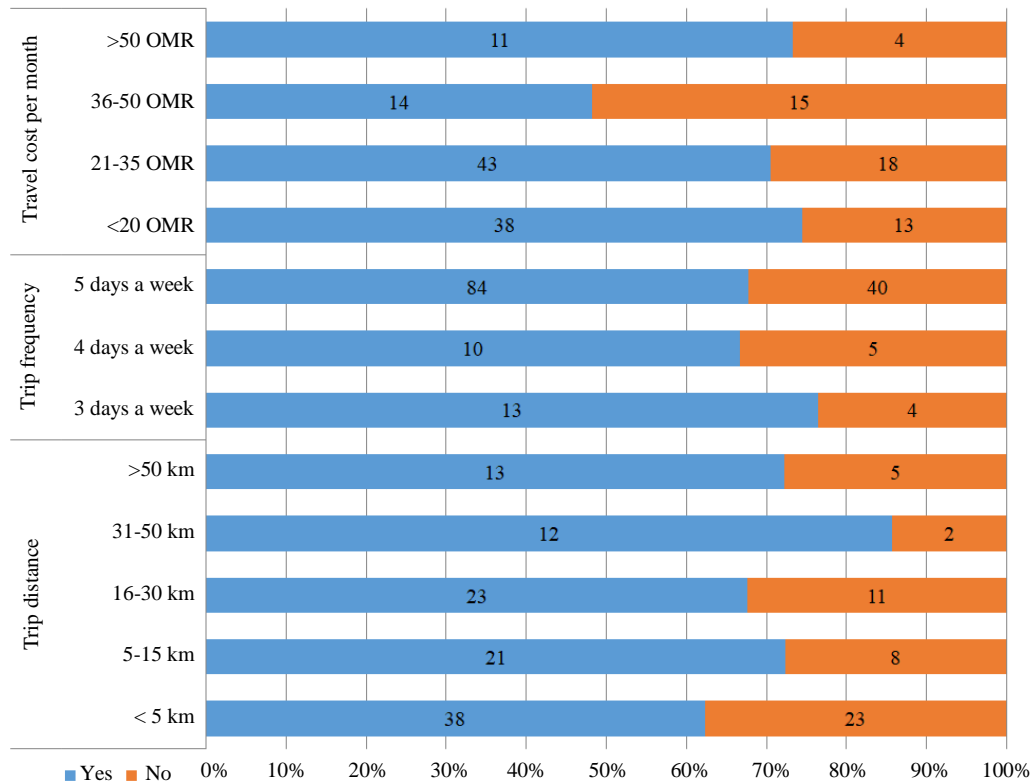
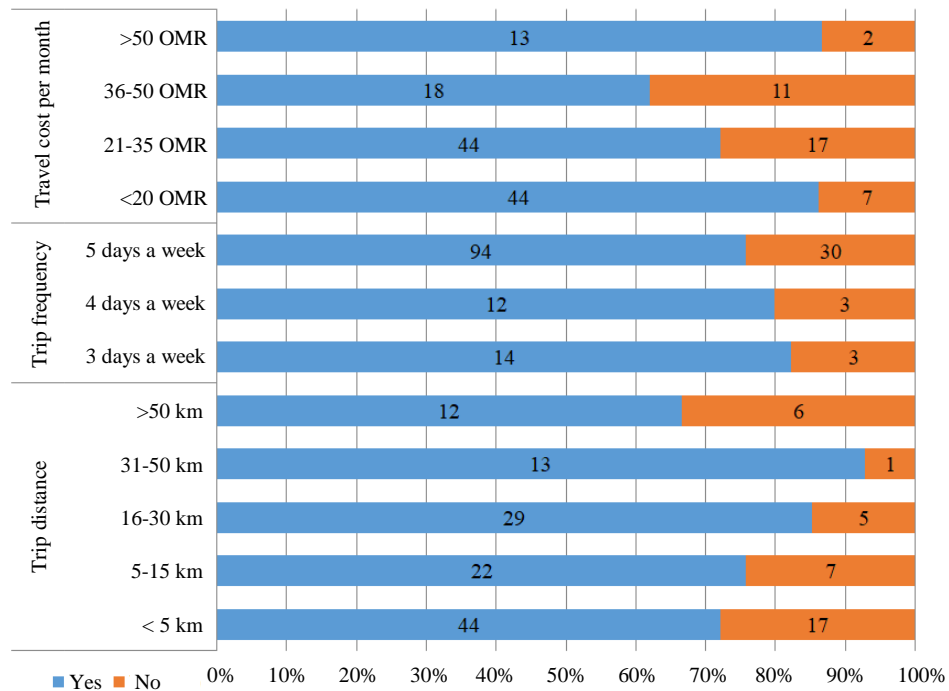**Figure 4** Carpooling interests as a driver versus travel characteristics

Figure 5 Carpooling interests as a passenger versus travel characteristics

3.4 Factor and reliability analysis

A factor analysis was conducted on observed variables of moral obligation to estimate the factor loadings and confirm the correlation among variables. The factor loadings are either more than 0.7 or near 0.7 and Cronbach's alpha value is more than 0.7 as shown in Table 2 [27, 28]. These results show good reliability of responses and mutual consistency among respondents for evaluation of the observed variables. The % of variance explained by this factor is more than 60%. The variables of moral obligations to carpool for a reduction in traffic congestion and air pollution have high factor loadings and influence in explaining the factor. It depicts that the respondents believe that carpooling has the potential to reduce traffic congestion and air pollution.

Table 2 Factor and reliability analysis of moral obligations

Observed statements	Factor loadings	% of variance explained	Cronbach's alpha
It is my moral obligation to carpool to reduce traffic congestion.	0.889		
It is my moral obligation to carpool to reduce air pollution.	0.826	65.03 %	0.843
It is my moral obligation to carpool to reduce energy consumption.	0.691		

3.5 Ordinal regression analysis of moral obligation for interests in carpooling

An ordered probit regression analysis was conducted using a factor of moral obligation and selected SEDs of the respondents. The extracted factor of moral obligation from Table 2 was used as an ordered latent variable. The SED variables were coded as 0 and 1 for ordered regression analysis.

- Gender female (female: 0, male:1)
- Carpooling as a passenger (Yes:0, No: 1)
- carpooling as a driver (Yes:0, No: 1)
- Present travel mode (car:0, others: 1)
- Car a drive (Yes:0, No: 1)
- Arrival time at the campus (8:00 AM:0, other: 1)
- Departure time from campus (4:00 PM:0, other: 1)
- Trip distance (< 30 km: 0, other:1)

The results of ordered regression analysis in Table 3 show that the defined variables of carpooling as a driver, same arrival time, and departure are not significant in determining the moral obligations of respondents to carpool for social well-being. The parameter estimate of gender as a female with moral obligation variable is positive and significant. Other studies have also shown the significance of gender in travelers' decision to carpool [21]. It shows that the female respondents have the tendency to carpool with their friends and colleagues for a better environment and reduced traffic congestion as it will help to save travel cost [29-31]. The correlation between carpooling as a passenger and moral obligation is positive which shows that most of the passengers have positive intention to carpool as passengers. The relationship of carpooling as a driver was insignificant. Carpooling as a passenger is more significant than as a driver because carpooling as a passenger helps to relax during traveling while driving causes additional stress [13, 21]. The travelers whose present travel mode is a private car, shared taxi or shared car will consider carpooling as the estimate is positive and significant. Similarly, the people who drive a car at present have a positive correlation with carpooling interests considering moral obligations. These results imply that travelers belonging to a specific social group have more likelihood to carpool for the reduction in traffic congestion, air pollution, and fuel consumption. However, the same arrival time and departure time of the arrivals are not significant in defining the carpool programs in the present scenario. The trip distance of less than 30 km has significant correlations with moral obligations. It shows that the students traveling within 30 km distance from the campus have more potential to consider carpooling programs. The same kind of behaviors are reported by other researchers [23]. The traveler's potential of saving fuel consumption, and reducing air pollution and traffic congestion considering carpooling programs help deriving sustainable travel interventions [32, 33]. It is required to make carpooling programs as a part of transport planning and policy-making to reduce the use of single occupancy vehicles. The integration of high occupancy vehicle lanes with carpooling initiatives will prove as a strong TDM policy to change travel behavior and make a proper modal shift [34, 35]. The gender-specific carpooling programs will be more effective in the local context of Oman where religious, privacy, and cultural values influence the people's decision to choose travel mode. The university can provide the required information to the interested student groups for making carpooling programs.

Table 3 Results of ordered regression analysis

Variables (coding)	Parameter estimate	Standard error	*p*-value
Gender Female(female: 0, male:1)	**0.516****	0.218	0.018
Carpooling as a passenger (Yes:0, No: 1)	**0.806*****	0.204	0.00
Carpooling as a driver (Yes:0, No: 1)	0.156	0.204	0.444
Present travel mode (car:0, others: 1)	**0.340****	0.201	0.033
Car drive (Yes:0, No: 1)	**0.543****	0.209	0.025
Arrival time at the campus (8:00 AM:0, other: 1)	-0.174	0.192	0.376
Departure time from campus (4:00 PM:0, other: 1)	-0.037	0.172	0.831
Trip distance < 30 km	**0.456****	0.213	0.045

4. Conclusions

This research analyzes the traveler's perceptions of their carpooling interests. The carpooling interests and moral obligation were analyzed using frequency, category, and ordered regression analysis. More than 65% of the respondents are interested in carpooling as a driver and a passenger. The results indicated differences between different groups in their intentions toward carpooling. Travelers have high moral obligations to carpool for a reduction in traffic congestion and environmental problems. The respondent's present travel mode, gender, carpooling as a passenger, and car driving at present are significant in determining the carpooling likelihood of the travelers considering moral obligations. Household car ownership and the availability of cars in the household can have a significant influence on a traveler's potential to carpool. Trip distance from the campus also has a significant impact on carpooling interests and shorter distance trips are more aligned with e.g. less than 30 km.

The findings imply that there is a potential to develop carpooling programs, especially for young Omanis who are students. The intended carpooling programs need to identify the potential groups based on specific SEDs having the same origin and destination places with the same travel route. The shared mobility will help in saving travel costs and reducing the traffic on road work. Gender-specific carpooling programs will only be a viable solution considering the cultural values and customs. Also, educational institutions

and organizations based carpooling strategy would be more suitable for commuters. It is also required to highlight the associated benefits to the potential groups through soft TDM policies such as awareness campaigns. These soft policies will develop a sense of awareness among travelers for sustainable travel alternatives. This study used a small sample size comprising a university student. Therefore, the category and regression analysis results have limitations in their policy implications. Future studies may focus on analyzing the potential of carpooling programs considering the perceptions of other travel market segments such as employees of specific organizations. The future studies also need to evaluate the social, cultural, temporal, and spatial aspects of the carpooling programs. This study only considered the SEDs of travelers in correlation to carpooling likelihood as a passenger and driver. The future researches should focus on evaluating the influence of various motivational factors on carpooling such as time-saving, cost-saving, trust, comfort, incentives and trip attributes that would help to developing matching programs among travelers. Such studies should also indentify the important barriers or constraints in developing the carpooling programs in the context of auto-dependent cities.

5. Acknowledgment

6. References

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