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Critical evaluation of smart transportation system in Muscat

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Abstract

The concept of a smart city is gaining popularity among politicians and academics. Despite the importance of smart cities, many of the words associated with cities can change and their meaning is still unclear. Many countries around the world have launched smart city initiatives to combat traffic congestion. This article is about the need for change in smart cities in Muscat. There is heavy traffic in the city of Muscat, especially in the morning and evening when people drive to work. Traffic congestion in Muscat is associated with congestion in the city and poor traffic management is associated with the city's population and the number of vehicles. This study examines the current state of the transportation system in the Sultanate, especially in Muscat. Appropriate mechanisms must be found to deal with congestion in the city, especially during peak hours and on weekends. Every problem has its own solution, and the development of smart transportation is seen as part of a comprehensive solution to congestion in Muscat. Research shows that most countries in the world want to develop their cities and use more technology for development projects, and Oman should benefit from the experience of other countries in this regard.

I. INTRODUCTION

The worldwide urban populace has developed quickly from 746 million in 1950 to 3.9 billion in 2014. Nowadays, 54% of the world's population lives in urban zones, an extent that's anticipated to extend to 66% by 2050. Therefore, development proceeds. Sustainability is one of the foremost vital objectives. Policymakers and city partners see this development as an opportunity to construct smart cities (Xiong, 2018). A smart city is a smart technology that covers different sectors such as transportation and construction divisions. In numerous nations, transportation is seen as a major zone that can offer assistance to encourage green technology. smart transportation alludes to the advancement of an appropriate transport system that is energy-efficient, naturally inviting, time-saving, and cost-effective. Smart transportation system points to plan appropriate technologies to unravel different transportation problems in urban centres, such as parking issues, traffic congestion, and others (Al Maqbali and Refeque, 2017).

A. PROBLEM STATEMENT

To develop the Omani economy through industrial divergence, as shown in the Government's Vision 2020 and Future Vision 2040, the advancement of a smart transport system is basic (Wrapping up Vision 2020, solidifying Vision 2040, 202. Due to the exceptional development within the world populace and the tall utilize of essential services, a prerequisite for urbanization has developed within the last few long time. Oman is presently overseeing the method of urbanization as its cities are getting way better day by day (Al Farsi and Achuthan, 2018).

Due to the far-reaching utilize of infrastructure, the transport division is a critical component of the economy and a common apparatus utilized for improvement. This is often indeed more genuine of the worldwide economy, where financial openings are progressively connected to the portability of individuals and goods, counting data, and communication innovation. There's a clear relationship between the amount and quality of the transport system and the level of financial advancement. Tall thickness transport systems and profoundly interconnected systems are ordinarily related to tall levels of improvement. When the transportation system is successful, they give financial and social openings and benefits that make positive multiplier impacts such as market access, employment, and additional investment. When the transportation system lacks

capacity or unwavering quality, it can have an economic cost such as reduced or lost opportunities and a decrease in quality of life (Rodrigue and Notteboom, 2021).

Car ownership in Muscat is increasing rapidly among families. In 1999, the number of cars in rich Asian cities was 123 cars per 1,000 people, while the number of cars in Muscat was estimated at 174 cars per 1,000 people. This means, therefore, not surprisingly, that Muscat is a city with serious congestion problems because the comparison of car owners in Muscat is more than 42% of the wealthy Asian cities, while the rich Asian cities have a higher population than Muscat (UKEssays. November 2018).

Traffic and parking problems influence the larger part of Muscat negatively, causing a parcel of unsettling influences and delays in their everyday operations. In this way, it influences their efficiency and influences the financial advancement within the country. Road widening isn't the as it were or best solution to these traffic problems. Instead, a mechanism is needed to implement the appropriate technique to minimize traffic problems and minimize parking problems.

B. Aims

The aim is to study the smart transportation system in Muscat to develop a smart road strategy. It aims to spell the effectiveness of that technology, identify the obstacles facing the adoption of this smart technology, and provide comprehensive information on technological interventions in various countries. Finally, the research wants to evaluate and analyses effectiveness, quality factors, and effective problem-solving and their impact on the future smart transportation strategy of Oman.

C. Research Objectives

- To study the current transport system in Muscat.
- To identify the challenges and issues in the current transport system.
- To critically evaluate the literature related to the transport system.
- To propose a smart transportation system for Muscat.
- To provide recommendations based on the study.

D. Research Questions

- What is the current transportation system in Muscat?
- What are the challenges of the current transportation system in Muscat?
- What literature support is available?
- What can be a best propose transportation system in Muscat?
- What are the recommendations based on the study?

II. LITERATURE REVIEW

A. Transport System

The purpose of transport systems is to coordinate the movement of people, vehicles, and goods to make more efficient use of roads. The objective of the transport system is to reduce transportation costs and reduce delivery times through effective road planning and management (Kohl, 2017). It can be said that a transportation system is a combination of elements and their interactions that creates a demand for travel in a certain area and the provision of transportation services to meet that demand (Anon, n.d.).

B. Current roads statements in Muscat:

According to Mahairzi and Reddy, (2017) Level of Service and Capacity analysis: In the event of congestion on the main road understudy, traffic volume is also recorded to assess the level of service. The design speed of the main road is 120 km / h. Road capacity per kilometer was estimated using the 1000V / S equation. Where V is designed for speed and S is the distance between the vehicle and the vehicle. For designated roads, road capacity was defined as 15oo vehicles per lane/hour.

Level of Service (LOS) may be a subjective measure utilized in connection to the quality of vehicle transportation administrations. LOS is utilized to analyze roads and crossing points by classifying traffic streams and determining levels of traffic quality based on execution measurements such as vehicle speed, density, congestion, and more. In common, benefit levels can be connected to all services within the resource management realm (Level of service (transportation) - Wikipedia, 2020).

According to service level (transportation) - Wikipedia, (2020) letters A through F are used in LOS, A is the best and F is the worst as mentioned in the following:

A: Free flow. Traffic flow over the speed limit and drivers can enjoy full lane navigation.

B: Adequate free flow. LOS A is maintained and traffic flow dynamics are somewhat limited.

C: Continuous flow, free flow, or nearby. Lane maneuver is very limited and lane changes should increase driver awareness.

D: Almost unstable flow. If the traffic increases a little, the speed drops a little. The roads have limited movement and less driver comfort.

E: The flow is unstable and operates with capacity. Since there is no maneuver interval in the traffic flow and the speed rarely reaches the prism point, the flow becomes irregular and the speed changes rapidly.

F: flow or forced failure. Each vehicle moves at a constant speed and the vehicle in front must repeatedly slow down. The movement time is unpredictable as the demand usually exceeds capacity.

Table 1 LOS of Muscat roads (Mahairzi and Reddy, 2017)

Tuesday18.04.2017					Direction: AlHail To Airport							
Time Morning Peak	Small cars	Big cars	Pick up	Trucks	2 Axel	3 Axel	Bus	Total Vehicles	Total PCU	Capacity	Volume/Capacity	LOS
PCU	1	1.5	1.5	3	3	4.5	3					
6:00-7:00	228	198	25	4	7	4	45	511	749	1500	0.5	A
7:00-8:00	1240	485	250	0	0	0	100	2075	2643	1500	1.76	D
8:00-9:00	1400	750	348	0	0	0	66	2564	3245	1500	2.16	F
9:00-10:00	950	400	202	3	3	1	18	1577	1930	1500	1.29	C
10:00-11:00	750	302	158	4	1	0	9	1224	1482	1500	0.99	C

Table 2LOS of Muscat roads (Mahairzi and Reddy, 2017)

Tuesday18.04.2017					Direction: Airport to Al Hail							
Time evening Peak	Small cars	Big cars	Pick up	Trucks	2 Axel	3 Axel	Bus	Total Vehicles	Total PCU	Capacity	Volume/Capacity	LOS
2:00-3:00	250	221	35	15	5	4	62	592	888	1500	0.59	A
3:00-4:00	1345	465	215	5	2	2	109	2143	2719	1500	1.81	D
4:00-5:00	1312	688	485	8	7	2	69	2571	3325	1500	2.22	F
5:00-6:00	1054	412	214	10	8	7	19	1724	2127	1500	1.42	C
6:00-7:00	685	342	112	6	4	5	10	1164	1443	1500	0.96	C

As shown in the number's tables 1 and 2 a case study of Al-Hail Airport Road in Muscat concludes traffic congestion hours and service levels on the road. Morning and evening peaks on the road indicate increased capacity and decreased service levels from A - F.

Effective traffic management monitoring is required by relying on smart road technology that can be provided through a smart transportation system. According to Mahairzi and Reddy, 2017 the main advantages of adopting the smart transportation system are:

- Way better traffic safety
- Decrease congestion.
- Improving get to work and services
- Superior accessibility and mobility Lower transportation costs for government and users
- Traffic administration through locale integration and surveillance
- Traffic information system for proficient routes for road users.

The current traffic conditions indicate the need for traffic management that can be achieved by adopting the smart transportation system described in the previous paragraph. Evaluation of smart technical infrastructure to implement smart transportation systems and presented on traditional roads.

C. Overview of Smart Transportation System:

The term "smart transportation system" refers to the integrated application of modern technology and management strategies in a transportation system (Michel, 2021). Smart Transportation System is an advanced application that provides innovative services related to various types of traffic and traffic management to help users get better information and make their transport network safer, more integrated and smarter (Wikipedia, 2021).

The smart transport system uses all the information around the vehicle. People can improve parking efficiency. It improves traffic safety by coordinating independent systems and providing drivers a coordinated communication channel (Peak, 2020).

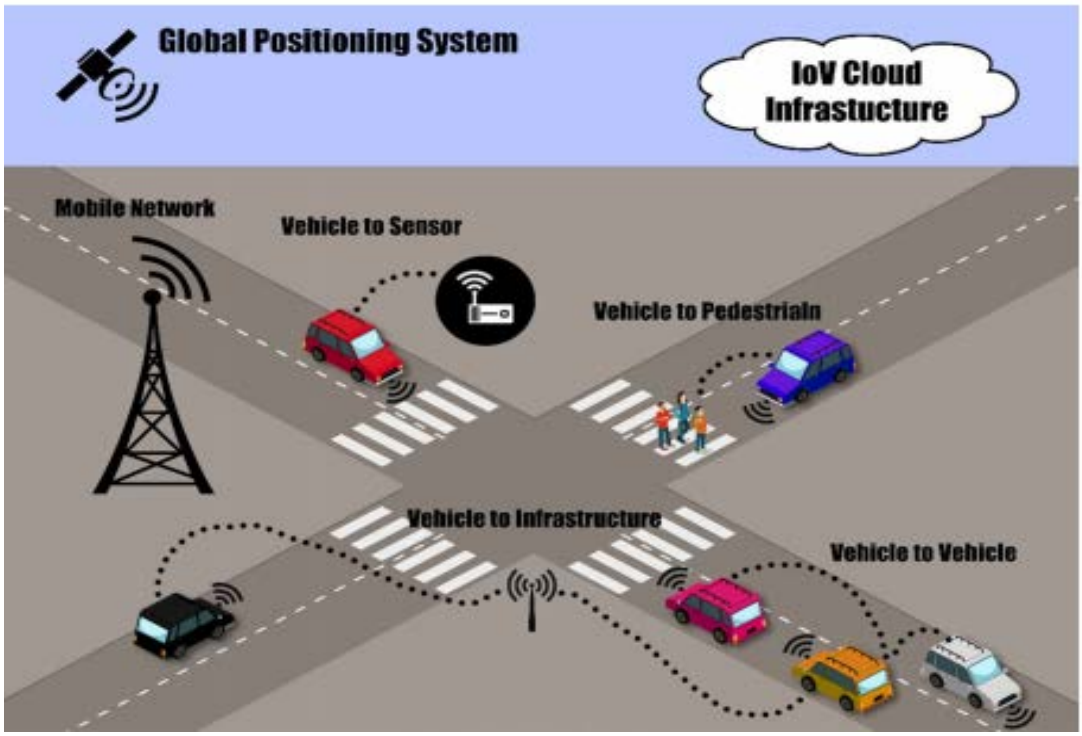


Figure 1Concept of smart transportation system (Aamir et al., 2019)

D. List of applications and purposes of use on smart transport system in the world:

City roads are succumbing to the pressure of a growing urban population. One of the main applications of a smart transportation system is smart traffic management. There is a list of applications used in smart transportation system showing in the below table:

S.No.	ITS Category	Specific ITS Applications
1.	Advanced Traveler Information System (ATIS)	• Real-time Traffic Information • Route Guidance / Navigation Systems • Roadside Weather Information Systems
2.	Advanced Transportation Management Systems (ATMS)	• Traffic Operations Centers • Dynamic Traffic Signs
3.	ITS-Enabled Transportation Pricing Systems (ITS-ETPS)	• Electronic Toll Collection • Variable Parking Fees
4.	Advanced Public Transportation System (APTS)	• Real-time Status Information for Public Transit System • Automatic Vehicle Location
5.	Fully Integrated Intelligent Transportation (FIIT)	• Collision Avoidance • Intelligent Speed Adaptation
6.	Advanced Traffic Management System (ATMS)	• Real-time Traffic Status • Dynamic Traffic Control • Incidence Response
7.	Commercial Vehicle Operations (CVO)	• Traceability and safety of commercial vehicles such as trucks, vans, and taxis.
8.	Advanced Vehicle Control Systems (AVCS)	• Collision Warning of the vehicles
9.	Advanced Rural Transportation System (ARTS)	• Provide Information about Remote roads via Radio.

Table 3 Applications and Categories (Singh, Bansal and Sofat, 2014).

III. RESEARCH METHODOLOGY

A. Research Methods

Information and data about Oman's transportation system are used to provide an objective representation for important decision-making. Instead, it relies on research methods and calculations to collect research data. Most of the answers provided are used to measure search results. And this research will depend on qualitative and quantitative data.

B. Research Methodology

The display study points to develop the transportation sector within the Sultanate of Oman and the Sultanate has not implemented a smart transportation system. Hence, this research is an exploratory methodology. Exploratory research is characterized as research utilized to explore an issue that's not clearly characterized.

C. Research Methodology Justification

Giving awesome significance to depending on research comes about, which lies in choosing the suitable research strategy. Amid this exploratory research, it is fundamental to study the components of activity around transport technology in common and how transportation systems work to develop the transport sector in specific. In this manner, it is critical to degree the reasonableness of this new transport system within the transport sectors within the Sultanate of Oman and how to actualize it within the future inside the legitimate controls and procedures in Oman, and a questionnaire to degree the level of satisfaction of the participants (Popping 2012).

D. Research Design

Research design could be a rationale that links the research reason and questions to gather test data, and information examination, in arrange to reach conclusions drawn from the data. The research design alludes to or is based on the chosen research frame. When utilizing the case studies translation for exploratory research, the most choices of the researcher relate to the part of the previous hypothesis, the unit (s) of examination, the number and choice of cases, the methods to be utilized to gather the data, and the strategy (s) by which the data collected will be analysed. The entirety of these choices comes about in a case study convention that makes a difference in guarantee consistency in inquiring about projects as information is collected in numerous locales over a long period of time. The taking after segments displays the hypothetical establishments of these key choices, as well as their application to the authors, research project (Ponelis, 2015).

In truth, the researcher ought to characterize the field of study of well-known smart transportation systems with the same format as within the literature review and past study, which decide the suitable consideration for the plan of the research. It breaks even with development. In like manner, research questions and destinations are characterized. Then the suitable plan sort is chosen to characterize the research factors and at last, the essential data is collected and analysed. The researcher accepts that the sort of research is classified after an in-depth study that exploratory study of the mixed-methods design is the foremost suitable and closest to current research.

E. Population of the Study

According to (Scribbr 2020) when looking for a gathering of individuals, it isn't conceivable to gather data from all the individuals in that gathering. Then again, you'll select a sample. A sample may be a group of individuals who will really take an interest in research. To draw

substantial conclusions from you comes about, you wish to carefully choose how you may select a sample that speaks to the gather. There are two types of sampling:

Probability sampling includes irregular determination, which permits you to create statistical factual inductions around the complete cohort.

A non-probability sampling includes non-random choice based on the appropriateness or other criteria, permitting you to effortlessly collect data.

A sample of probability is used in this research because the researcher identifies the main population for the case study, that is, Roads Users in Muscat. There are four types of probability and non-probability samples, as shown in Figure below underneath:

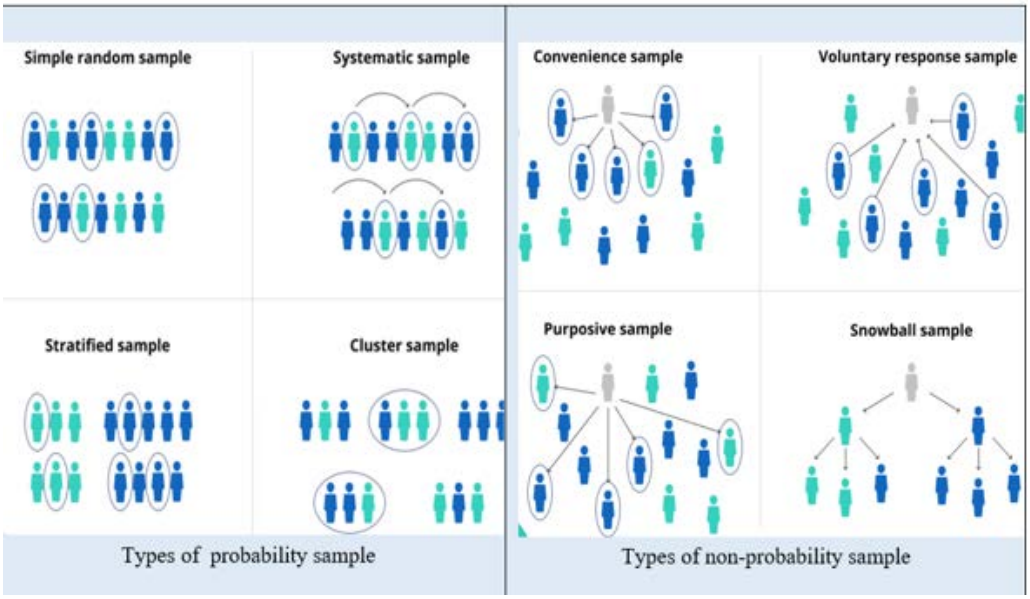


Figure 2 Four 2 main types for both samples (Scribbr 2020)

A simple random sample was used to sample the possibilities in this research. The most popular simple random sampling format allows researchers to maximize simplicity so that all frame elements have the same selectivity (Scribbr 2020).

On the other hand, the available population refers to the true measurable group. This is less than expected because few target members do not participate in the research. This paper explains how and why the sampling method was chosen. One of the factors for project success is selecting the right samples. The target groups in this research are the supervisors and workers of the Ministry

of Housing and Urban Planning and Roads users, as it is an active new project that sheds light on developments in the framework of smart transportation in Muscat.

F. Research Data Collection

Data collection is a necessary step in dealing with research. The tool you choose to collect data will depend on what type of data you plan to collect and how you arrange its collection (Becker 2019). The current research used the interview and questionnaire tools to collect data. A questionnaire is a survey tool written by topic. The questionnaire can consist of short (multiple choice) questions or full questions. Questionnaires are used to collect data on a variety of topics on a particular topic. Various questionnaires are currently being developed and administered online.

IV. RESULT DISSCUSION

A. Spilt-Half Reliability Result

Table 4 Total Scale Statistics of 3 Items

Scale Statistics

	Mean	Variance	Std. Deviation	N of Items
Part 1	8.7826	1.329	1.15303	2[a]
Part 2	4.1957	.694	.83319	1[b]
Both Parts	12.9783	3.088	1.75739	3

a. The items are: Q12, Q9.

b. The items are: Q11

Table 5 Reliability Statistics of 3 Items

Reliability Statistics

Cronbach's Alpha	Part 1	Value	.221
		N of Items	2[a]
	Part 2	Value	1.000
		N of Items	1[b]
	Total N of Items		3
Correlation Between Forms			.554
Spearman-Brown Coefficient	Equal Length		.713
	Unequal Length		.732
Guttman Split-Half Coefficient			.690

a. The items are: Q12, Q9.

b. The items are: Q9, Q11.

The researchers grouped the three questions on the same Likert scale and divided them into two parts. The first part has two questions and the second part has one question, so they weren't equal in length. This was confirmed by the hash reliability analysis model.

What correlation to choose, the correlation between the elements Spearman-Brown coefficient or Guttmann coefficient is split-half.

In this case, the scientific hypothesis for calculating reliability appears in the tables above as follows:

a) The researcher detects a difference between Cronbach's alpha values in Part 1 and Cronbach's alpha values in Part 2.
b) As shown in the Table there was a difference in the scale variances of the items.
c) The number of items is different in both parts.

When these conditions are combined into a single condition, the split-half style reliability test is based on a discrete Gutmann coefficient of 0.690, which measures the reliability of the survey on a 2:1 gold scale.

B. Demographic Data

Personal data were collected from participants based on age and gender variables at the educational level. Using demographic data, the researcher can understand why participants make their decisions, which is gives the researcher the move to the next step in solving technical questions and be discovered how ready participants are to add a new technology based on smart transportation systems on the transport sector, traffic management system.

❖ **Descriptive Statistics (Frequency Analysis):**

Statistics

		Q1	Q2	Q3
N	Valid	47	47	47
	Missing	0	0	0
Mean		1.1277	2.2553	2.8511
Median		1.0000	3.0000	3.0000
Mode		1.00	3.00	3.00
Std. Deviation		.33732	.92002	.99954
Variance		.114	.846	.999
Range		1.00	2.00	4.00
Minimum		1.00	1.00	1.00
Maximum		2.00	3.00	5.00
Sum		53.00	106.00	134.00

Frequency Table

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	41	87.2	87.2	87.2
	Female	6	12.8	12.8	100.0
	Total	47	100.0	100.0	

Age

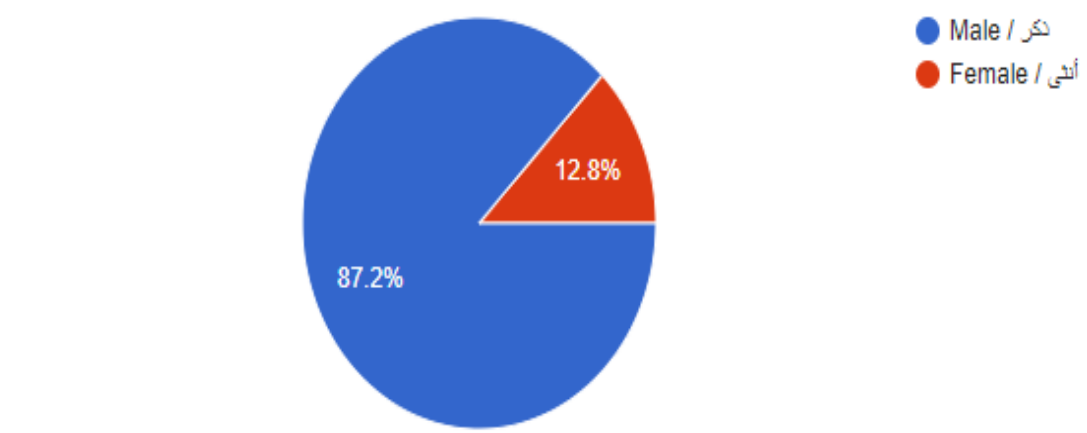
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	25 or less	15	31.9	31.9	31.9
	26-30	5	10.6	10.6	42.6
	Above 30	27	57.4	57.4	100.0
	Total	47	100.0	100.0	

Education

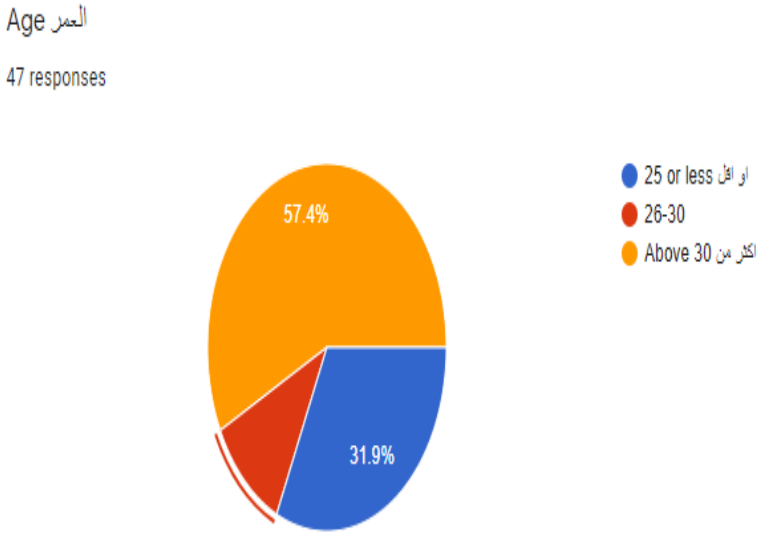
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Secondary School	8	17.0	17.0	17.0
	Diploma	1	2.1	2.1	19.1
	Bachelors	30	63.8	63.8	83.0
	Masters	6	12.8	12.8	95.7
	PhD	2	4.3	4.3	100.0
	Total	47	100.0	100.0	

Table 6 Demographic Profile Summary

There were 47 participants in total, which is a good indicator. Based on the demographics of participants in the Table above use descriptive statistical analysis to obtain specific results for frequency, mean, minimum, maximum, and standard deviation. Approximately 87.2% of the participants were male and only 12.8% were female, with a lower proportion of women than men in the total sample of 47. It is important that men are more active in this study because men drive all cars and have more experience with women with road problems.


Gender / النوع
47 responses
Male / ذكر
Female / أنثى
12.8%
87.2%

Gender


Age العمر
47 responses
25 or less او اقل
26-30
Above 30 اكثر من
57.4%
31.9%

Age

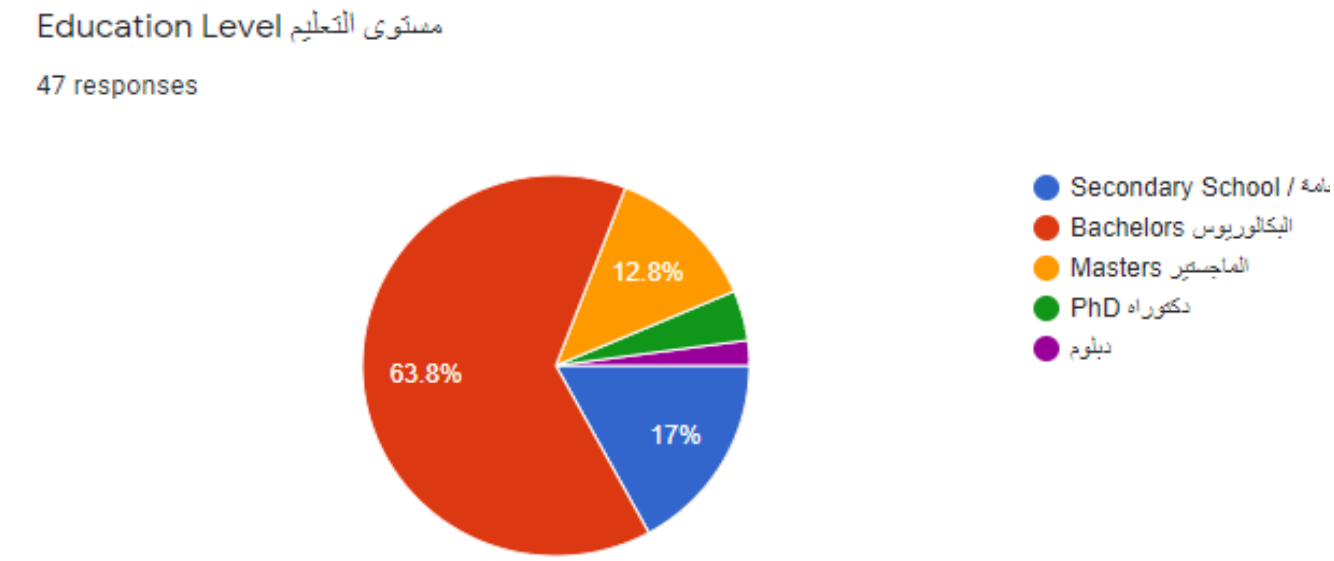


Figure Education Level

Minimum age (25 or less) and maximum age of 30 years and above. Furthermore, the mean age of 2.28 is a good indicator for the most likely age group between 26-30 and above 30. Research is also being conducted to target youth with rich experience rather than recent graduates. Requirements for participation are a minimum high school and a maximum is PhD. In addition, the mean qualification is 2.84, which is most likely for a bachelor's degree, which is very good.

C. The research questions:

The researcher converted the research questions into questionnaire-based research questions to achieve the main objectives of this research. There was a total of thirteen technical questions. The researcher analysed the questions in groups based on a specific task, which differed in the need to clarify and substantiate other conclusions. To achieve the research objectives, the researcher analyses the research questions.

Based on research question 1. What is the current transportation system in Muscat?

Table 7 frequency Analysis of Q4

Q4. The transportation system used in Muscat is a systematic system that can provide information to the driver in real-time

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	20	42.6	43.5	43.5
	No	26	55.3	56.5	100.0
	Total	46	97.9	100.0	
Missing	System	1	2.1		
Total		47	100.0		

Table 8 frequency Analysis of Q5

Q5. The method of reporting traffic accidents and traffic congestion on the roads with the Traffic Department is:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Manually through phone and social media	30	63.8	63.8	63.8
	Both	17	36.2	36.2	100.0
	Total	47	100.0	100.0	

Table 9 frequency Analysis of Q6

Q6. What is the current transportation system use in Muscat?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Public transportations system	45	95.7	97.8	97.8
	Other	1	2.1	2.2	100.0
	Total	46	97.9	100.0	
Missing	System	1	2.1		
Total		47	100.0		

Table 10 frequency Analysis of Q7

Q7. Compared to five years ago, it can be said that there is a traffic jam:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	worse	12	25.5	25.5	25.5
	It stayed the same	15	31.9	31.9	57.4
	better	20	42.6	42.6	100.0
	Total	47	100.0	100.0	

Table 11 frequency Analysis of Q8

Q8. Need a system to redirect the car driver to free-flowing roads.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	43	91.5	93.5	93.5
	No	3	6.4	6.5	100.0
	Total	46	97.9	100.0	
Missing	System	1	2.1		
Total		47	100.0		

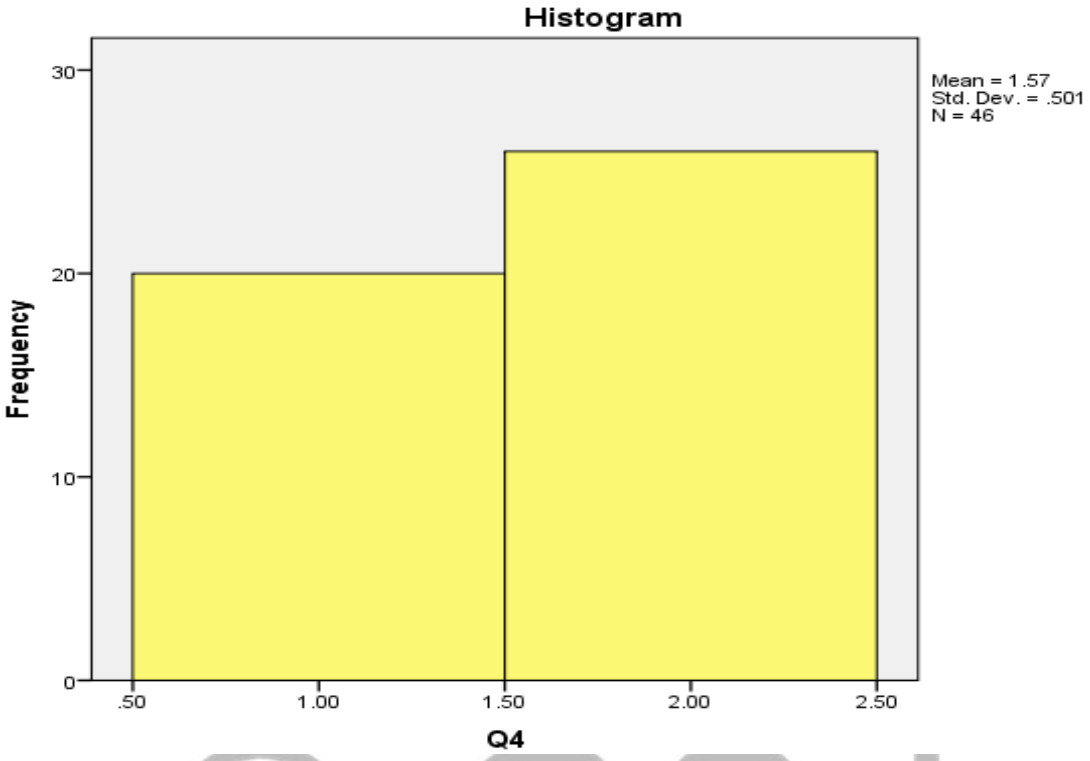


Figure 3 frequency Histogram of Q4

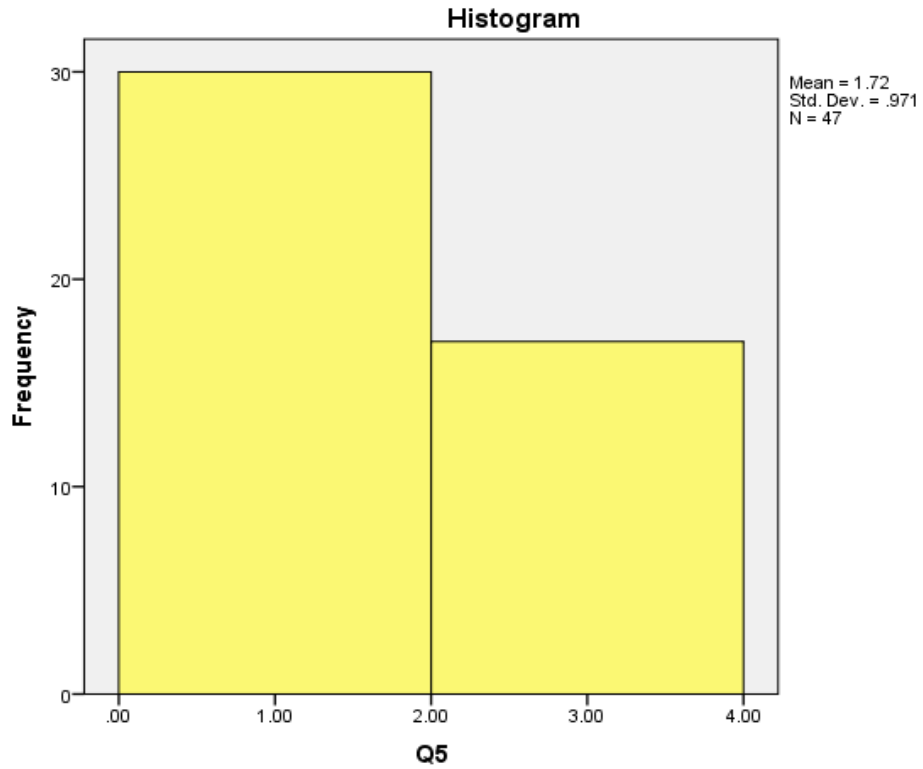


Figure 4 frequency Histogram of Q5

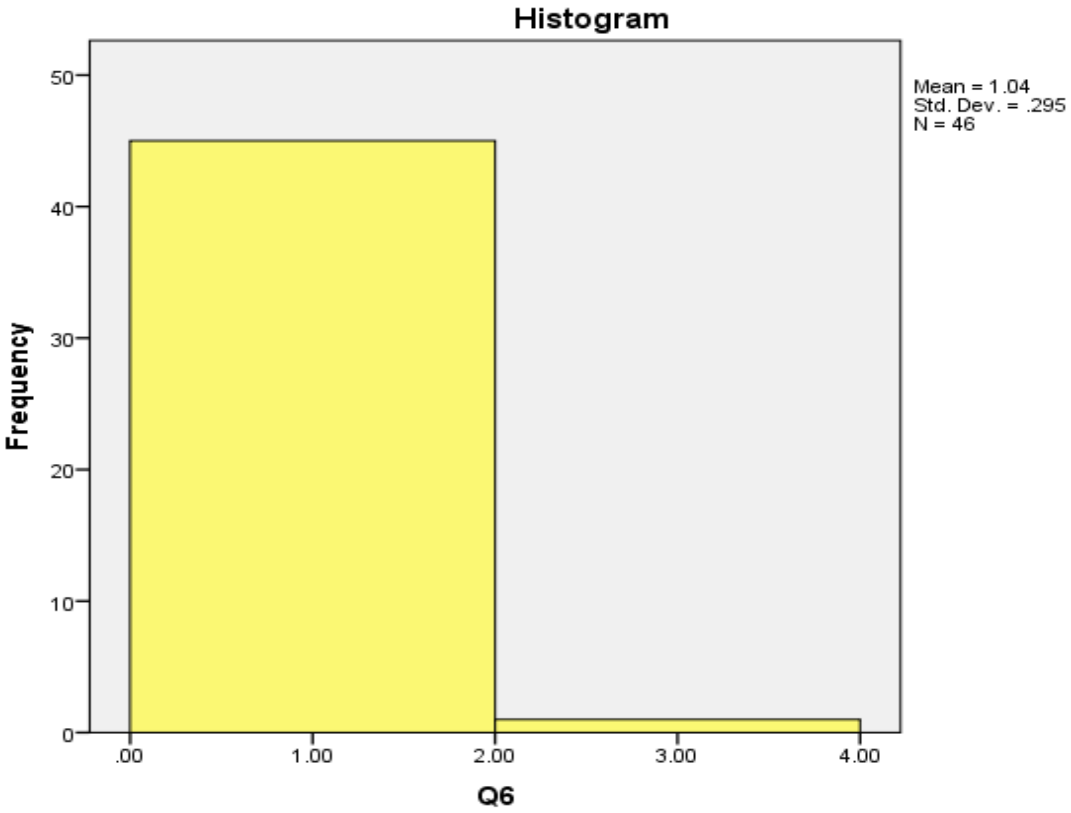


Figure 5 frequency Histogram of Q6

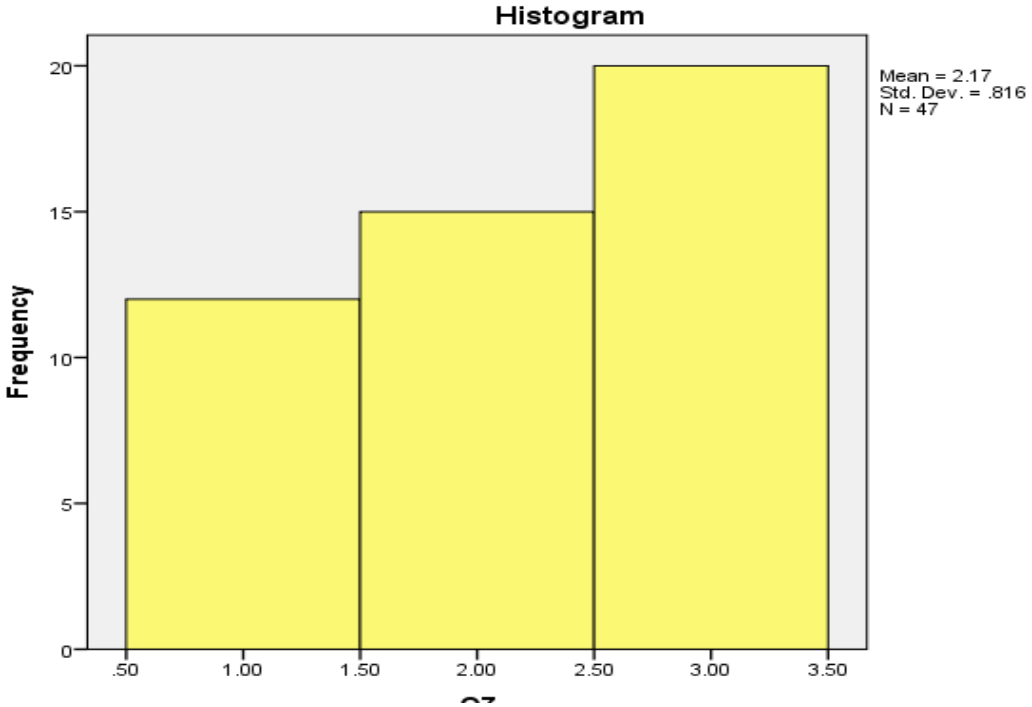


Figure 6 frequency Histogram of Q7

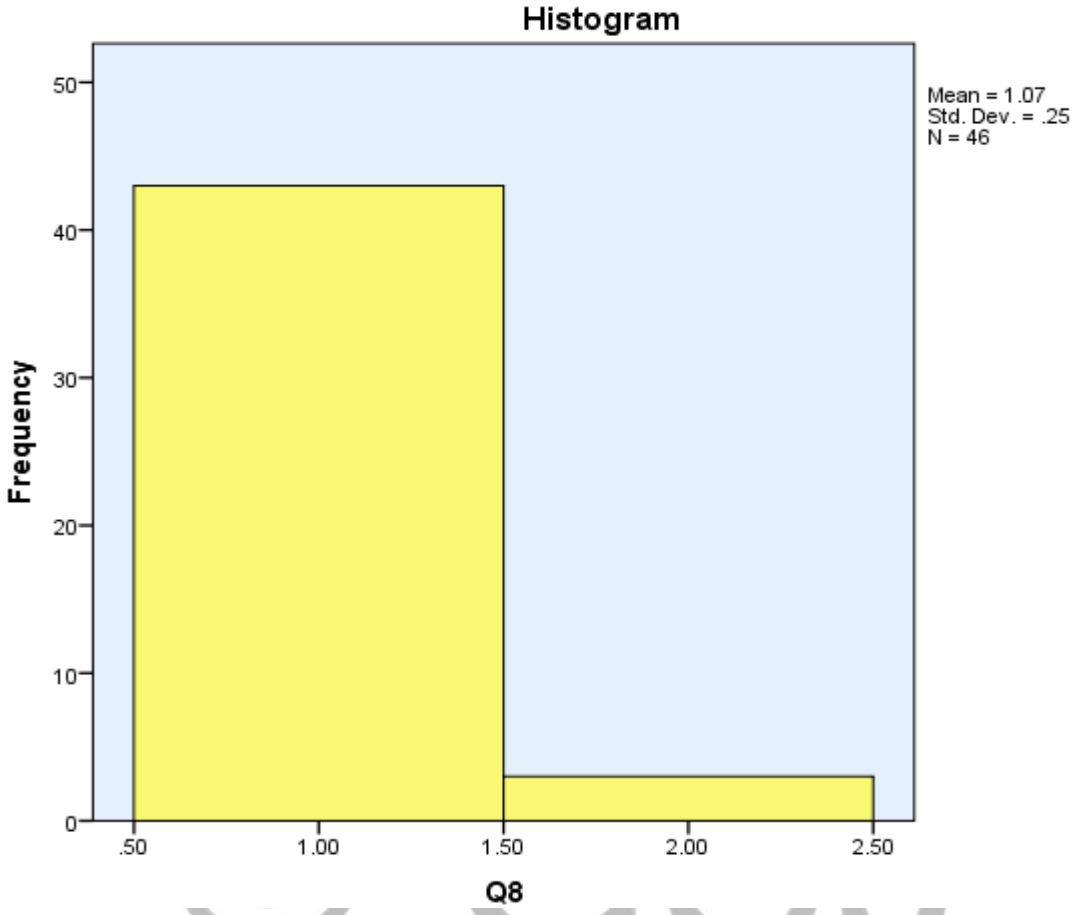


Figure 7 frequency Histogram of Q8

The highest response rate from participation in this research survey, as shown in the figures11 and tables12 above, depending on whether a systematic system is used for transportation from Muscat or not, was 26 participants (55.3% with a mean score of 1.57) who answered no systematic system was used in transportation, and 30 participants respond the (63.8% with a mean score of 1.72) reporting about congestion manually over the phone and on social media. The figure 13 and table14 show the current transportation system in use in Muscat based on the response of 45 participants (95.7% with a mean score of 1.04), the public transportation system currently in use in Muscat. Also, in the table 15 and figure 14 on a comparison of 5 years of traffic congestion, 20 participants (42.5% with an average of 2.17) answered “Better”. In addition, 43 participants (91.5% with a mean score of 1.07) who answered “yes” needed a system to redirect the motorist to free-flowing roads as shown in the table 16 and figure 15

The researcher accomplishes the expected objective 1: To study the current transport system in Muscat using five questions and information collected previously.

- **Descriptive Statistics (Descriptive Analysis):**

Based on research question 2. What are the challenges of the current transportation system in Muscat?

Table 12 Descriptive Analysis of Q10

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation
Q10	46	1.00	1.00	2.00	1.6087	.49344
Valid N (listwise)	46					

The researcher in Q10 noticed that the mean is 1.6 and that the standard deviation of the variables is positive and about zero.

Table 13 Descriptive Analysis of Q9, Q11 and Q12

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation
Q9	46	4.00	1.00	5.00	4.4783	.72232
Q11	46	3.00	2.00	5.00	4.1957	.83319
Q12	47	3.00	2.00	5.00	4.2979	.80528
Valid N (listwise)	46					

The table above shows the variables (Q9, Q11 and Q10) and how the researcher intends to use them to achieve a particular goal. The researcher pointed out that the mean values are very close to each other and are round about equal to the value of 4, and since std.dev is equal to 1. The standard deviation of whole variables is positive and in close proximity to each other about zero.

That positive score, there is no dispersion as showed in the above table between the values and achieved the objective 2: To identify the challenges and issue in the current transport system.

❖ Compare Means (One Sample T-Test):

Table 14 T-Test for challenges of transportation and the current system in Muscat

```
T-TEST
  /TESTVAL=3
  /MISSING=ANALYSIS
  /VARIABLES=Q4 Q10
  /CRITERIA=CI(.95).
```

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Q4. The transportation system used in Muscat is a systematic system that can provide information to the driver in real-time	46	1.5652	.50121	.07390
Q10. The roads have enough capacity to serve road users at present	46	1.6087	.49344	.07275

One-Sample Test

	Test Value = 3					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Q4. The transportation system used in Muscat is a systematic system that can provide information to the driver in real-time	-19.415	45	.000	-1.43478	-1.5836	-1.2859
Q10. The roads have enough capacity to serve road users at present	-19.124	45	.000	-1.39130	-1.5378	-1.2448

For such type of t-test (one-sample t-test), the first order of the t-test was to identify two factors: a dependent factor and an independent factor. As you can see from the table above for the Q4 and & Q10, there were two factors: study the current system of transportation and see the challenges of the transportation. TESTVAL = 3 means that the software was randomly selected for all three respondents to calculate every 3 mean. This also means that the confidence level for the CRITERIA = CI (0.95), that is, the t-test is 95%, and it can only show an error of 5% only. From the table above, the researcher concluded that the T-test for studying the current system for the presence or absence of smart traffic system is 19.418, and the T-test for the road capacity provided by the service is 19.124, sig =. 000. This means that the significance is less than 0.05, indicating that the relationship between the two factors is a positive outcome and acceptable (Coakes and Steed 1998).

- **Correlation Analysis:**

Table 15 Correlations

```
CORRELATIONS
  /VARIABLES=Q11 Q12
  /PRINT=TWOTAIL NOSIG
  /MISSING=PAIRWISE.
```

Correlations

		Q11	Q12
Q11	Pearson Correlation	1	.566**
	Sig. (2-tailed)		.000
	N	46	46
Q12	Pearson Correlation	.566**	1
	Sig. (2-tailed)	.000	
	N	46	47

**. Correlation is significant at the 0.01 level (2-tailed).

By analyzing the correlation, it was found that the relationship between "Traffic congestion affects the country's economy" and "Employees have difficulty reaching their workplaces due to traffic congestion" is moderately positive and statistically significant (566.p < .001). The results were satisfactory with the objectives.

❖ Proposed Analysis:

Based on research question 4. What can be a best propose transportation system in Muscat?

Table 16 Frequency Analysis of Q13

```
FREQUENCIES VARIABLES=Q13
  /STATISTICS=STDDEV VARIANCE RANGE MINIMUM MAXIMUM MEAN MEDIAN MODE SUM
  /HISTOGRAM
  /ORDER=ANALYSIS.
```

Statistics

Q13

N	Valid	45
	Missing	2
Mean		2.5778
Median		3.0000
Mode		3.00
Std. Deviation		.91674
Variance		.840
Range		3.00
Minimum		1.00
Maximum		4.00
Sum		116.00

In your opinion, what is the appropriate system to solve the problem of traffic congestion in Muscat?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Public transportation	10	21.3	22.2	22.2
	Putting a police officer on the roads to control the movement of roads	2	4.3	4.4	26.7
	Smart traffic control helps redirect car driver to free up traffic routes	30	63.8	66.7	93.3
	Other	3	6.4	6.7	100.0
	Total	45	95.7	100.0	
Missing	System	2	4.3		
Total		47	100.0		

It has been observed as a result of this question answered by 30 participants, that Smart traffic control helps redirect car drivers to free up traffic by 63.8% which means that this will solve traffic congestion problems as mentioned in the above table. This result will support the smart transportation system for Muscat's proposal.

Question 13 allows the researcher to achieve the perspective of objective 4: To propose a smart transportation system for Muscat.

❖ **Open-ended questions:**

The survey utilized open-ended question types to provide additional space for respondents to expand those suppositions and gather details around the current transportation system and recommendations from study participants.

Question 14: Is there a system associated with the road user to inform him of the condition of the road such as an accident, traffic jam, weather, etc.? If yes, please write the current system used?

As shown in the figure, the total number of answers to question 14 is 47, which is 100% of the total 47 survey participants. The majority common frequent response is "No", with 40.5 % of responses, which indicates that there is no system associated with the road user to inform him of the condition of the road such as an accident, traffic jam, weather, etc.

This question is part of achieving the first objective: To study the current transport system in Muscat.

Question 15: Any recommendation to improve the current transportation system?

As shown in the See Appendix, the total number of answers to question 15 is 27, which is 57.4% of the total 47 survey participants. The majority common frequent response is "Adding new roads (with 22.2 %)" and “develop or use Public transportation (with 22.2 %)".

This question is part of achieving the first objective 5: To provide recommendation based on the study.

D. Critical evaluation of the study

Studying Smart Transportation System in Muscat has been beneficial in many ways. This study was able to identify the transportation problems in Muscat. Traffic flow has always been one of the important variables that can stimulate economic activity, and this study is useful for improving urban traffic. Case studies also helped ensure accurate and reliable research results. Several countries have developed durable solutions to traffic congestion to assess whether the same solution is appropriate for Muscat. This will help you find specific solutions to the congestion problem. Comparisons with other studies previously conducted in this field are

important to ensure the validity and reliability of the results. The main finding of this study is that the main research suffers from significant traffic congestion. This finding is consistent with the results of Rodrigue and Notteboom (2021) studies due to the far-reaching utilize of infrastructure, the transport division is a critical component of the economy and a common apparatus utilized for improvement. This is often indeed more genuine of the worldwide economy, where financial openings are progressively connected to the portability of individuals and goods, counting data, and communication innovation. A study by Jalagat and Jalagat (2016) suggests that traffic congestion may become a major problem in most countries as the number of vehicles increases. The strength of this study is that you can get real data including the underlying data sources. The strength of this study is that you can get real data including primary data sources. The lack of a real-time traffic management system has been identified as the cause of traffic problems in Muscat. The driver of the vehicle does not know the road condition if there is traffic congestion due to weather, accidents, etc. So, the driver of the vehicle must know the road condition and traffic congestion condition. If they have any system that provides this information to road users, they can either re-route the vehicle themselves or follow the route that a transportation system that has a real-time traffic management system can provide. This will reduce traffic congestion and will also provide instant information to the traffic management department to make quick decisions to solve road problems. Muscat, the biggest challenge is the lack of a proper information technology system to inform motorists about road conditions and guide them on a traffic-free road. Many countries such as Japan, South Korea, Singapore and other cities in the world and GCC countries such as Dubai have established an effective real-time traffic congestion information platform for all motorists to provide important information about traffic and its flow (Singh, Bansal and Sovat, 2014). In addition, the study appears to be consistent with findings and findings from other research considered in this area. In many countries, drivers currently obtain traffic data through their smartphones (Danh, 2016). It moreover illustrates the significance of research studies for creating an effective transportation system. In spite of the fact that the study was connected to numerous benefits, it was also impacted by a number of factors that hampered its viability. One of the components that contrarily negatively to the result of the study is the need for enough resources and time. Due to a need for enough resources and time, the study was incapable to capture huge data sources to progress the precision of the results.

Through this part it allows the researcher to achieve the perspective of objective 3: To critically evaluate the literature related to the transport systems.

E. Best Practice Analysis:

Based on the literature review in the previous chapters, most countries implement real-time traffic management which they can provide through a smart transportation system. Real-time traffic provides real-time information about road conditions such as traffic congestion, accidents, and weather conditions. Best practices are based on critical evaluation of the study Real-time traffic information can be provided and applied or implemented through ATMS. ATMS content of some devices to provide real-time traffic information such as cameras, sensors, monitors, software, GPS, emergency call box, etc.

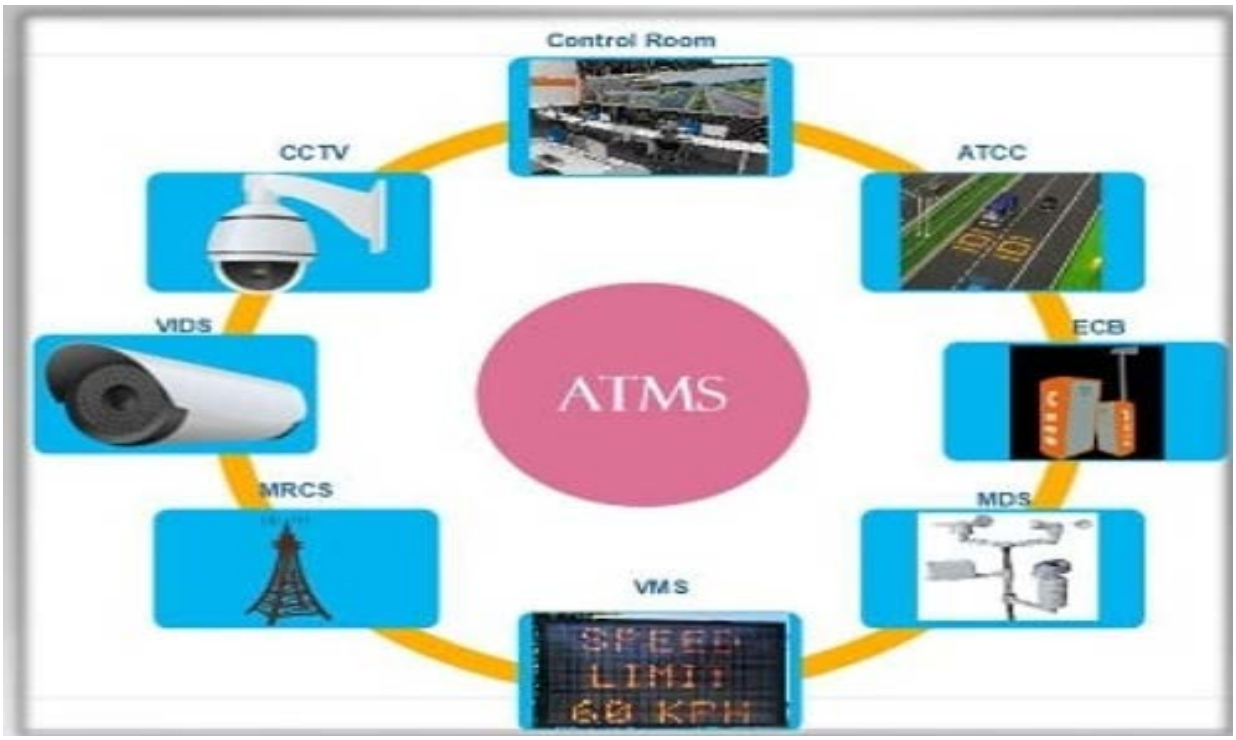


Figure 8 ATMS (Trafiksol ITS Technologies Pvt. Ltd, 2018)

V. Conclusion and Recommendation:

A. Main Findings of the study:

Research and extraction from the previous chapter are the main points of analytical results that allow you to achieve the objectives of the study. The major search finding is as follows:

- For the study sample, 47 responses were received.
- We got more responses from males (87.2%) of the total research participants.
- Most of the participants are male and most have a bachelor's degree. Some of the participants were even high school and master's degrees. This ensures that the responses we obtained were accurate and less "guesswork" than expected because it was the professionals who answered the survey. It is also a good and important indicator that men are more active in this study because men drive all cars and have more experience with women who have problems on the road.
- The result of using a systematic system for transport in Muscat or not was 26 respondents (56.5%) who answered that no systematic system was used for transport in Muscat.
- Most participants in this research answered that the current system used in Muscat for the transportation system is a manual system, and there is no system that detects traffic congestion and then informs the Traffic Management Centre about it and road users about it to avoid those types of traffic congestion.
- The results of the type of transport system used in Muscat mostly answered the current public transport system (with 95.7%) used in Muscat.
- When comparing 5 years of traffic congestion, 20 participants (42.6%) answered "best" and 15 participants (31.9%) answered "It stayed the same".
- The result of needing a system to redirect the driver to free-flowing roads was a predominantly “yes” answer with a rate of 93.5%. This is a sign that most roads have to be smart ways.
- Most participants agreed that traffic is wasting their time and money 25 respondents (54.3%) answered “strongly agree” and 20 participants (43.5%) answered, “agree”.
- As a result of the road's capacity to serve road users, most respondents with 28 respondents (60.9%) answered "No" which means that the roads cannot provide sufficient service to road users.
- As a result, if traffic congestion affects the country's economy, most respondents are between "strongly agree" and "agree" traffic congestion affects the country's economy, with the number of participants equal (19) and the percentage (41.3%).
- Based on the research participants, most of them were having problems getting to their workplace. 24 respondents (52.2%) answered “strongly agree” that they had difficulty getting to their workplace due to traffic congestion.

- The results of the participant's opinion on the appropriate system to solve the problem of traffic congestion in Muscat was that 30 participants (60.7%) answered, "Smart traffic control helps redirect car drivers to free up traffic routes".

B. Conclusion

Through the positive literature review scale and current research lines of study described in the previous chapters. In this study, the researcher obtained the expected results. In addition, there are no rigorous conclusions regarding data analysis and practice assessment, as this is an exploratory study. It is necessary to add smart roads to the smart transportation system to improve the level of services on the roads and avoid traffic congestion.

Smart transportation systems may influence the revival of road services to transform manual services into systematic services for road users and traffic management systems to make an important contribution to the national economy by providing an active transportation system.

C. Recommendation:

The study recommends the development of an effective traffic management system in Muscat to manage urban traffic. The expansion of a traffic management system, like the utilize of a smart transport system, is an appropriate way to solve a country's traffic problems. In addition, it is good for the government to study the real-time activity management framework to help oversee the traffic stream. It was clear that there was a lack of real-time information on the condition of the roads to avoid traffic congestion and to provide good statistics to the relevant ministry and because the majority of Muscat residents needed such a system as they mentioned in the research survey. It is important to install an effective traffic management system, such as cameras and other technological devices that regularly update traffic and traffic information all of which can be provided through ATMS. ATMS is recommended for Muscat roads, ATMS is one of the most popular and used branches of the Smart Transportation System. The ATMS system will help transform Muscat's roads into smart roads.

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