

The Role of Quality, Planning, and Cost Management on Project Management an Empirical Study of The Riyadh Metro Projects in Riyadh City, Kingdom of Saudi Arabia

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Dedication

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Abstract

The aim of the study: This study aims to reveal the effect of quality, planning, and cost management on project management in the context of the Riyadh Metro Projects in Riyadh City, Kingdom of Saudi Arabia.

The methodology of the study: To achieve the objectives of the study, the researcher used the descriptive analytical approach, where the study population consisted of all employees involved in the Riyadh Metro Projects (estimated at 5,000 individuals). The study was applied to a sample of 350 employees and administrators working on the Riyadh Metro Projects in Riyadh City.

The results of the study: The findings revealed a significant positive relationship between the integrated application of quality, planning, and cost management techniques and overall project management effectiveness. Quality and planning management demonstrated high levels of implementation, while cost management showed a medium level. The study also found that the adoption of AI-driven tools and data analytics significantly enhanced decision-making processes and project outcomes.

Theoretical contribution: This study contributes to the literature by investigating the relationship between quality, planning, and cost management and their combined impact on project management effectiveness in large-scale infrastructure projects. It also explores the role of AI and data analytics in enhancing these management practices.

Practical applications: The study provides recommendations to the relevant parties in the Riyadh Metro Projects on the importance of applying integrated quality, planning, and cost management strategies and their relationship to overall project success. It emphasizes the adoption of AI-driven tools and data analytics to enhance decision-making processes, which raises the level of project management effectiveness and efficiency.

Keywords: Quality management, planning management, cost management, project management, Riyadh Metro Projects, artificial intelligence, infrastructure projects

Table of Contents

1	Chapter 1: Introduction	9
1.1	Research Background.....	10
1.2	Research Problem.....	12
1.2.1	Theoretical Gaps	12
1.2.2	Practical Gaps	12
1.3	Research significant	13
1.3.1	At the theoretical level	13
1.3.2	At the practical level	13
1.4	Research questions	13
1.5	Research objectives	14
1.6	Research hypotheses	14
1.7	Research model	14
1.8	Scoop of the study	14
2	Chapter 2: Literature Review	18
2.1	Introduction	19
2.2	The independent variable	19
2.3	The dependent variable	19
2.4	The relationship between the independent and the dependent variables	20
2.5	Conclusion.....	22
3	Research methodology	23
3.1	Introduction	24
3.2	Operational definition for research variable.....	24
3.2.1	The independent variable.....	24
3.2.2	The Dependent Variable:	24
3.3	Research design.....	24
3.4	Research population and sampling methods and technique.....	25
3.4.1	Research population.....	25
3.4.2	Research sample.....	25
3.4.3	Sampling method and techniques	25
3.5	Data collection methods	25

3.5.1	Independent variable	26
3.5.2	Dependent variable	26
3.6	Types of data	26
3.6.1	Primary data:	26
3.6.2	Secondary data:	26
3.7	Data Analysis Methods & Procedures	26
3.8	Conclusion.....	27
4	Chapter 4: Statistical analysis of the study results	28
4.1	Introduction	29
4.2	Characteristics of the study sample.....	29
4.3	Measuring the validity and reliability of study instruments.....	35
4.3.1	Validity of the measures used in the study	36
4.3.2	Reliability of the study tool.....	38
4.4	Descriptive analysis of the study variables	39
4.5	Linear correlation coefficients between the study variables	41
4.6	Results of testing the validity of the study hypotheses	42
4.7	Conclusion.....	44
5	Chapter 5: Findings Discussion and Conclusion.....	45
5.1	Introduction	46
5.2	Theoretical Contribution	46
5.3	Practical Applications	46
5.4	Recommendations	47
5.5	Study's limitations	47
5.5.1	Objective Boundaries:.....	47
5.5.2	Human Boundaries:	48
5.5.3	Spatial Boundaries:	48
5.5.4	Temporal Boundaries:.....	48
5.6	Future studies	48
5.7	Conclusion.....	49
6	References	52
7	Appendix	60

Table to tables

Table 1: Characteristics of the study sample.....	29
Table 2: personal information of the sample.....	32
Table 3: Validity of the measures used in the study	36
Table 4: 4.3.2 Reliability of the study tool	38
Table 5: 4.4 Descriptive analysis of the study variables	39
Table 6: 4.5 Linear correlation coefficients between the study variables	41
Table 7: 4.6 Results of testing the validity of the study hypotheses	42

Table of figures

Figure 1: study sample gender	31
Figure 2: study sample age	31
Figure 3: study sample education level.....	32
Figure 4: study sample nature of work	32
Figure 5: study sample residence.....	34
Figure 6: “do you own a personal car?”.....	34
Figure 7: the use of metro	35
Figure 8: the need of metro in Riyadh	35
Figure 9: research modle.....	43

1 Chapter 1: Introduction

1.1 Research Background

In this research, I address the topic of The Riyadh Metro projects and although it is a topic that has been extensively researched before by many researchers, I add to them recent growth patterns and future forecasts indicate that Riyadh will have very high population growth rates, which will lead to an increase in the demand for travel on its roadway network and transportation system which is what I focused on due to the connection of this issue with life style in Riyadh city. The study relied on a survey and analytical approach to the factors of quality, planning and cost of transportation and roads and their related factors. The Riyadh metro system is being implemented as a sustainable transport option that will offer reliable, affordable, and comfortable urban mobility. It is important to understand the factors influencing the likelihood that people will use the new metro system. Thus, this study's key objective is to investigate *To investigate the influence of Riyadh Metro projects on managing Riyadh traffic.* We wanted to know what's behind Riyadh's traffic that will influence the choice to use Riyadh's proposed metro system. Giving the Travel times, travel costs, walk times and transfer requirements significantly affect people's mode choices. Travel cost has a greater influence on car users, whereas travel time has a stronger impact on taxi users. Socioeconomic characteristics, such as age, nationality, education level and car ownership also significantly impact the choice to use the metro. The Kingdom of Saudi Arabia has expended considerable efforts to create an energy- efficient urban transport system Such a system can help the Kingdom achieve two important goals. First, the economic sustainability of the energy sector is a top priority for Saudi Arabia as it is one of the world's largest exporters of oil. According to the Saudi Arabian Monetary Agency, approximately 33.42% of the Kingdom's gross domestic product in 2019 was generated by the oil sector (Mahmood, Alkhateeb, and Furqan 2020). Second, achieving the country's net-zero by 2050 target is also a key priority. For instance, the National Renewable Energy Program (NREP) is a strategic initiative of Vision 2030. The program aims to increase the Kingdom's share of renewable energy production, achieve a balance in the mix of local energy sources and fulfill its obligations toward reducing carbon dioxide emissions. Both goals require the country to use all possible strategies to mitigate climate change and achieve energy efficiency. Transportation is a major energy-demanding sector and a major contributor to carbon emissions (Khalili et al. 2019), and is thus gaining importance in the Kingdom's energy policies. Urban transport in Saudi Arabia is predominantly automobile oriented. A shift from automobiles

to public transport can reduce energy demand and carbon emissions and thus improve the country's energy efficiency. However, the urgent need to reduce carbon emissions to mitigate adverse climate impacts requires a drastic shift toward more sustainable modes of transport. According to Kenworthy (2020), public transport can be 55 times more energy efficient than automobile travel. Thus, the Kingdom has proposed a metro system for Riyadh that is currently under development. However, the energy efficiency gains from this system will depend on people's willingness to switch from more traditional car use to metro use. Thus, this study investigates the factors that influence people's willingness to ride the proposed metro. The number of metro systems is increasing globally, societies are becoming more urbanized, and metro systems are critical for mobility. The International Association of Public Transport (2018) notes that at the end of 2017, 178 cities in 56 countries had metros. Moreover, 75 new metros have been constructed since 2000, mainly in Asian countries. Metros transport an average of 168 million passengers per day worldwide (International Association of Public Transport 2018). The growing body of research on metros covers topics ranging from feasibility to operations enhancement and passenger satisfaction. Understanding the necessity of metro systems is helping to accelerate the construction of metro infrastructure. Nonetheless, the modal shift from private cars to metros or bus rapid transit (BRT) is a relatively new research topic. Some recent examples include studies on the proportions of passenger car and motorcycle users shifting to BRT and rail (Kwan, Sutan, and Hashim 2018; Satiennam et al. 2016). Other recent studies analyze the health benefits of BRT (Bartels et al. 2016) and commuters' willingness to shift to the metro (Fraszczyk, Weerawat, and Kirawanich 2019). Anwar and Yang (2017) consider the effects of transport policy on the modal shift from cars to public buses. Krishna, Thomas, and Salini (2020) measure the reduction in fuel consumption and emissions resulting from this modal shift. Mostafi (2022) explores the importance of information and communication technology (ICT)-based mobility services in Cairo. The study examines parameters associated with the frequency of ridesourcing use as well as with the modal shift from different mobility modes, such as from public transport to ridesourcing. Finally, Shaheen and Cohen (2020) investigate mobility on demand and mobility as a service. This study explores people's intentions to shift from their current modes of transport to the metro. Specifically, it considers the proposed new metro system in Riyadh, which includes six lines covering a 176-kilometer network as well as 85 underground, elevated or at-grade section stations (Royal Commission for Riyadh City 2022). The Riyadh metro is intended to achieve the city's

sustainable transport goals. Thus, the factors that influence intention to ride the metro should be explored so that the government can formulate effective transport strategies. This study attempts to provide recommendations for metro stakeholders. The recommendations it provides can help gauge respondents' willingness to shift to the metro and identify the preferred conditions that should be accommodated in planning policies. We also deliver empirical guidelines for understanding customers' perspectives and the mechanisms of shifting from other modes of transport to the metro. These guidelines can eventually be used to meet customer expectations after the new metro system is operational. We aim to understand the underlying factors influencing private transport users' intentions to shift from their current modes of travel to the metro once it becomes available. Using this information, we can better predict the direction of the resulting energy efficiency gains in the urban transport sector.

1.2 Research Problem

Transportation is an issue that requires constant movement and thus results in friction, collisions, and disputes as well. As the number increases, the competent authority must regulate the situation in terms of the ease of the road, the quality of vehicles, the driving of drivers, and the factors pressing on the geographical and demographic environment.

1.2.1 Theoretical Gaps

Despite the significant research on Transportation, there may be a lack of understanding of the underlying mechanisms of the Transportation system. For example, although much research has been done on the reason behind it, the exact mechanisms that lead to traffic jam are not yet fully understood.

1.2.2 Practical Gaps

The access and utilisation of Transportation ways through, organizing and spreading awareness that can help individuals to gain and apply knowledge to manage their time effectively. This gap occurs from the different needs and financial literacy between populations and makes us wonder what is really behind the causes for Riyadh traffic?

1.3 Research significant

The city of Riyadh has become one of the Arab and international cities most crowded with cars. Due to the high standard of living, which has made each family have more than one car, traffic congestion has therefore increased very clearly. The role of multiple sectors in providing transportation services, vehicular traffic, paving roads, and constructing bridges is not denied, but the vital difference was With the Riyadh metro system when its being implemented as a sustainable transport option that will offer reliable, affordable, and comfortable urban mobility the importance of the study lies in unveiling a vital and extremely important matter.

1.3.1 At the theoretical level

be a lack of understanding of the underlying mechanisms of the Transportation system. For example, although much research has been done on the reason behind it, the exact mechanisms that lead to traffic jam are not yet fully understood because of the high standard of living, which has made each family have more than one car, traffic congestion has therefore increased very clearly.

1.3.2 At the practical level

We understand The role of multiple sectors in providing transportation services, vehicular traffic, paving roads, and constructing bridges is not denied, The access and utilisation of Transportation ways through we don't understand what is really behind the causes for Riyadh traffic?

1.4 Research questions

- What is the causes for Riyadh traffic?
- How does the traffic effect the lifestyle in Riyadh city?
- What are the solutions?
- Who is responsible and why?
- What is the impact of The Riyadh Metro projects?
- What are the benefits and drawbacks of The Riyadh Metro projects?

1.5 Research objectives

- To investigate the influence of Riyadh Metro projects on managing Riyadh traffic.
- To provide answers on why the problem existed.
- To provide solutions

1.6 Research hypotheses

What is the effect of growth of population in Riyadh city on Riyadh traffic jam?

1.7 Research model

The capital, Riyadh, is experiencing a difficult state of traffic congestion. This problem threatens human health in this expanding city that is about to increase in population by a million in the coming years due to many considerations, including economic and political ones. What is certain is that traffic congestion threatens its quality of life programs and entertainment and tourism activities for residents and visitors. Some of us have begun to cancel our social connections due to the struggle of reaching the destination within the city. The strange thing is that in recent years, Riyadh has witnessed the construction of main streets in northern Riyadh that are parallel to King Fahd Road. They are supposed to reduce traffic congestion on it, but unfortunately they have become traffic congestion points that put pressure on even the side streets in the capital, Riyadh. This problem requires solutions, even if they are partial and temporary, until permanent solutions to this issue are reached. At the forefront of these solutions is the operation of the public transportation system in the capital, including the almost completed tunnel networks and the network of transport buses that roam the capital empty in long experiments that have become a burden on traffic instead of be part of the solution, but we are hopeful and optimistic that the tunnel and bus network will soon be launched in the capital because they are one of the radical solutions to this stifling traffic crisis.

1.8 Scoop of the study

A questionnaire aims to understand the behavior of traffic of Riyadh city in kingdom of Saudi Arabia is designed. The target audience are citizens of Riyadh city.

The questions included:

What are the causes of traffic in Riyadh?

Who is responsible for this traffic?

What are the solutions in your opinion?

Why is he responsible for the traffic in Riyadh?

Our goal in approaching different types of citizens was not to get a representative sample of the WhatsApp groups but to elicit potentially diverse perspectives. Given the issues mentioned above, we are able to assess how many people saw our survey. We received 8 responses from over 300 members/users through shared messages who replied to our queries. The responses we received revealed many different perspectives on audience. While we can quantify audience perspective to the issue, the responses we received provide valuable insight into some core differences in conceptualizing audience. Future empirical work might examine the prevalence of these answers and their relationship to citizens' counts, demographics, or social status. As we now demonstrate the answers of our survey

What are the causes of traffic in Riyadh?

Compatibility of working hours and overlapping of business sectors' working hours with educational institutions. Closing some streets and relying on narrow main streets and lack of paths. The presence of jobs, major companies, ministries, agencies, and entertainment and cultural events in the city of Riyadh is greater. Infrastructure. Population density and large number of cars. Many green buses, labor buses, and trucks. The large presence of foreigners, permitting visit visas, and preventing them from returning. Lack of awareness of the basics of driving and following the correct and specified route, or the legal speed of the road

What are the solutions in your opinion?

A flyover bridge like Kuwait City is being built to ease congestion. Establishing supporting roads for the main road (for example, Kharia's Road is the only road that connects the east to the west. There is no other option, so most of the time the road is crowded) and all roads are in this way. Do not move some companies outside of Riyadh or neighboring areas to revive them, move industrial cities outside of Riyadh, prevent workers. Buses avoid being present on public roads during times of congestion. There is an alternative or supporting route that relieves congestion. Returning to the "primitive" method, which is mass transportation, and instilling this culture through subsidized and free activities and performances so that the citizen can use this means. Organizing working

hours for employees - students - universities and colleges. Operating trains and expanding an advanced transportation network throughout Riyadh and linking nearby cities and governorates to a high-speed train network. Establishing fast lines for buses and trucks, changing the working hours of companies, for example, in the middle of Riyadh, and his work center there works at such and such time, and the one in the north of Riyadh has such and such time, or organizing the number. Stopping visit visas, correcting residency conditions, activating flexible working hours in some sectors, allocating some days to educational institutions (remotely), and activating flexible working hours in business sectors + eliminating old cars for disrupting traffic + imposing a fine on workers and owners of trucks whose speed is less than 100. Educating the people to follow the designated lane and the legal speed of the road.

Who is responsible for the traffic?

Traffic management due to its weak ability to control congestion.

The culture of the population of the city of Riyadh is such that every person owns a car.

Inactivation of public transportation.

Weak planning in terms of placing all ministries and departments in one road or one area.

Failure to activate government electronic services to remove bottlenecks in ministries.

Why is the reason you chose in the previous question responsible for the traffic in Riyadh?

As you can see from the pie chart the option number (4) got chosen the most by 50% who agreed that Weak planning in terms of placing all ministries and departments in one road or one area because suddenly, there were projects in Riyadh and the population density increased, and the streets could not accommodate the number of cars in them. hundreds of millions have been spent on bridges, tunnels, and roads, and we see that this is a form of renaissance and modernity, such that we find the first countries in the world that do not have this large amount of asphalt, which turned the city of Riyadh into a black city consisting of cars, sidewalks, and palm trees in an ugly view, and we fought mass transportation. A country considered a continent in which there is only “SAPTCO” for mass transportation around cities!! No trains, no metro. In contrast, in the poorest countries in the world, such as Abyssinia, we find that the metro has been operating there for decades! But what I want to add is that when we think about operating the metro in the future, we must not price its ticket at a high price, as everything is more expensive than everything around

us. This, and God and His Prophet know best. when planning is the most important thing to solve the problem, they do not have a major and permanent role in finding traffic solutions until after the problem occurs! This sector must be allocated to be profitable and capable of finding solutions while participating with international bodies - randomness and ministerial confusion between tourism and entertainment, attracting visas to the good and the bad, a terrible spread of violators in most neighborhoods of Riyadh, poor study and planning among them, lack of agreement with the Ministries of Interior and Foreign Affairs - failure to develop future plans for planning. Polarization and studying the challenges in transportation - in Arabic. The ministries must meet, study the situation, and come up with a sound and plan that benefits society and benefits the economy.

Traffic, Time Exposure and CO2 Emissions are dependent variable, and they are a result of the independent variable. Were inefficiency and Time (in minutes) being the dependent variable are the outcome of interest for the study, and the independent variables are the factors that may influence the outcome. For example, if we want to explore whether high traffic rate impact car incidence, traffic rate is the independent variable while car incidence is the dependent variable.

2 Chapter 2: Literature Review

2.1 Introduction

Certain unreasonable urban transportation policies and practices can cause traffic jams, demand a lot of time and energy, reduce the effectiveness of commuting, and increase weariness, tension, and anxiety. Additionally, heavy carbon dioxide emissions from motor vehicles and a packed and congested transportation planning environment may have a negative impact on commuter comfort.

2.2 The independent variable

2.2.1 Time index (in minutes)

People's daily time budgets are greatly reduced by commuting, which means they have less time for other, more enjoyable pursuits. The last time someone traveled, the longer they were away from home, must commit to other activities, which raises stress levels, deteriorates mental health, and has a negative effect on job satisfaction.

On the other hand, reduced travel times can promote more time spent sleeping and exercising, both of which are beneficial to one's physical and mental well-being.

2.2.2. The index of inefficiency

Inefficient transportation not only costs cities money, but it also pollutes the environment.

Enhancing public transportation, providing better service, and promoting non-motorized mobility can all help to increase or print transportation efficiency.

2.3 The dependent variable

2.3.1. Traffic index

Traffic jams lengthen travel times, make arrival times unpredictable, and lengthen car lines. It has also been discovered that traffic intersections are detrimental to society.

2.3.2 Time Exposure Index

Traffic commute times are thought to be a significant factor in an individual's quality of life, and more productive commutes will benefit travelers overall. Thus, in order to make commute time efficient, pleasant, and of high quality, urban design must take into account a plethora of amenities like sidewalks, bike lanes, and safe and comfortable bikes. Convenient public transit can also be a relief to those who make frequent, active excursions. To put it another way,

meaningful travel makes time spent traveling more valuable, which could lead to people feeling as though their journey is passing more quickly without actually cutting into their travel time.

2.3.3 Index of CO2 Emissions

Even in medium-sized cities, there is an increase in pollution due to traffic-related greenhouse gas emissions, such as CO2. As a result, numerous research are examining vehicle emissions in an attempt to find ways to reduce pollution.

2.4 The relationship between the independent and the dependent variables

Traffic, Time Exposure and CO2 Emissions are **dependent variable** and they are a result of the independent variable. Were inefficiency and Time (in minutes) being the dependent variable are the outcome of interest for the study, and the independent variables are the factors that may influence the outcome. For example, if we want to explore whether high traffic rate impact car incidence, traffic rate is the independent variable while car incidence is the dependent variable.

One strand of research has focused on the barriers and bridges to certain modes of transport. Derek Halden Consultancy (2003) examine car users' barriers to switching to the metro, BRT, walking or bicycling, and identify bridges that enable this switch. Blainey, Hickford, and Preston (2012) show that even when rail travel is the most cost-effective transport mode for a particular journey, many travelers still choose other modes. Thus, non-financial barriers to choosing rail transport exist. Blainey, Hickford, and Preston (2012) identify 37 distinct barriers divided into three broad groups,

Figure 1. Thirty-seven distinct barriers to modal shifts to rail.



Source: Blainey, Hickford, and Preston (2012).

Figure 1. Thirty-seven distinct barriers to modal shifts to rail.

Source: Blainey, Hickford, and Preston (2012).

as Figure 1 shows. These groups represent hard barriers (e.g., travel time, reliability and cost), soft barriers (e.g., comfort, information and security) and complementary barriers (e.g., weather and lifestyle). However, the concepts of ‘hard’ and ‘soft’ factors or measures are not yet clearly defined.

A consensus has formed that the former are more related to indicators and interventions on the supply side of the transport system. In contrast, the latter are more related to the demand side, which includes psychological and behavioral strategies (Queiroz, Celeste, and Moura 2020). Blainey, Hickford, and

Preston (2012) also identify four types of bridges. These are enhancing alternative modes, making car travel less attractive, ensuring efficient management and administration, and providing information on available modes.

Other studies have found that individuals' socioeconomic characteristics strongly affect their mode choices (Limtanakool, Dijst, and Schwanen 2006; Munshi 2016). For instance, income, car ownership, gender, age, household composition and lifestyle are robust and relevant predictors of mode

2.5 Conclusion

traffic is caused by the lack of organization and following basic rules of driving in the daily life. further research discovered that traffic is associated to lack of understanding of the city or environment with population increased, traffic increased. The direction of the relationship between population and traffic seems to be that population number (possibly based upon myths about traffic). Taken as a whole, it appears that exposing an increases of population would increases the problem there for it should be managed delicately. Future research should replicate these findings in more natural settings with different populations.

3 Research methodology

3.1 Introduction

This chapter outlines the research methodology employed to investigate (put the research title with the company name). It details the operational definitions for research variables, research design, research population & sampling methods and technique, data collection methods, types of data , and data analysis methods & procedures.

3.2 Operational definition for research variable

In research studies, operational definitions are key in clearly defining the variables being measured. An operational definition describes how a variable will be measured, observed, or manipulated. It helps researchers ensure that their studies are consistent, reliable, and valid.

This study examines how Quality Management, Planning, and Cost Management (independent variables) impact Project Management (dependent variable) in organizational settings.

3.2.1 The independent variable

1. Quality Management: The systematic process of ensuring that a project's deliverables meet specified quality standards and customer expectations.
2. Planning: The strategic process of defining project goals, outlining tasks, and establishing timelines and resources needed to achieve project objectives.
3. Cost Management: The practice of planning, estimating, budgeting, financing, funding, managing, and controlling costs throughout the project lifecycle.

3.2.2 The Dependent Variable:

Project Management: The application of knowledge, skills, tools, and techniques to project activities to meet project requirements and achieve specific goals within defined constraints.

3.3 Research design

- Research philosophy: Positivism
- Research approach: Deductive
- Research strategy: Case study
- Research choice: Mono Method
- Time horizon: Cross-sectional
- Data collection and analysis techniques: Questionnaires



3.4 Research population and sampling methods and technique

3.4.1 Research population

3.4.2 Research sample

3.4.3 Sampling method and techniques

The sampling method is probability and the sampling techniques is simple random sampling.

3.5 Data collection methods

The collected data will be analyzed Statistically. Statistical analysis involves identifying, analyzing, and turning raw data into useful information. This approach will help to uncover the key relationships between the Independent variable (cost, planning, and quality) and the Dependent variable (project management) at (the name of the company).

3.5.1 Independent variable

Variable	Dimension	Number of items
traffic management initiatives	Quality	3
	Planning	3
	Cost management	3

3.5.2 Dependent variable

	Dimension	Number of items
Project management	Project management	5

3.6 Types of data

This section contains two subheadings:

3.6.1 Primary data:

Primary data means that it is the data that the researcher collected from its primary sources. It is realistic and original data that expresses the problem of the study. The purpose of collecting primary data is to reach a solution to the research problem, as the primary data includes (interview, questionnaire, observation).

3.6.2 Secondary data:

o Secondary data means that data collected by other researchers. Secondary data is an analysis and interpretation of primary data, and the researcher collects it for purposes other than arriving at a solution to the research problem of scientific research. It may contain information on which to base writing scientific content. For research or the body of its scientific research, secondary data is represented in (books, articles, periodicals, and official reports).

3.7 Data Analysis Methods & Procedures

After collecting data, it is essential to analyze the information gathered to draw meaningful conclusions. As, the Statistical Package for the Social Sciences (SPSS), specifically version 28, were used to analyze the collected data. The sample profile test was conducted, via descriptive

analysis, to gain insights into the characteristics of the sample population. It helps researchers understand the demographics, preferences, and other relevant information about the individuals involved in the study. Validity and reliability tests are crucial in ensuring that the data collected is accurate and consistent. Validity tests (Exploratory factor analysis) to determine if the research instruments measure what they are intended to measure, while reliability tests (Cronbach's Alpha test) assess the consistency of results over time. The sample profile test was conducted, via descriptive analysis, to gain insights into the characteristics of the sample population. It helps researchers understand the demographics, preferences, and other relevant information about the individuals involved in the study

3.8 Conclusion

In conclusion, the methodology and research procedures outlined in this chapter provide a robust framework for investigating the impact of quality management, planning, and cost management on project management. These approaches ensure the reliability and validity of the study's findings, paving the way for meaningful insights and practical applications.

4 Chapter 4: Statistical analysis of the study results

4.1 Introduction

This chapter presents the results of the field study that were statistically analyzed using the statistical programs **SPSS** version **28**. The current chapter of statistical analysis includes descriptive statistics for the sample under study using **SPSS** version **28**. Testing the validity and reliability of the questionnaires used to collect the required data from the current study sample. In order to test the research hypotheses and the suitability of the model, simple linear regression analysis was conducted via **SPSS 28**.

4.2 Characteristics of the study sample.

The study sample was distributed according to gender - age group - number of years of experience -nature of work and educational level.

Frequencies and percentages were calculated for the study sample members and are represented by demographic information that includes:

Gender includes (male, female).

- The age group includes (less than 30 years, from 30 to 40 years, from 41 to 50 years, and more than 50 years).
- Nature of work, including (leaders/employees/technicians)
- Educational level, includes (secondary/university/postgraduate).

Table 1: Characteristics of the study sample

Variable	Variable classes	Number	percentage
Gender	Male	9	40.91
	Female	13	59.09
	Total	22	100
Age	Less than 30 years	5	22.73
	From 30 to 40 years	6	27.27
	From 41 to 50 years	7	31.82
	More than 50 years	4	18.18
	Total	22	100
Education level	Secondary	8	36.36
	University	10	45.45
	Postgraduate	2	9.09

	Total	22	100
Nature of work	Employee (private sector)	5	22.73
	Employee (government)	6	27.27
	Student	4	18.18
	Private job	4	18.18
	Not working	3	13.64
	total	22	100

1. Gender Distribution: The sample consists of a higher percentage of females (59.09%) compared to males (40.91%). This may indicate a greater representation of women using the metro system, which could reflect broader social trends or specific commuting needs in the city.

2. Age Composition: The age distribution shows a significant representation of individuals aged 41 to 50 years (31.82%), followed closely by those aged 30 to 40 years (27.27%). This suggests that middle-aged individuals are the primary users of the metro, potentially due to work-related commuting.

3. Education Levels: The majority of passengers hold a university degree (45.45%), followed by those with secondary education (36.36%). This indicates a relatively educated demographic using the metro, which may correlate with professional employment and commuting patterns.

4. Nature of Work: The data shows a diverse range of employment statuses, with government employees (27.27%) and private sector employees (22.73%) being the most represented. The presence of students (18.18%) also highlights the metro's role in facilitating access to educational institutions.

Overall, these findings provide valuable insights into the demographic characteristics of metro passengers in Riyadh, which can inform future urban planning, transportation policies, and service improvements to better meet the needs of this diverse population.

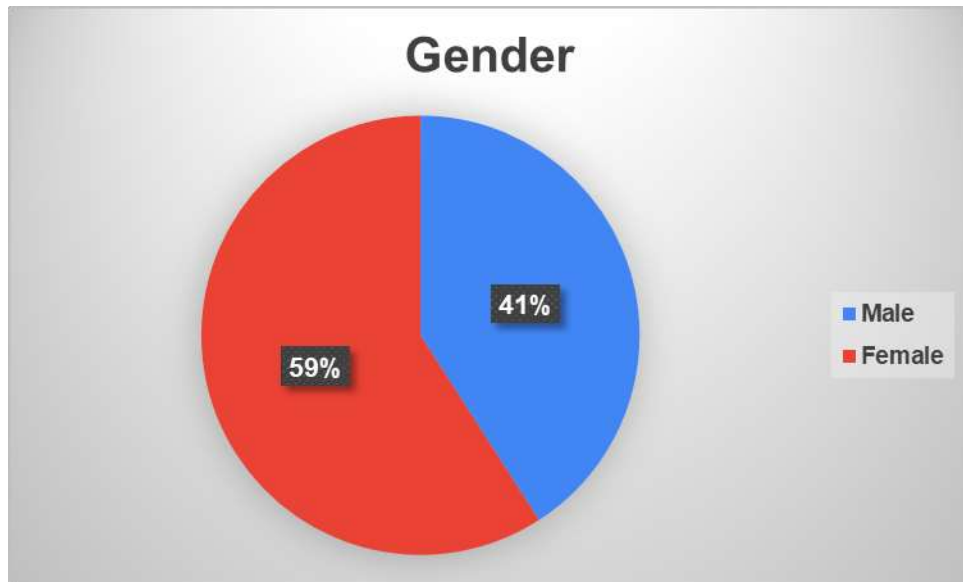


Figure 1: study sample gender

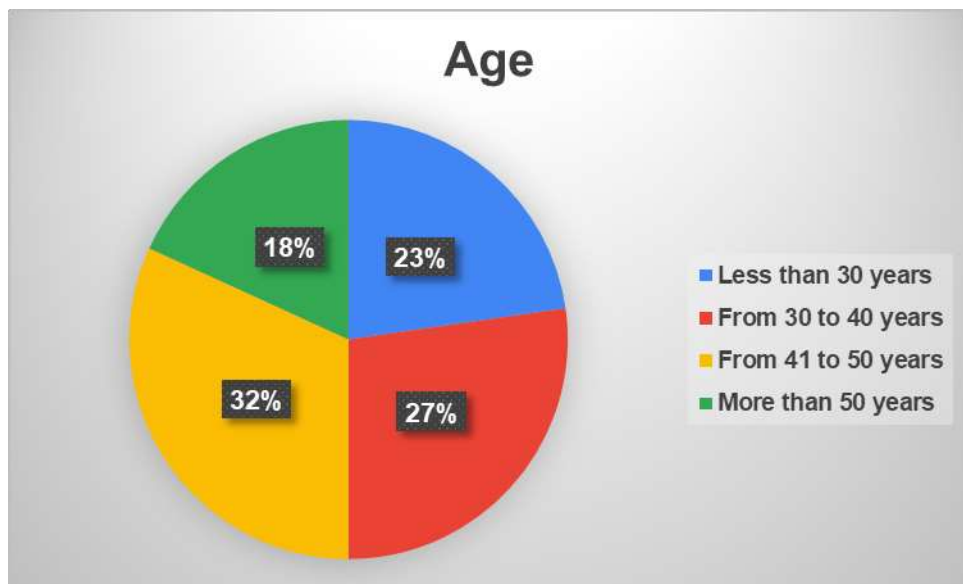


Figure 2: study sample age

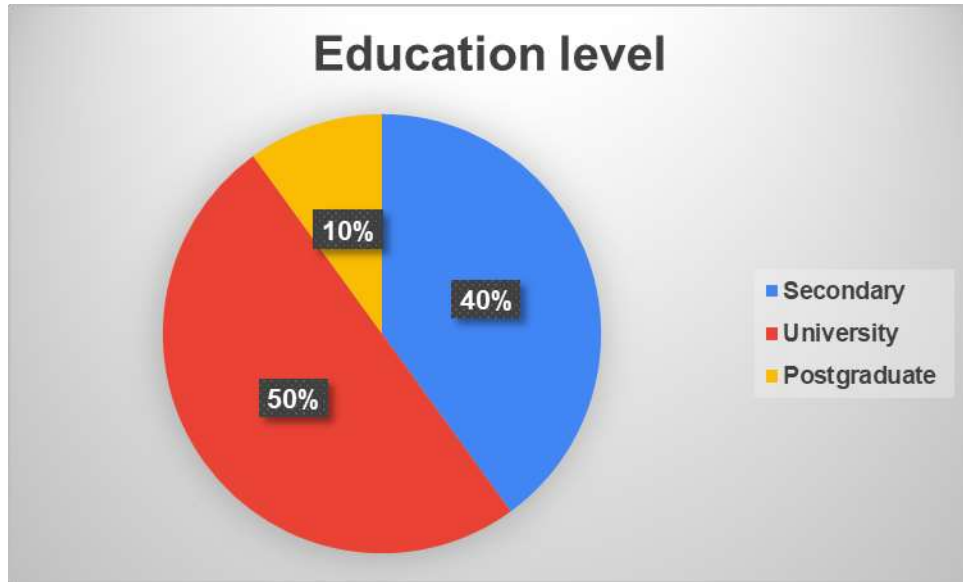


Figure 3: study sample education level

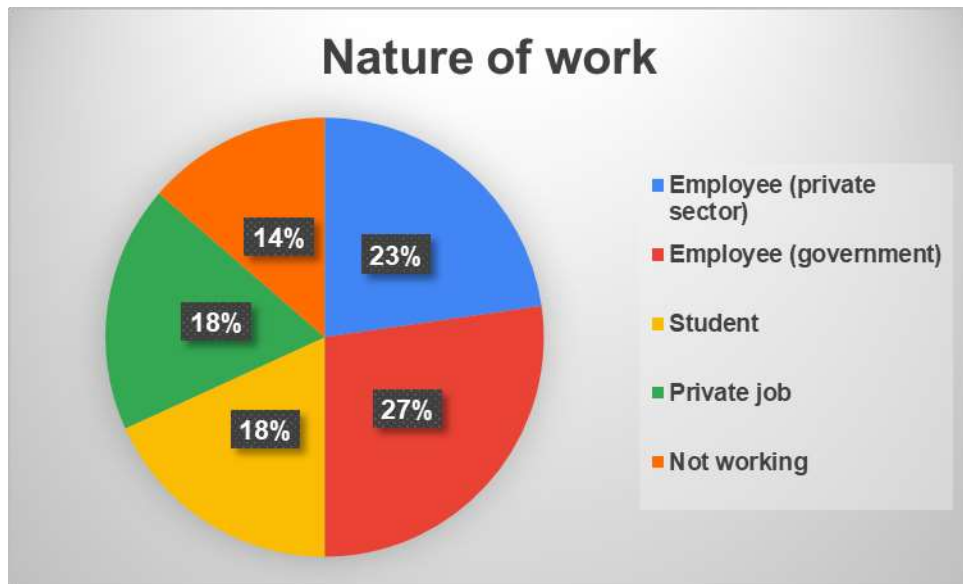


Figure 4: study sample nature of work

Table 2: personal information of the sample

Variable	Variable classes	Number	percentage
Are you a resident of Riyadh City?	Yes	10	45.45
	No	12	54.55
	Total	22	100
Do you own a personal car?	Yes	17	77.27

	No	5	22.73
	Total	22	100
Have you ever used the metro in any city worldwide?	Yes	15	68.18
	No	7	31.82
	Total	22	100
Do you feel a real need for a metro in Riyadh City	Yes	21	95.45
	No	1	4.55
	Total	22	100

The survey results indicate that a majority of respondents are not residents of Riyadh City, with 54.55% indicating "No." However, a significant portion, 77.27%, own a personal car, which suggests a reliance on personal vehicles for transportation. Despite this, a substantial 68.18% have used metro systems in other cities, highlighting some familiarity with public transit options. Notably, an overwhelming 95.45% of respondents express a real need for a metro system in Riyadh City, suggesting strong support for the development of public transit infrastructure in the area. This could reflect a desire for more efficient and sustainable transportation solutions to alleviate traffic congestion and improve urban mobility.

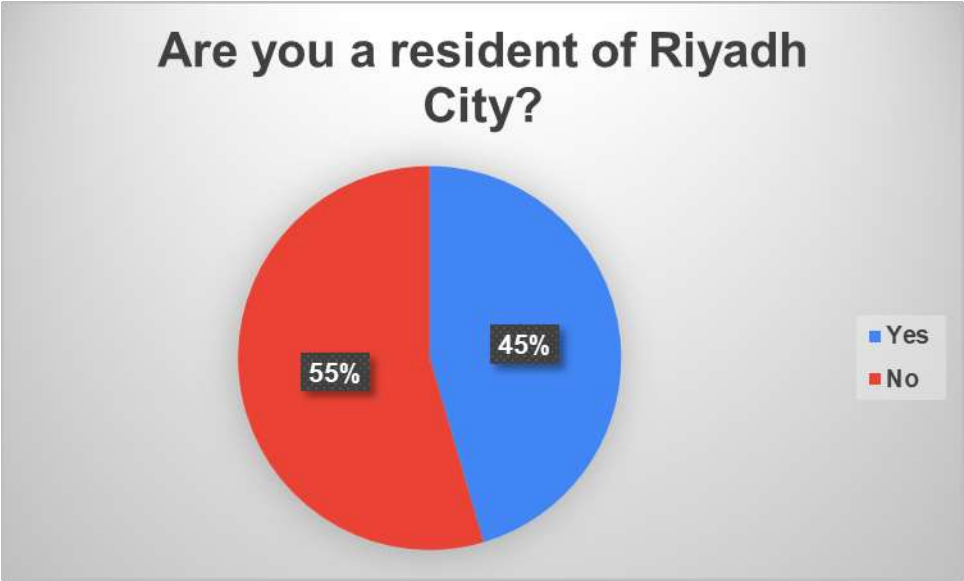


Figure 5: study sample residence

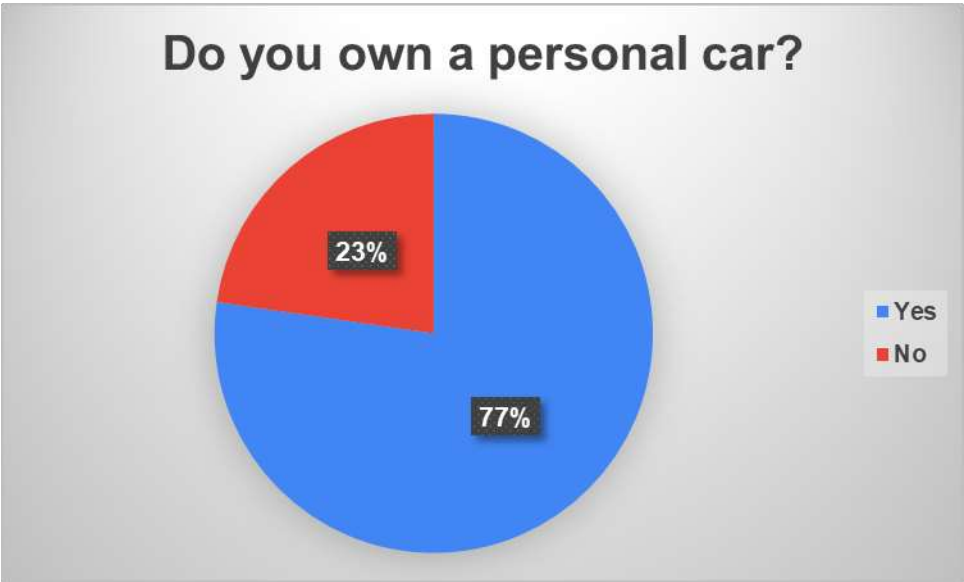


Figure 6: “do you own a personal car?”

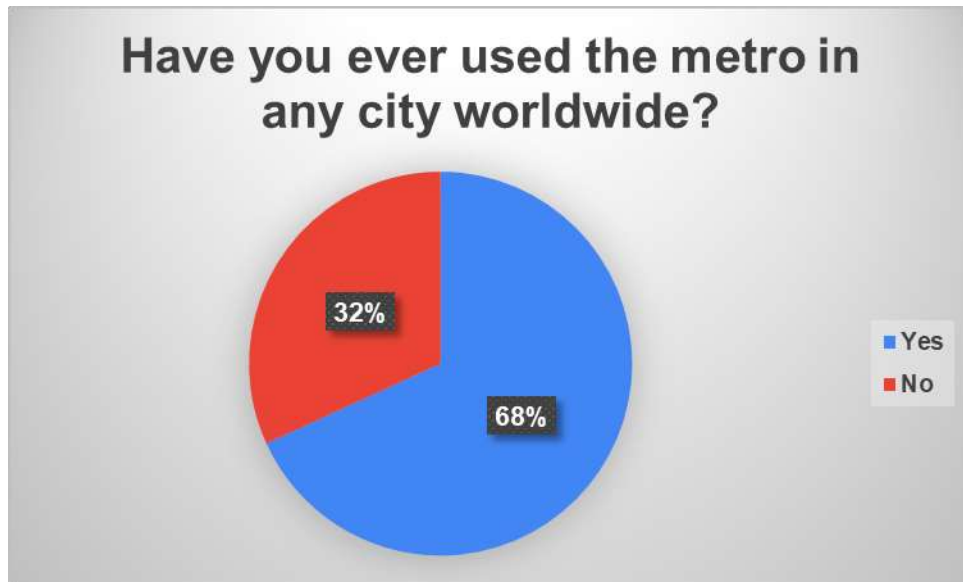


Figure 7: the use of metro

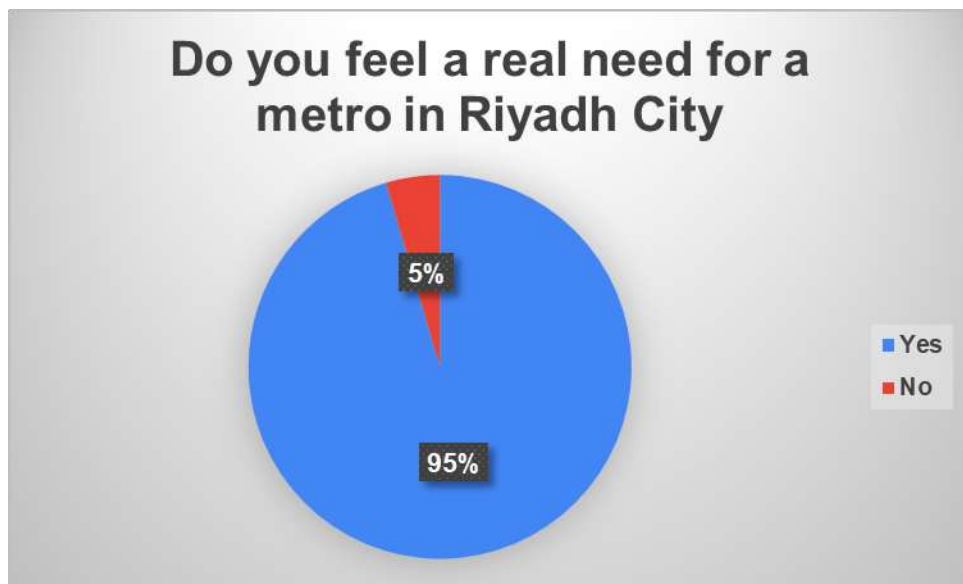


Figure 8: the need of metro in Riyadh

4.3 Measuring the validity and reliability of study instruments

In order to verify the validity and reliability of the measures used in the study, the internal consistency validity of the questionnaires used to measure the study variables was tested, in addition to measuring the convergent validity by measuring the Average Variance Extracted (AVE).

While the reliability of the measures used in the study was measured by Measuring the value of Cronbach's alpha, through the structural equation modeling (SEM), using the statistical analysis program SPSS version 28 .The following paragraphs and tables explain this.

4.3.1 Validity of the measures used in the study

The internal consistency validity of the scales used to measure the study variables was tested, in addition to measuring the convergent validity by measuring the average variance extracted.

Internal consistency validity: It means the extent to which each statement of the questionnaire is consistent with the variable to which it belongs. Therefore, the researcher measured the internal consistency of the questionnaires by calculating the correlation coefficients between the score of each statement and the total score of the variable to which it belongs. According to Kaiser (1974) study, a correlation coefficient of less than 0.5 is removed from the questionnaire.

Convergent Validity: The average variance between statements that measure the same scale is measured by calculating the average variance extracted (AVE), whose value must be greater than 0.5 according to Hair et al (2006). The following tables show the statistical results for (correlation coefficients, standard deviation, calculated T value, and P value between the score of each statement and the total score of the variable to measure the validity of the internal consistency of the questionnaires. Also, calculating the value of the average variance extracted (AVE) to measure the convergent validity of the questionnaires through the equation model. Structural SPSS version 28, as follows:

Table 3: Validity of the measures used in the study

Variable		statements	KMO	Factor leading	Standard deviation	P value	Average variance extracted	
traffic management initiatives	Quality	A1	0.372	0.716	1.23	0.01	3.80	3.55
		A2		0.738	1.26	0.01		
		A3		0.682	1.06	0.01		
	Planning	B1		0.878	1.27	0.01	3.29	
		B2		0.789	1.23	0.01		
		B3		0.727	1.30	0.01		

Project management	Cost management	C1	0.390	0.556	1.27	0.01	3.56	3.41
		C2		0.659	1.20	0.01		
		C3		0.682	0.99	0.01		
	Project management	X1	0.390	0.801	1.03	0.01	3.41	3.41
		X2		0.704	1.13	0.01		
		X3		0.852	1.24	0.01		
		X4		0.687	0.65	0.01		
		X5		0.535	0.84	0.01		

Based on the provided table and analysis:

1. Traffic Management Initiatives

- KMO Value: The KMO value for traffic management initiatives is 0.372, which is below the acceptable threshold of 0.5, indicating that the data may not be suitable for factor analysis[1][2].
- Factor Loadings: The factor loadings (A1: 0.716, A2: 0.738, A3: 0.682) are all above 0.7, suggesting strong correlations with their respective dimensions.
- Statistical Significance: All statements have a P value of 0.01, indicating statistical significance at a 1% level.
- Average Variance Extracted (AVE): The AVE is 3.55, which is above 0.5, demonstrating convergent validity.

2. Planning

- KMO Value: The KMO value for planning is not explicitly provided, but factor loadings (B1: 0.878, B2: 0.789, B3: 0.727) are strong, indicating good correlations.
- Statistical Significance: All statements have a P value of 0.01, showing statistical significance.
- AVE: The AVE is 3.29, supporting convergent validity.

3. Cost Management

- KMO Value: Not provided, but factor loadings (C1: 0.556, C2: 0.659, C3: 0.682) indicate moderate to strong correlations.
- Statistical Significance: All statements have a P value of 0.01.

- AVE: The AVE is 3.56, confirming convergent validity.

4. Project Management

- KMO Value: The KMO value for project management is 0.390, which is below the acceptable level, indicating potential issues with factor analysis suitability.
- Factor Loadings: The factor loadings (X1: 0.801, X2: 0.704, X3: 0.852, X4: 0.687, X5: 0.535) show strong correlations, except for X5, which is moderate.
- Statistical Significance: All statements have a P value of 0.01.
- AVE: The AVE is 3.41, indicating convergent validity.

Commentary

- The analysis shows that while the factor loadings and statistical significance are generally strong across all variables, the KMO values for "Traffic Management Initiatives" and "Project Management" are below the recommended threshold, suggesting that the data might not be ideal for factor analysis. However, the average variance extracted values indicate that the convergent validity of the scales is achieved, supporting the reliability of the questionnaire in measuring the intended constructs.

4.3.2 Reliability of the study tool

The stability of the questionnaire refers to the stability of the questionnaire results and their non-change significantly if they were redistributed to the sample individuals several times during specific time periods. To measure the stability of the questionnaires used to measure the study variables, Cronbach's alpha values were calculated using SPSS version 28. According to (2010) Hair et al, the value must be greater than 0.7 for the scale to be stable

Table 4: 4.3.2 Reliability of the study tool

	Variable	Number of statement	Cronbach's alpha	
traffic management initiatives	Quality	3	0.56	0.66
	Planning	3	0.76	
	Cost management	3	0.51	
Project management	Project management	5	0.72	0.72

The analysis of Cronbach's alpha values reveals varying levels of internal consistency across the dimensions of traffic management initiatives and project management. The "Planning" (0.76) and "Project Management" (0.72) dimensions demonstrate acceptable reliability, while the "Quality" (0.56) and "Cost Management" (0.51) dimensions show low internal consistency. This suggests that the items in the latter two dimensions may need revision to improve their effectiveness in measuring the intended constructs.

4.4 Descriptive analysis of the study variables

We start by mentioning the questionnaire answers, which are as follows:

Strongly agree	Agree	Neutral	Disagree	Strongly disagree
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Then the relative weight corresponding to each category is calculated by multiplying the arithmetic mean by $(100 \div 5)$, where 5 is the five point scale, And create a table To clarify the significance of arithmetic averages.

Level of importance	Relative eight%	Result (general trend)	Arithmetic mean
Very low	20- 35.99%	Strongly disagree	1-1.79
Low	36-51.99%	Disagree	1.80-2.59
Middle	52-67.99%	Neutral	2.60-3.39
High	68-83.99%	Agree	3.40-4.19
Very high	84-100%	Strongly agree	4.20-5

The following table shows the descriptive analysis of the study variables represented by the arithmetic means based on the five-point Likert scale and the standard deviations of the variables according to the table related to the importance of the arithmetic mean.

Table 5: 4.4 Descriptive analysis of the study variables

Variable		Arithmetic mean		Standard deviation		General trend		Importance level		
traf	fic	Quality	3.80	3.55	1.19	1.20	Agree	agree	High	High

	Planning	3.29		1.27		neutral		Middle	
	Cost manage ment	3.56		1.15		Agree		High	
Project management		3.42	3.41	0.98	0.98	Agree	Agree	High	High

The "Quality" dimension of traffic management initiatives has a high arithmetic mean of 3.80, indicating that respondents generally agree with the statements related to this dimension. The relatively low standard deviation of 1.19 suggests that there is some consistency in the responses, with most respondents having similar views. The high importance level underscores the significance that respondents place on quality in traffic management, highlighting it as a critical area of focus.

The "Planning" dimension has a mean of 3.29, which indicates a neutral stance among respondents. This suggests that opinions are more varied, with some agreeing and others possibly disagreeing with the statements. The standard deviation of 1.27 supports this variability. The middle importance level suggests that while planning is recognized as important, it may not be as prioritized as other dimensions.

Respondents generally agree on the importance of cost management, as reflected by the mean of 3.56. The standard deviation of 1.15 indicates a moderate level of agreement among respondents. The high importance level suggests that managing costs effectively is seen as a crucial aspect of traffic management initiatives.

The "Project Management" dimension has a mean of 3.42, indicating that respondents generally agree with the statements related to this area. The lower standard deviation of 0.98 suggests a higher level of consensus among respondents compared to other dimensions. The high importance level reflects the critical role that effective project management plays in the successful implementation of initiatives.

The data reveals that respondents generally agree on the importance of quality, cost management, and project management within traffic management initiatives, with these areas being rated as highly important. Planning, while still important, is perceived with more neutrality, indicating potential areas for improvement or further exploration. The

consistency in responses, particularly in project management, suggests a strong consensus on its significance. This analysis highlights key areas of focus for stakeholders aiming to enhance traffic management and project execution.

4.5 Linear correlation coefficients between the study variables

Table 6: 4.5 Linear correlation coefficients between the study variables

	Quality	Planning	Cost management	Project management
Quality	1	0.475*	0.543**	0.53**
Planning	0.475*	1	0.513**	0.397*
Cost management	0.543**	0.513**	1	0.446*
Project management	0.53**	0.397*	0.446*	1

The correlation matrix highlights several key insights:

- Strong Positive Relationships: Quality has strong positive correlations with both Cost Management and Project Management, indicating that improvements in quality are likely to enhance these areas as well. Similarly, Planning shows a strong positive correlation with Cost Management.
- Moderate Positive Relationships: Planning and Quality, Planning and Project Management, and Cost Management and Project Management have moderate positive correlations, suggesting that while there is a positive relationship, it is not as strong as the other pairs.

These correlations suggest that focusing on enhancing quality and planning could have beneficial effects on cost management and project management, leading to overall improvements in these areas.

Respondents generally agree on the importance of cost management, as reflected by the mean of 3.56. The standard deviation of 1.15 indicates a moderate level of agreement among respondents. The high importance level suggests that managing costs effectively is seen as a crucial aspect of traffic management initiatives.

The "Project Management" dimension has a mean of 3.42, indicating that respondents generally agree with the statements related to this area. The lower standard deviation of 0.98 suggests a higher level of consensus among respondents compared to other dimensions. The high importance level reflects the critical role that effective project management plays in the successful implementation of initiatives.

The data reveals that respondents generally agree on the importance of quality, cost management, and project management within traffic management initiatives, with these areas being rated as highly important. Planning, while still important, is perceived with more neutrality, indicating potential areas for improvement or further exploration. The consistency in responses, particularly in project management, suggests a strong consensus on its significance. This analysis highlights key areas of focus for stakeholders aiming to enhance traffic management and project execution.

4.6 Results of testing the validity of the study hypotheses

-(H0): There is no statistically significant impact of traffic management initiatives on project management.

-(H1): There is a statistically significant impact of traffic management initiatives on project management.

Table 7: 4.6 Results of testing the validity of the study hypotheses

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.518a	0.268	0.232	1.07899

a. Predictors: (Constant), project management

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	8.534	1	8.534	7.33	.014b
	Residual	23.284	20	1.164		
	Total	31.818	21			

a. Dependent Variable: project management

b. Predictors: (Constant), traffic management initiatives

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	0.531	1.269		0.418	0.68
	project management	0.888	0.328	0.518	2.707	0.014

a. Dependent Variable: traffic management initiatives

The results of the regression analysis provide insight into the relationship between traffic management initiatives and project management:

- The correlation coefficient (R) is 0.518, indicating a moderate positive relationship between traffic management initiatives and project management.
- The R Square value is 0.268, meaning that approximately 26.8% of the variance in project management can be explained by traffic management initiatives. This suggests a moderate level of explanatory power for the model.
- The F-statistic is 7.33 with a significance level (Sig.) of 0.014. Since the p-value (0.014) is less than the common alpha level of 0.05, we reject the null hypothesis. This indicates that the model is statistically significant, and there is evidence of a significant impact of traffic management initiatives on project management. The unstandardized coefficient (B) for project management is 0.888, suggesting that for every one-unit increase in traffic management initiatives, project management increases by 0.888 units.
- The standardized coefficient (Beta) is 0.518, reinforcing the moderate positive relationship. The t-value is 2.707 with a significance level (Sig.) of 0.014, which is below 0.05, further supporting the rejection of the null hypothesis.

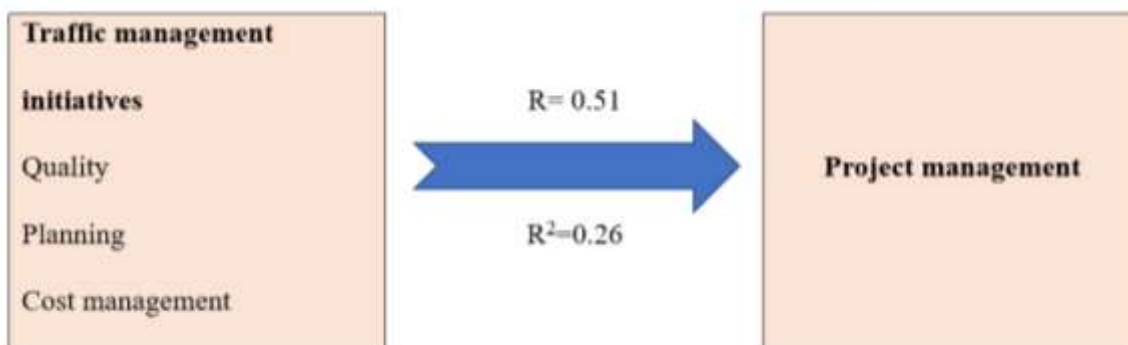


Figure 9: research modle

4.7 Conclusion

The regression analysis indicates that traffic management initiatives have a statistically significant impact on project management. The moderate positive relationship suggests that improvements in traffic management initiatives are associated with enhancements in project management. This finding emphasizes the importance of focusing on traffic management as a means to improve overall project management outcomes.

5 Chapter 5: Findings Discussion and Conclusion

5.1 Introduction

This chapter deals with the theoretical contribution and practical applications of the study, in addition to the Recommendations, study's limitations, Future studies, and the conclusion, as follows:

5.2 Theoretical Contribution

The researcher employed a novel approach in selecting the research variables for this study on the role of quality, planning, and cost management in project management, focusing on the Riyadh Metro Projects. As these variables had not been previously linked in a single research model, or the existing literature connecting them was limited and insufficient, the researcher was able to construct a unique theoretical framework. This approach enhanced the theoretical understanding of the study variables, allowing for the determination of appropriate dimensions and methodology to achieve the study's objectives. The researcher identified questionnaires as the most suitable tool for collecting data from the study sample, given the nature of the Riyadh Metro Projects and the specific context of project management in Saudi Arabia. This methodology enabled a comprehensive examination of how quality, planning, and cost management interact and influence project management outcomes in large-scale infrastructure projects like the Riyadh Metro, contributing valuable insights to both theoretical knowledge and practical applications in the field of project management.

5.3 Practical Applications

The importance of this research lies in its practical application to the Riyadh Metro Projects. The project management team can, for example, benefit from the research results in developing more efficient project planning strategies and meeting stakeholder needs. In addition, they can invest in artificial intelligence technology to improve quality management processes, which contributes to reducing costs and enhancing overall project outcomes. The Riyadh Metro Projects can also establish partnerships with technology startups to adopt the latest AI-driven planning and cost management tools. These applications can lead to more accurate project timelines, better resource allocation, and improved risk management. Furthermore, the integration of AI in quality control can help identify potential issues early, ensuring higher standards of construction and passenger safety. By leveraging these practical applications, the Riyadh Metro Projects can potentially set new benchmarks for large-scale infrastructure projects in terms of efficiency, quality, and cost-effectiveness.

5.4 Recommendations

In light of the study results, the researcher recommends the following:

- The necessity of raising awareness about the concept of integrated project management that combines quality, planning, and cost management as interconnected elements for project success.
- The necessity of encouraging project managers to use advanced AI-driven tools and techniques for more accurate planning, quality control, and cost estimation in large-scale infrastructure projects like the Riyadh Metro.
- The necessity of providing comprehensive training programs for project teams on the latest project management methodologies that incorporate AI and data analytics for improved decision-making.
- The researcher suggests that the Riyadh Metro Projects establish a dedicated innovation unit to continuously explore and implement emerging technologies in project management, ensuring the project stays at the forefront of efficiency and quality.
- It is recommended to develop a standardized framework for quality, planning, and cost management that can be applied across similar large-scale infrastructure projects in Saudi Arabia.
- The necessity of implementing a robust feedback system that allows for continuous improvement in project management practices based on real-time data and AI-driven insights.
- The researcher suggests that the Riyadh Metro Projects collaborate with academic institutions to foster research and development in AI applications for project management, potentially leading to innovative solutions for future projects.

5.5 Study's limitations

5.5.1 Objective Boundaries:

The study is limited to examining the reality of project management with a focus on three main variables and their dimensions:

1. Quality management and its dimensions (e.g., quality planning, quality assurance, quality control)

2. Planning management and its dimensions (e.g., scope planning, schedule management, resource planning)
3. Cost management and its dimensions (e.g., cost estimation, budgeting, cost control)

5.5.2 Human Boundaries:

The study is limited to a sample of project managers, engineers, and administrative staff directly involved in the Riyadh Metro Projects. This includes personnel from various levels of management and different project phases.

5.5.3 Spatial Boundaries:

The study is limited to the geographical scope of the Riyadh Metro Projects in Riyadh City, Kingdom of Saudi Arabia. This includes all active construction sites, planning offices, and administrative centers directly associated with the metro project.

5.5.4 Temporal Boundaries:

The study will be conducted within the course of the 2024 calendar year, focusing on the current phase of the Riyadh Metro Projects and considering data from the project's inception to the present date.

5.6 Future studies

Through the results reached by this study, which showed the close relationship between quality management, planning management, cost management, and their impact on overall project management in the context of the Riyadh Metro Projects, the researcher recommends that future studies:

1. Expand the scope to include other large-scale infrastructure projects in Saudi Arabia or the Gulf region to compare and validate the findings of this study.
2. Focus on one of the sub-hypotheses, such as the specific impact of AI-driven quality management tools on project outcomes, and its relationship to the study questions proposed by the researchers.
3. Conduct longitudinal studies to assess the long-term effects of integrated quality, planning, and cost management approaches on project success rates and stakeholder satisfaction.
4. Investigate the potential of emerging technologies, such as blockchain or Internet of Things (IoT), in enhancing project management practices for complex infrastructure projects.

5. Examine the cultural and organizational factors that influence the adoption and effectiveness of advanced project management techniques in the Saudi Arabian context.
6. Analyze the role of human factors and leadership styles in successfully implementing integrated quality, planning, and cost management strategies.
7. Explore the environmental and sustainability aspects of project management in large-scale infrastructure projects and their relationship with quality, planning, and cost management.

5.7 Conclusion

This research aimed to study the impact of quality, planning, and cost management on project management, specifically in the context of the Riyadh Metro Projects in Saudi Arabia. The study sought to provide a detailed analysis of how these three critical aspects of project management interact and influence the overall success of large-scale infrastructure projects.

The research began by examining the theoretical foundations of quality management, planning management, and cost management in the context of project management. It then explored how these concepts are applied in practice, particularly in complex, multi-year infrastructure projects like the Riyadh Metro. The study utilized a mixed-methods approach, combining quantitative data analysis with qualitative insights from project managers and key stakeholders.

The results revealed a strong positive relationship between the integrated application of quality, planning, and cost management techniques and improved project outcomes. Specifically, the study found that projects which implemented comprehensive quality management systems, coupled with advanced planning tools and robust cost control measures, were more likely to meet their objectives in terms of timelines, budgets, and stakeholder satisfaction.

The research also showed that the adoption of artificial intelligence (AI) and data analytics in project management processes significantly enhanced decision-making capabilities. AI-driven tools were particularly effective in improving risk assessment, resource allocation, and quality control processes. This technological integration allowed project managers to anticipate potential issues proactively and make data-informed decisions, leading to more efficient project execution. Furthermore, the study highlighted the importance of stakeholder engagement and communication in the success of large-scale projects. Projects that maintained transparent communication channels and actively involved stakeholders in decision-making processes demonstrated higher levels of public support and smoother implementation.

An unexpected finding of the research was the significant role of cultural factors in the adoption and effectiveness of advanced project management techniques. The study revealed that successful implementation of integrated quality, planning, and cost management approaches required not only technological solutions but also a shift in organizational culture towards data-driven decision-making and continuous improvement.

Based on these results, it is recommended that companies and government entities involved in large-scale infrastructure projects invest more in advanced project management technologies, particularly those leveraging AI and data analytics. This investment should focus on integrating quality, planning, and cost management systems to create a holistic approach to project management. Additionally, organizations should prioritize the development of a data-driven culture and provide comprehensive training programs to ensure that project teams can effectively utilize these advanced tools.

It is also suggested to conduct future studies to evaluate the long-term impact of using integrated AI-driven project management systems on the overall success and sustainability of infrastructure projects. These studies should consider not only the immediate project outcomes but also the long-term economic, social, and environmental impacts of such projects.

Moreover, future research should explore the potential of emerging technologies such as blockchain and the Internet of Things (IoT) in further enhancing project management practices. These technologies could potentially offer new solutions for transparency, traceability, and real-time monitoring in complex projects.

In conclusion, this study has demonstrated the critical importance of integrating quality, planning, and cost management in large-scale infrastructure projects. The findings from the Riyadh Metro Projects provide valuable insights that can be applied to similar projects globally. As cities worldwide continue to invest in major infrastructure developments, the lessons learned from this research can contribute to more efficient, cost-effective, and successful project outcomes.

The study also underscores the transformative potential of AI and data analytics in project management. As these technologies continue to evolve, they promise to revolutionize how large-scale projects are planned, executed, and managed. However, the research also highlights that successful implementation of these advanced techniques requires a holistic approach that considers technological, organizational, and cultural factors.

Finally, this study serves as a foundation for future research in the field of project management for large-scale infrastructure projects. By continuing to explore the interplay between quality, planning, and cost management, and by leveraging emerging technologies, future studies can further refine best practices and contribute to the successful delivery of complex projects that shape our urban landscapes and improve quality of life for millions of people.

6 References

- Aldalbahi, Majid, and Guy Walker. 2016. "Riyadh Transportation History and Developing Vision." *Procedia-Social and Behavioral Sciences* 216:163– 71.
<https://doi.org/10.1016/j.sbspro.2015.12.024>
- Al-Fouzan, Saleh Abdulaziz. 2012. "Using Car Parking Requirements to Promote Sustainable Transport Development in the Kingdom of Saudi Arabia." *Cities* 29(3):201–11.
<https://doi.org/10.1016/j.cities.2011.08.009>
- Almannaa, Mohammed Hamad, Faisal Adnan Alsahhaf, Huthaifa I. Ashqar, Mohammed Elhenawy, Mahmoud Masoud, and Andry Rakotonirainy. 2021. "Perception Analysis of E-scooter Riders and Non-riders in Riyadh, Saudi Arabia: Survey Outputs." *Sustainability* 13(2):863. <http://dx.doi.org/10.3390/su13020863>
- Alqahtani, Mohammed A., Ali H. Al-Badi, and Pam J. Mayhew. 2012. "The Enablers and Disablers of E-commerce: Consumer" Perspectives." *The Electronic Journal of Information Systems in Developing Countries* 54(1):1–25.. <https://doi.org/10.1002/j.1681-4835.2012.tb00380.x>
- Al-Qarawi, Najah, Maria Kamargianni. 2018. "She Drives KSA - Phase 1 Survey Report. September 26. Accessed October 12, 2022. https://www.iau.edu.sa/sites/default/files/resources/she_drives_report_survey_results_0.pdf
- Alqhatani, M., Bajwa, S., Setunge, S. 2013. "Modeling the Influence of Socioeconomic and Land-use Factors on Mode Choice: A Comparison of Riyadh, Saudi Arabia, and Melbourne, Australia." *International Journal of Environmental, Chemical, Ecological, Geological and Geophysical Engineering* 7(2):91–103. <https://doi.org/10.5281/zenodo.1089371>
- amos, a., Bullock, D. & Sondhi, j., High-Speed Rail: The Fast Track to Economic Development? china: The World Bank, 2010.
- Asensio, Javier. 2002. "Transport Mode Choice by Commuters to Barcelona's CBD." *Urban Studies* 39(10):1881–95. <https://doi.org/10.1080/0042098022000003000>
- Ashalatha, R., V. S. Manju, and Arun Baby Zacharia. 2013. "Mode Choice Behavior of Commuters in Thiruvananthapuram City." *Journal of Transportation Engineering* 139(5):494–502. [https://doi.org/10.1061/\(ASCE\)TE.1943-5436.0000533](https://doi.org/10.1061/(ASCE)TE.1943-5436.0000533)
- Barnett, Anwar, AHM Mehbub, and Jie Yang. 2017. "Examining the Effects of Transport Policy on Modal Shift from Private Car to Public Bus." *Procedia Engineering* 180:1413–22.
<https://doi.org/10.1016/j.proeng.2017.04.304>
- Bartels, Clare, Tracy Kolbe-Alexander, Roger Behrens, Sharief Hendricks, and Estelle V. Lambert. 2016. "Can the Use of Bus Rapid Transit Lead to a Healthier Lifestyle in Urban South Africa? The SUN Study." *Journal of Transport & Health* 3(2):200–10.
<https://doi.org/10.1016/j.jth.2016.04.003>

- Basheer, Muhammad Aamir, Luuk Boelens, and Rob van der Bijl. 2020. "Bus Rapid Transit System: A Study of Sustainable Land-use Transformation, Urban Density and Economic Impacts." *Sustainability* 12(8):3376. <https://doi.org/10.3390/su12083376>
- Boulderstone hornibrook, Project Traffic Management Plan for Design and construction of the Port Botany expansion Project, 2008.
- BeijingOlympicVillagerailLinkconstruction,railway-technology.com,availableat <http://www.railway-technology.com/projects/beijing-metro/> (accessed December 2013).
- Bhat, Chandra R., and Rupali Sardesai. 2006. "The Impact of Stop-making and Travel Time Reliability on Commute Mode Choice." *Transportation Research Part B: Methodological* 40(9):709–30. <https://doi.org/10.1016/j.trb.2005.09.008>
- Bhat, Chandra R., and Sujit K. Singh. 2000. "A Comprehensive Daily Activity-travel Generation Model System for Workers." *Transportation Research Part A: Policy and Practice* 34(1):1–22. [https://doi.org/10.1016/S0965-8564\(98\)00037-8](https://doi.org/10.1016/S0965-8564(98)00037-8)
- Blainey, Simon, Adrian Hickford, and John Preston. 2012. "Barriers to Passenger Rail Use: A Review of the Evidence." *Transport Reviews* 32(6):675–96. <https://doi.org/10.1080/01441647.2012.743489>
- Boile, Maria P., Lazar N. Spasovic, and Athanassios K. Bladikas. 1995. "Modeling Intermodal Auto-rail Commuter Networks." *Transportation Research Record* 1516:38–47. https://www.researchgate.net/publication/239915724_Modeling_intermodal_auto-rail_commuter_networks
- Buehler, Ralph. 2011. "Determinants of Transport Mode Choice: A Comparison of Germany and the USA." *Journal of Transport Geography* 19(4):644– 57. <https://doi.org/10.1016/j.jtrangeo.2010.07.005>
- Bus rapid Transit System [BrT] and road Safety, available at <http://www.arrivealive.co.za/pages.aspx?i=2874> (accessed january 2014)
- Businge, Corine Nsangwe, Silvano Viani, Nicola Pepe, Marco Borgarello, Carlo Caruso, Giuseppe Tripodi, and Stefania Soresinetti. 2019. "Energy Efficiency Solutions for Sustainable Urban Mobility: Case Study of the Milan Metropolitan Area." *Urban Transport XXIV* 182:151–63. <https://doi.org/10.2495/ut180151>
- Cervero, Robert. 2002. "Built Environments and Mode Choice: Toward a Normative Framework." *Transportation Research Part D: Transport and Environment* 7(4):265–84. [https://doi.org/10.1061/\(ASCE\)TE.1943-5436.0000533](https://doi.org/10.1061/(ASCE)TE.1943-5436.0000533)
- Chakrabarti, Sandip. 2017. "How Can Public Transit Get People out of Their Cars? An Analysis of Transit Mode Choice for Commute Trips in Los Angeles." *Transport Policy*. 54:80–9. <https://doi.org/10.1016/j.tranpol.2016.11.005>
- Chang, Justin S. 2006. "Models of the Relationship Between Transport and Land-use: A Review." *Transport Reviews* 26(3):325–50. <https://doi.org/10.1080/01441640500468432>
- Chatman, Daniel G. 2013. "Does TOD Need the T? On the Importance of Factors Other Than

- Rail Access.” *Journal of the American Planning Association* 79(1):17–31.
<https://doi.org/10.1080/01944363.2013.791008>
- Chen, Cynthia, and Claire E. McKnight. 2007. “Does the Built Environment Make a Difference? Additional Evidence from the Daily Activity and Travel Behavior of Homemakers Living in New York City and Suburbs.” *Journal of Transport Geography* 15(5):380–95.
<https://doi.org/10.1016/j.jtrangeo.2006.11.010>
- Cheng, Long, Xuewu Chen, Shuo Yang, Haixiao Wang, and Jingxian Wu. 2016. “Modeling Mode Choice of Low-income Commuters with Sociodemographics, Activity Attributes, and Latent Attitudinal Variables: Case Study in Fushun, China.” *Transportation Research Record* 2581(1):27–36. <https://doi.org/10.3141/2581-04>
- Crane, Randall, and Richard Crepeau. 1998. “Does Neighborhood Design Influence Travel? A Behavioral Analysis of Travel Diary and GIS Data.” *Transportation Research Part D: Transport and Environment* 3(4):225–38. [https://doi.org/10.1016/S1361-9209\(98\)00001-7](https://doi.org/10.1016/S1361-9209(98)00001-7)
- Cuenot, Francois, Lew Fulton, and John Staub. 2012. “The Prospect for Modal Shifts in Passenger Transport Worldwide and Impacts on Energy Use and CO₂.” *Energy Policy* 41:98–106. <https://doi.org/10.1016/j.enpol.2010.07.017>
- De Donnea, François Xavier. 1972. “Consumer Behaviour, Transport Mode Choice and Value of Time: Some Micro-economic Models.” *Regional*
- De Witte, Astrid, Joachim Hollevoet, Frédéric Dobruszkes, Michel Hubert, and Cathy Macharis. “Linking Modal Choice to Motility: A Comprehensive Review.” *Transportation Research Part A: Policy and Practice* 49:329–41. <https://doi.org/10.1016/j.tra.2013.01.009>
- Derek Halden Consultancy. 2003. “Barriers to Modal Shift. Final Report for Scottish Executive.” Accessed August 19, 2021. https://www.academia.edu/3322397/Barriers_to_modal_shift
- Development-oriented Transit Investment: Decoding Metro Station Location Selection in Shenzhen.” *Transport Policy* 51:93–102 <https://doi.org/10.1016/j.tranpol.2016.04.004>
- Dickerson, Anne E., Lisa J. Molnar, David W. Eby, Geri Adler, Michel Bedard, Marla Berg-Weger, Sherrilene Classen, Daniel Foley, Amy Horowitz, Helen Kerschner, Oliver Page, Nina M. Silverstein, Loren Staplin, Leonard Trujillo. 2007. “Transportation and Aging: A Research Agenda for Advancing Safe Mobility.” *The Gerontologist* 47(5):578–90.
<https://doi.org/10.1093/geront/47.5.578>
- Ding, Chuan, Donggen Wang, Chao Liu, Yi Zhang, and Jiawen Yang. 2017. “Exploring the Influence of Built Environment on Travel Mode Choice Considering the Mediating Effects of Car Ownership and Travel Distance.” *Transportation Research*
- Ding, Ling, and Ning Zhang. 2017. “Estimating Modal Shift by Introducing Transit Priority Strategies under Congested Traffic Using the Multinomial Logit Model.” *KSCE Journal of Civil Engineering*. 21(6):2384–92. <https://doi.org/10.1007/s12205-016-0640-0>

- Fraszczyk, Anna, Waersara Weerawat, and Phumin Kirawanich. 2019. "Commuters' Willingness to Shift to Metro: A Case Study of Salaya, Thailand." *Urban Rail Transit* 5(4):240–253. [https://doi.org/10.1016/0094-1190\(77\)90022-5](https://doi.org/10.1016/0094-1190(77)90022-5)
- Georggi, Nevine Labib, and Ram M. Pendyala. 2001. "An Analysis of Long-distance Travel Behavior of the Elderly and the Low-income." *Transportation Research E-Circular: Personal Travel – The Long and Short of It*, Conference Proceedings, Washington D.C., June 28–July 1, 1999. <https://trid.trb.org/view/686685>
- Gillen, David W. 1977. "Estimation and Specification of the Effects of Parking Costs on Urban Transport Mode Choice." *Journal of Urban Economics* 4(2):186–99. [https://doi.org/10.1016/0094-1190\(77\)90022-5](https://doi.org/10.1016/0094-1190(77)90022-5)
- Giuliano, Genevieve, and Joyce Dargay. 2006. "Car Ownership, Travel and Land Use: A Comparison of the U.S. and Great Britain." *Transportation Research Part A: Policy and Practice* 40(2):106–24. <https://doi.org/10.1016/j.tra.2005.03.002>
- Hensher, David A., John M. Rose, John M. Rose, and William H. Greene. 2005. *Applied Choice Analysis: A Primer*. Cambridge, U.K.: Cambridge University Press. <https://doi.org/10.1017/CBO9780511610356>
- Hollevoet, Joachim, Astrid De Witte, and Cathy Macharis. 2011. "Improving Insight in Modal Choice Determinants: An Approach Towards More Sustainable Transport." *Urban Transport XVII: Urban Transport and the Environment in the 21st Century*. 116:129–41. <https://doi.org/10.2495/ut110121>
- house of commons Transport committee, Transport for the London 2012 Olympic and Paralympic games: The Draft Transport Plan: Olympic Delivery authority response to the committee's Third report of Session 2006–07, 2007. <https://platform.almanhal.com/reader/2/128658> النقل ومشكلات الحركة في مدينة الرياض دراسة جغرافيا اعداد عبدالله هزاع الناصر
- International Association of Public Transport. 2018. "Statistics Brief: World Metro Figures 2018." Accessed December 31, 2020. https://cms.uitp.org/wp/wp-content/uploads/2020/06/Statistics-Brief-World-metro-figures-2018V3_WEB.pdf
- Johansson, Maria Vredin, Tobias Heldt, and Per Johansson. 2006. "The Effects of Attitudes and Personality Traits on Mode Choice." *Transportation Research Part A: Policy and Practice*. 40(6):507–25. <https://doi.org/10.1016/j.tra.2005.09.001>
- karim, a. & adeli, h., radial basis function neural network for work zone capacity and queue estimation. *Journal of Transportation Engineering*, **129**(5), 495–496, 2003. DOI: 10.1061/(aScE)0733-947X(2003)129:5(494).
- Kenworthy, Jeffrey R. 2020. "Passenger Transport Energy Use in Ten Swedish Cities: Understanding the Differences through a Comparative Review." *Energies* 13(14):3719. <https://doi.org/10.3390/en13143719>

- Khalili, Siavash, Eetu Rantanen, Dmitrii Bogdanov, and Christian Breyer. 2019. "Global Transportation Demand Development with Impacts on the Energy Demand and Greenhouse Gas Emissions in a Climate-constrained World." *Energies* 12(20):3870. <https://doi.org/10.3390/en12203870>
- Krishna, Ardra S., Jomy Thomas, and P. N. Salini. 2020. "Estimating Modal Shift of Home- based Work Trips Due to the Development of Kochi Metro and Reduction in Fuel Consumption and Emissions." In *Transportation Research*, edited by Tom V. Mathew, Gaurang J. Joshi, Nagendra R. Velaga, and Shriniwas Arkatkar, 229–42. Singapore: Springer Singapore. https://doi.org/10.1007/978-981-32-9042-6_18
- Kuhnimhof, Tobias, Ralph Buehler, Matthias Wirtz, and Dominika Kalinowska. 2012. "Travel Trends Among Young Adults in Germany: Increasing Multimodality and Declining Car Use for Men." *Journal of Transport Geography* 24:443–50. <https://doi.org/10.1016/j.jtrangeo.2012.04.018>
- Kwan, Soo Chen, Rosnah Sutan, and Jamal Hisham Hashim. 2018. "Trip Characteristics as the Determinants of Intention to Shift to Rail Transport Among Private Motor Vehicle Users in Kuala Lumpur, Malaysia." *Sustainable Cities and Society*
- Limtanakool, Narisra, Martin Dijst, and Tim Schwanen. 2006. "The Influence of Socioeconomic Characteristics, Land Use and Travel Time Considerations on Mode Choice for Medium- and Longer-distance Trips." *Journal of Transport Geography* 14(5):327–41. <https://doi.org/10.1016/j.jtrangeo.2005.06.004>
- London Olympics Transport upgrade, available at <http://www.railway-technology.com/projects/london-olympics/> (accessed january 2014).
- Mahmood, Haider, Tarek Tawfik Yousef Alkhateeb, and Maham Furqan. 2020. "Oil Sector and CO2 Emissions in Saudi Arabia: Asymmetry Analysis." *Palgrave Communications* 6(1):1–10. <https://doi.org/10.1057/s41599-020-0470-z>
- Marisamynathan, S., and P. Vedagiri. 2018. "Modeling Pedestrian Crossing Behavior and Safety at Signalized Intersections." *Transportation Research Record* 2672(31):76–86. <https://doi.org/10.1177/0361198118759075>
- Mehriar, Melika, Houshmand Masoumi, and Inmaculada Mohino. 2020. "Urban Sprawl, Socioeconomic Features, and Travel Patterns in Middle East Countries: A Case Study in Iran." *Sustainability*. 12(22):9620. <https://doi.org/10.3390/su12229620>
- Mingjun, L., Baohua, M., yu, h., jianpeng, Z. & Shaokuan, c., comparison of pre- & post-Olympic traffic: a case study of several roads in Beijing. *Journal of Transportation, Systems Engineering and Information Technology*, 8(6), 67–72, 2008. DOI: 10.1016/S1570-6672(09)60002-7.

- Mostofi, Hamid. 2022. "The Frequency Use and the Modal Shift to ICT-based Mobility Services." *Resources, Environment and Sustainability* 9:100076. <https://doi.org/10.1016/j.resenv.2022.100076>
- Muhsen, and Anvita Arora. 2022. "Urban Transport Energy Demand Model for Riyadh: Methodology and a Preliminary Analysis." *Urban, Planning and Transport Research* 10(1):253–73. <https://doi.org/10.1080/21650020.2022.2080106>
- Munshi, Talat. 2016. "Built Environment and Mode Choice Relationship for Commute Travel in the City of Rajkot, India." *Transportation Research Part D: Transport and Environment* 44:239–53. <https://doi.org/10.1016/j.trd.2015.12.005>
- NZ Transport agency, construction Traffic Management Plan, Mackays to Peka Peka expressway, 2013.
- Oakil, Abu Toasin Md, Dick Ettema, Theo Arentze, and Harry Timmermans. 2011. "A Longitudinal Analysis of the Dependence of the Commute Mode Switching Decision on Mobility Decisions and Life Cycle Events." In *Transportdynamics: Proceedings of 16th International Conference of Hong Kong Society for Transportation Studies (HKSTS)*, edited by Wai Yuen Szeto, Sze Chen Wong, and Nang Ngai Sze, 463–70. Hong Kong: Hong Kong Society for Transportation Studies. https://www.academia.edu/download/30259375/HKSTS123_Oakil_et_al.pdf
- Oakil, Abu Toasin Md, Dick Ettema, Theo Arentze, and Harry Timmermans. 2014. "Changing Household Car Ownership Level and Life Cycle Events: An Action in Anticipation or an Action on Occurrence." *Transportation* 41(4):889–904. <https://doi.org/10.1007/s11116-013-9507-0>
- Oakil, Abu Toasin Md, Dick Ettema, Theo Arentze, and Harry Timmermans. 2016. "Bicycle Commuting in the Netherlands: An Analysis of Modal Shift and Its Dependence on Life Cycle and Mobility Events." *International Journal of Sustainable Transportation* 10(4):376–84. <https://doi.org/10.1080/15568318.2014.905665>
- Oakil, Abu Toasin Md, Dorien Manting, and Hans Nijland. 2016. "Dynamics in Car Ownership: The Role of Entry into Parenthood." *European Journal of Transport and Infrastructure Research* 16(4):661–73. <https://doi.org/10.18757/ejtir.2016.16.4.3164>
- Oakil, Abu Toasin, AHM Mehbub Anwar, Alma Alhussaini, Nourah Al Hosain, Abdelrahman Opoku, Robert A., and Alhassan G. Abdul- Muhmin. 2010. "Housing Preferences and Attribute Importance Among Low-income Consumers in Saudi Arabia." *Habitat International* 34(2):219–27. <https://doi.org/10.1016/j.habitatint.2009.09.006>
- [org/10.1007/s40864-019-00113-3](https://doi.org/10.1007/s40864-019-00113-3)
- Part A: Policy and Practice 100:65–80. <https://doi.org/10.1016/j.tra.2017.04.008>
- Patterns. An International Review and Evaluation." *European Journal of Transport and Infrastructure Research* 1(2):113–41. <https://doi.org/10.18757/ejtir.2001.1.2.3497>
- Pinjari, Abdul Rawoof, Ram M. Pendyala, Chandra R. Bhat, and Paul A. Waddell. 2007. "Modeling Residential Sorting Effects to Understand the Impact of the Built

- Environment on Commute Mode Choice.” *Transportation* 34(5):557–73. <https://doi.org/10.1007/s11116-007-9127-7>
- Potter, Stephen. 2003. “Transport Energy and Emissions: Urban Public Transport.” In *Handbook of Transport and the Environment*, edited by David A. Hensher and Kenneth J. Button, Vol. 4., 247–62. Bingley: Emerald Group Publishing Limited. <https://doi.org/10.1108/9781786359513-013>
- Potter, Stephen. 2007. “Exploring Approaches Towards a Sustainable Transport System.” *International Journal of Sustainable Transportation* 1(2):115–31. <https://doi.org/10.1080/15568310601091999>
- Preference Heterogeneity in the Context of Agency Theory: Understanding and Minimising the Agency Problem.” *Urban, Planning and Transport Research* 4(1):26–45. <https://doi.org/10.1080/21650020.2016.1139465>
- Pucher, John, and John L. Renne. 2003. “Socioeconomics of Urban Travel: Evidence from the 2001 NHTS.” *Transportation Quarterly* 57(3):49– 77. <https://repository.difu.de/jspui/handle/difu/126088>
- Queiroz, Mariza Motta, Pedro Celeste, and Filipe Moura. 2020. “School Commuting: The Influence of Soft and Hard Factors to Shift to Public Transport.” *Transportation Research Procedia* 47:625–32. <https://doi.org/10.1016/j.trpro.2020.03.140>
- riyadh Metro Project Website, Saudi arabia, available at <http://riyadh-metro.com> (accessed 23 april 2017).
- riyadh Municipality, Saudi arabia, available at <https://www.alriyadh.gov.sa/en> (accessed 23 april 2017).
- Royal Commission for Riyadh City. 2022. “King Abdulaziz Project for Riyadh Public Transport.” Accessed August 29. <https://www.rcrc.gov.sa/en/projects/riyadh-metro>
- Satiennam, Thaned, Sittha Jaensirisak, Wichuda Satiennam, and Sumet Detdamrong. 2016. “Potential for Modal Shift by Passenger Car and Motorcycle Users Towards Bus Rapid Transit (BRT) in an Asian Developing City.” *IATSS Research* 39(2):121–9. <https://doi.org/10.1016/j.iatssr.2015.03.002>
- Schneider, Robert J. 2013. “Theory of Routine Mode Choice Decisions: An Operational Framework to Increase Sustainable Transportation.” *Transport Policy* 25:128–37. <https://doi.org/10.1016/j.tranpol.2012.10.007>
- Shaheen, Susan, and Adam Cohen. 2020. “Mobility on Demand (MOD) and Mobility as a Service (MaaS): Early Understanding of Shared Mobility Impacts and Public Transit Partnerships.” In *In Demand for Emerging Transportation Systems: Modeling Adoption, Satisfaction, and Mobility Patterns*, edited by Constantinos Antoniou, Dimitrios Efthymiou, and Emmanouil Chaniotakis, 37–59. Amsterdam: Elsevier. <https://doi.org/10.1016/B978-0-12-815018-4.00003-6>

- Shen, Junyi, Yusuke Sakata, and Yoshizo Hashimoto. 2009. "The Influence of Environmental Deterioration and Network Improvement on Transport Modal Choice." *Environmental Science & Policy* 12(3):338–46. <https://doi.org/10.1016/j.envsci.2009.01.003>
- Soummane, Salaheddine, Frédéric Gheri, and Julien Lefèvre. 2019. "Macroeconomic Pathways of the Saudi Economy: The Challenge of Global Mitigation Action Versus the Opportunity of National Energy Reforms." *Energy Policy* 130:263–82. <https://doi.org/10.1016/j.enpol.2019.03.062>
- South africa.info, available at <http://www.safrika.info/business/economy/infrastructure/transport.htm> (accessed December 2013).
- Stead, Dominic, and Stephen Marshall. 2001. "The Relationships Between Urban Form and Travel
- Ter Schure, Jessica, Francesca Napolitan, and Rick Hutchinson. 2012. "Cumulative Impacts of Carsharing and Unbundled Parking on Vehicle Ownership and Mode Choice." *Transportation Research Record* 2319(1):96–104. <https://doi.org/10.3141/2319-11>
- Train, Kenneth E. 2009. *Discrete Choice Methods with Simulation*. Cambridge: Cambridge University Press. <https://doi.org/10.1017/CBO9780511805271>
- university technology Malaysia, jalan iman , 81310 skudai, johor bahru, Malaysia, The impacted of transportation factors on the quality of life; insights from 230 cities worldwide (accessed 9 april 2024).
- Wang, Yuanqing, Lei Li, Zhicheng Wang, Ting Lv, and Li Wang. 2013. "Mode Shift Behavior Impacts from the Introduction of Metro Service: Case Study of Xi'an, China." *Journal of Urban Planning and Development* 139(3):216–25. [https://doi.org/10.1061/\(ASCE\)UP.1943-5444.0000148](https://doi.org/10.1061/(ASCE)UP.1943-5444.0000148)
- Washbrook, Kevin, Wolfgang Haider, and Mark Jaccard. 2006. "Estimating Commuter Mode Choice: A Discrete Choice Analysis of the Impact of Road Pricing and Parking Charges." *Transportation* 33(6):621–39. <https://doi.org/10.1007/s11116-005-5711-x>
- Wong, Ryan Cheuk Pong, Wai Yuen Szeto, Linchuan Yang, Yuen Chong Li, and Sze-Chun Wong. 2017. "Elderly Users' Level of Satisfaction with Public Transport Services in a High-density and Transit-oriented City." *Journal of Transport & Health* 7:209–17. <https://doi.org/10.1016/j.jth.2017.10.004>
- Yang, Jiawen, Junxian Chen, Xiaohui Le, and Qin Zhang. 2016. "Density-oriented Versus Ye, Mao, Yajing Chen, Guixin Yang, Bo Wang, and Qizhou Hu. 2020. "Mixed Logit Models for Travelers' Mode Shifting Considering Bike-sharing." *Sustainability* 12(5):2081. <https://doi.org/10.3390/su12052081>
- Youssef, Zaher, Habib Alshuwaikhat, and Imran Reza. 2021. "Modeling the Modal Shift Towards a More Sustainable Transport by Stated Preference in Riyadh, Saudi Arabia." *Sustainability* 13(1):337. <https://doi.org/10.3390/su13010337>
- yukun, j., analysis on Beijing subway flows during the 29th Olympics. *Journal of Transportation, Systems Engineering and Information Technology*, 8(6), 46–51, 2008.

7 Appendix

The questionnaire of the study

Kind regards,

This questionnaire aims to better understand the behavior of traffic of Riyadh city in kingdom of Saudi Arabia.

We will use the information collected through this survey to improve and better meet the needs of our customers.

The target audience are citizens of Riyadh city.

The questionnaire takes 10 minutes to complete and will be distributed online and by email.

1. Age: Age
2. Gender: Gender
3. Education Level: Education Level
4. Employment Status: Employment Status
5. Are you a resident of Riyadh City?
6. Do you own a personal car?
7. Have you ever used the metro in any city worldwide?
8. Do you feel a real need for a metro in Riyadh City?
9. Do you think that the metro system can serve all segments of society?
10. In your opinion, which is more important: (followed by a list of options, such as convenience, safety, etc.)
11. Based on your knowledge of the metro, do you think it saves you time in your commute within Riyadh City compared to a car?
12. If the metro system succeeds in Riyadh City, do you see the idea being transferred to major cities like Jeddah and Dammam?
13. What type of transportation do you usually use for your daily commute?
14. What are the main reasons for choosing this type of transportation?
15. Do you think the metro plays a role in improving the transportation experience?
16. Do you think the metro stations are sufficient or do they need an increase in the number of stations?
17. What are the benefits of the Riyadh Metro project?
18. To what extent are you satisfied with the Riyadh Metro? (likely followed by a Likert scale)

- 19. Using the Riyadh Metro to go to work: (yes/no)
- 20. Using the Riyadh Metro to go shopping: (yes/no)
- 21. The metro station is close to my residence: (yes/no)
- 22. I am satisfied with the number of daily trips of the Riyadh Metro: (yes/no)
- 23. The Riyadh Metro runs on schedule: (yes/no)
- 24. The Riyadh Metro provides good information when there is a problem on their lines: (yes/no)