THE EFFECT OF THE EXPANSION OF KING ABDUL-AZIZ INTERNATIONAL AIRPORT ON THE URBAN CONTEXT

A RESEARCH PAPER

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BY

IBRAHIM A. ALTASAN

PROF. FRANCIS PARKER - ADVISOR

PROF. MICHAEL BURAYIDI - CHAIRPERSON

BALL STATE UNIVERSITY

MUNCIE, INDIANA

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ABSTRACT

Expanding airports are a common thing that is currently occurring in many cities around the world. This massive airport expansion will lead to a wide range of implications and effects on many aspects such as land use, transportation, ownership, and housing prices. Therefore, the new expansion of King Abdul-Aziz International Airport in Jeddah, Saudi Arabia will impact the roads that lead to the airport especially on land use and transportation. This expansion is needed to be studied in order to minimize the negative impact and increase the positive impacts. A two airport expansion that occurred recently have been examined as a case study approach. As a result, the expansion will affect the land use on the roads that leading to the airport by making it compatible with airports such as hotels and commercial uses. The expansion will also affect the roads by making all the intersections free by building tunnels. After all, airport expansion will have a huge impact that is needed to be taken into consideration and addressed while the airport is planned to be expanded not after.
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Chapter One: Introduction

1-1 Problem Statement

The government of Saudi Arabia is planning to expand King Abdul-Aziz International Airport to increase the efficiency of the transportation services that is provided to serve the visitors of the holy city of Mecca. This new expansion of King Abdul-Aziz International Airport will lead to a wide range of implications and effects on many aspects such as land use and transportation in the surrounding neighborhood. Therefore, I will study this new development to identify the possible impacts and provide suggestions to minimize the negative impact and increase the positive impacts.

1-2 Objective of the Study

I have two main objectives that I want to accomplish in this study. First, study the compatible land use near King Abdul-Aziz Airport airport and come up
with an appropriate land use plan. The reason for the first goal of my paper is that the current land use near the King Abdul-Aziz Airport is range between industrial and residential. There are only few hotels and retail stores which is not compatible with land uses around airports.

Secondly, identify the possible traffic conflicts and decrease it. The reason for this second goal in my paper is that the main access to King Abdul-Aziz International Airport will be changed from Al-Medina highway to Prince Majed Highway. This change in access required study the new road that will lead to the airport and try to minimize the possible traffic conflicts.

At the end of my paper, I will propose a plan for a distance of one mile of the road that leading to the airport. In addition, I will take a distance of 400 feet from each side of the new road and propose a plan for the land use in both sides of the new access of King Abdul-Aziz International Airport.

1-3 Overview of Saudi Arabia

The government of Saudi Arabia is planning to expand King Abdul-Aziz International Airport. The Kingdom of Saudi Arabia is in the Middle East region and is the third largest country after Turkey and Algeria. Saudi Arabia has an area of 870,000 sq mi and has the largest oil reserve in the world (CIA World Factbook). It is also the world’s largest exporter of oil. These factors led Saudi Arabia to be one of the wealthiest nations in the world. Saudi Arabia is also
called the land of the two holy mosques which refer to the holy mosques in Mecca and in Medina, the two holiest places in the Islam religion. The city of Mecca which has one of the two holy mosques doesn’t have access except from the neighbor city of Jeddah. Jeddah is the second largest city in Saudi Arabia after the capital city Riyadh. Jeddah is called the gate of Mecca because anyone who wants to visit the holy city must come through Jeddah. Visitors of the holy city mainly arrive at King Abdul-Aziz International Airport and few visitors arrive through Jeddah Islamic Sea Port which is the biggest seaport in the Red Sea, and then visitors must use the Jeddah-Mecca highway to reach the holy city. From this perspective, the national government of Saudi Arabia proposed an expansion to King Abdul-Aziz International Airport (Figure1). What needs to be mentioned is that the General Authority of Civil Aviation is Saudi Arabia doesn’t have its own rules, but it follows the rules of the Federal Aviation Administration in the United States.
1-4 Definitions of Airports

The International Civil Aviation Organization (ICAO) defines airports as "A defined area on land or water (including any buildings, installations, and equipment) intended to be used either wholly or in part for the arrival, departure, and surface movement of aircraft." In addition, the Federal Aviation Administration defines airport as “any area of land or water used or intended for landing or takeoff of aircraft.”
1-5 Types of Airports

National Aeronautics and Space Administration (NASA) stated that there are seven types of airports in the United States of America. The first type is the rural airstrip, which are located in agricultural areas. The second type is the private airport, which is a group of homes that have hangers to garage their airplane and these homes share the runway. The third type is the military airport, which is only used by military aircrafts and the military use their airport for training purposes. The fourth type is the small community airports, which usually have one runway and doesn’t have control tower and it is often used for training student pilots. The fifth type is the regional community airport, which is larger than the small community airport. That is because it has a control tower and usually has some commercial airlines. The sixth type is the regional airports, which serves many communities and have commercial airline service and cargo but is not the major city airport. The final type of airports is the major city airports, which have large facilities with terminal and lots of passengers and have two or more runways. This type also serves the whole nation and has international flights beside the domestic flights.

The type of King Abdul-Aziz International Airport is the major city airports. That is because King Abdul-Aziz International Airport has several terminals and
millions of passengers each year. In addition, King Abdul-Aziz International
Airport has two runways and serving both domestic and international flights.

1.6 Importance of Airports

Airports are an important for every development. According to Cherry
(2006) passenger traffic, cargo volumes, and the development of lands near the
airport drives the economies of their communities. Cherry also indicated that
commercial air flight and cargo are increasing every year and the passenger
movement is increasing %4 annually accompanied with an increase in the air
fright by %5.1 per year. He also stated that the number of passengers is 3.7
billion per year and there are 4.5 million airport workers. Cherry said that all
these indicators encouraged local governments to expand their airports. For
instance, airport expansion in the countries of the Arabian Gulf costs more than
20 billion US dollars. Another example is in Canada, where airports produces 34
billion US dollars to the Canadian economy and provide 300,000 direct and
indirect jobs.

1.7 King Abdul-Aziz International Airport

The current terminals of King Abdul-Aziz International Airport were
officially opened for service in 1981 and have a total area of 40 sq. mi and it is
located in the northern part of Jeddah city (Figure 2). King Abdul-Aziz
International Airport consists of four terminals, north terminal for foreign airlines, south terminal for Saudi airlines, Hajj terminal for foreign pilgrims, and the royal terminal for foreign kings and presidents, and the Saudi Royal Family. King Abdul-Aziz International Airport had 17 million travelers last year (Figure 3).

According to Sorin Voicu “The Jeddah airport Hajj Terminal is estimated to be, at five million square feet (465,000 m²), among the world's largest air terminals after Beijing Capital International Airport, Dubai International Airport and Hong Kong International Airport. It covers over 100 acres (405,000 m²) and is known for its tent-shaped roof. The terminal's roof is not actually a tent, but a white colored fiberglass. The Hajj Terminal offers pilgrims many facilities, including a mosque, and can accommodate 80,000 travelers at a time.” The south terminal is designed to accommodate 2500 passengers per hour, it has 40 gates, and it only serves the domestic and international flights of Saudi Airlines. The north terminal has 14 gates and it serves the frequent airline and 20 additional airlines during Al Hajj season (General Authority of Civil Aviation).
Figure 2: The location of KAIA to north of Jeddah


From the figure, one can see that the number of passengers at King Abdul-Aziz International Airport was more than 11,000,000 in 1998 and 1999.
The number of passengers increased in 2000 as people became more depended on airlines. However, this number declined in 2001 perhaps because of 9/11. Thereafter the number of passengers continued to increase every year till 2005 this has more than 15 million passengers. In 2006, the number of passengers declined because of the stock market crisis that happened that year in Saudi Arabia. In the two following years, the number of passengers increased to reach 17 million.

1-8 Expansion of the King Abdul-Aziz International Airport Project

According to Net Resources International (2003), a website that is interested in airports related subjects, one of the huge things that will occur when the airport is expanded is the new twin crescent terminal. This new terminal will have an area of 165 acres. This new terminal will have 46 gates, more than 90 bridges for boarding, hotel, and food court as well as commercial stores. The new terminal will have about 37 miles of luggage belts and its related services and this new terminal will provide the necessary services for the new air jet A380. The new terminal would be linked to the other areas in the airport by automatic lines to move the passengers. Airport technology.com stated that “the expansion also includes construction of a transportation center featuring a rail station, a 136m high air traffic control tower, taxiways, roads, tunnels, utilities networks,
support facilities, fuel tank farm, internal gardens and walkways.” The airport expansion will also improve and enhance the current infrastructure at the old terminals. As part of increasing the provided spaces and enhancing serving passengers, the south and north terminals would be upgraded. All the services in the field of the airport such as the runways and lighting system would be renewed. The expansion of the airport will include building a village for the air cargo that can handle more than 4 million tons by the end of all the phases of the airport expansion. There will also be a two level car garage that can handle 5700 cars. In addition, the access to King Abdul-Aziz International Airport will be changed from Al-Medina highway to Prince Majed Highway (Figure 4).

Figure 4: The new terminal after the expansion of KAIA
1-9 Methodology

The methodology of my study is the case study approach. I will follow two case studies to see what impact happened on land use and traffic. These case studies will be guidelines to figure out how the local government decreased the negative impact on the three aspects of my study, and how they took the advantages of the positive impact.

The first case study I want to follow is Dubai International Airport. The reason for choosing Dubai International Airport is because the expansion of Dubai airport started in 2000 and it will completed at the end of 2013 (dubaifaqs.com). Moreover, Dubai International Airport is in the United Arab Emirates, which is the neighbor country of Saudi Arabia and both countries share and have many similarities.

The second case study is Kuala Lumpur Airport in Malaysia. The reason for choosing Kuala Lumpur Airport is because it has the same area of King Abdul-Aziz International Airport. In addition, the main source of income in Malaysia is oil which is similar to Saudi Arabia. Moreover, Malaysia is a Muslim country as Saudi Arabia, so both countries share the same restrictions.

In addition, I will explore two aspects in order to achieve my objectives. First, I will examine the planning aspect, which will help to know the current land use, road conditions, and landmarks near King Abdul-Aziz International Airport.
Next, I will list some criteria that will help to know the appropriate land uses that are compatible with airports. Examining these different aspects will help to determine what are the opportunities and constraints to develop the areas near King Abdul-Aziz International Airport to list the appropriate land uses, and to propose enhancing to the future road that will lead to King Abdul-Aziz International Airport (Figure 5).

1-10 Outline of the Thesis

My study will consist of five chapters. The first chapter is the introduction which states the importance of Jeddah city, the problem statement, and the importance of airports. The second chapter is the literature review which will consist of reviewing previous studies on the effect of airport expansions and the compatible land use and transportation near airports. The third chapter will be about the case studies which are the expansion of Dubai International Airport, and Kuala Lumpur International Airport expansion. The fourth chapter will be about the current situation of King Abdul-Aziz International Airport and studying the effects of the expansion. The final chapter, which is the concluding chapter will be addressing the possible impact and how to decrease the negative impact and increase the positive impacts.
Figure 5: The needed studies to examine the effect.
Chapter Two: Literature Review

2-1 Introduction

Expanding airports have both positive and negative impact on several aspects. The major negative impacts are on land use, transportation, noise levels, heights, and hazard areas. Therefore, this literature review will focus mainly on these different aspects.

2-2 Planning Issues

2-2-1 Land Use Compatibility

The Federal Aviation Administration (FAA) stated in their Land Use Compatibility and Airports document that there are some uses that can be affected by the high noise levels and can affect the airport development. These uses are residential and public facilities such as schools, churches, public health facilities, and concert halls. In addition, the FAA mentioned “Incompatible land uses can include wildlife-attracting land uses such as wetlands and landfills, cell towers and antennae transmitting signals that interfere with radio transmissions
and/or navigational aids, lights that may be disorienting to a pilot, and tall structures including towers and construction cranes that may impact an airport’s airspace” (p. 9). Moreover, land uses that depend on the airport to attract customers such as hotels, restaurants, warehouses, cargo representatives, industries that are related to planes, industries that take advantage from the access to an airport, and most commercial and industrial uses are compatible with airports.

May & Hill (2006) stated that when the local authorities expanded Canberra international airport a conflict occurred. This conflict was between the airport authority and an owner of a residential area who complained about the aircraft noise. As a result of this conflict, the local authorities proposed a “high noise corridor.” This corridor is the way that has very high volume of aircraft movement. One feature of this corridor is that no residential would be allowed within the boundary of the corridor (figure 6).

Figure (6) shows the high noise corridor that was proposed by the local authorities in Canberra. The corridor is divided into six areas. Each area has the number of flights that make the level of noise greater than 70 dB (A). For instance, the area with the red border in the map has an average of 10 to 20 flights per day that have levels of noise that is greater than 70 dB (A).
Figure 6: High Noise Corridor in Canberra airport

2-2-2 Transportation near Airports

De Neufville (2007) stated that low-cost airlines are focusing to operate their services from secondary airports. According to De Neufville (2007) “a secondary airport is any airport that effectively serves and competes for passenger traffic from a large conurbation, whether or not it is in the same state or even the same country” (p. 351). The reason why those low-cost airlines are focusing to operate their services from secondary airports is because the rent is lower than the major city airports, using airport facilities is cheaper, using their space intensively so it will be even cheaper, and, most importantly, parking and reaching the airport costs less.

De Neufville (2007) conducted that accessing an airport through projects like special-purpose, high-speed, fixed-route access are not the appropriate way. That is because it costs too much to be built and operated. For instance, the project that connects New York’s airports to the rail metropolitan network, which is the AirTrain, is nearly costing $200 million per mile.

De Neufville (2007) mentioned two ways that might be appropriate solutions to reduce the cost of building special projects that provide access to an airport. One possible solution is to make the airport stop as a frequent stop in cities that have rail or metro transit system. This solution is very common in Europe, but in the United States it can be done, for instance, in Chicago and
Washington D.C. That is because rail network system is not common in most of the U.S. cities. The author proposed this solution because it won’t be built only to access an airport, but it will connect an airport with other destinations. In addition, thousands employees are working in airports, so they move to and from airport whereas passengers go in one direction.

The other solution according to De Neufville (2007) is to provide bus and van vehicles that take passengers directly to the airport. One example of van vehicles is “Super Shuttle” which is service that own and run by a private company. One feature of this service is that it carries passengers from a major city airport and has specific lanes that go to different destinations in the metropolitan area. In addition, one example of bus service to the airport now exists in Boston, MA. There is a bus service that specifically goes to the airport from three suburban towns in the metropolitan area of Boston. There is also in Boston a public bus system that has stops at the airport and drives through bus-lane-only. Also the public bus system connects the airport with the subway system in Boston. The author proposed this solution because it has less mechanical problems than rail and metro. This solution also can extend the services instantly and doesn’t require as much capital cost as the rail and metro services.
California Department of Transportation (2009) stated that each regional transportation plan should take into consideration the linkage to airports. That is because it improves the mobility of people and goods. For instance, the annual value of transport air cargo is more than $170 billion and tourism earns to the state $14 billion. In addition, 9% of the employment in California works in the aviation industry (1.7 million jobs).

In order to enhance the transportation near airports, the California Department of Transportation (2009) stated that the local documents should be reviewed. The airport master plan should be reviewed in order to identify the future needs of transit system if the airport is planning to expand its services. Moreover, Local, regional and state plans should be reviewed in order to identify the current issues, needs, and problems in transportation systems.

2-3 Environmental Issues

2-3-1 Noise Exposure

Airport's noise affects primarily the workers and travelers in the airport and then the residential areas surrounding and near the airport. Most of these effects are the health effects on hearing where someone may suffer hearing difficulties. In addition, it may affect the productive capacity during working hours where studies have shown that they can only absorb 25% of their work performance. There are four airport noise factors which are 1) noise source from any aircraft,
2) density of air traffic at the airport, 3) distance of populated areas to airports, and 4) personal reaction to the noise (Girgis, 2002).

2-3-1-1 Contours of Airport Noise

Figure 7: Contours of airport noise in feet
Source: Girgis, 2002.

From Figure (7), one can see that the highest level of noise will occur within a radius of 2600 feet from the runway. In addition, a medium level of noise may occur within a radius that range between 2601 to 7900 feet from the runway. Moreover, the lowest level of noise is placed within a radius that ranges between 7901 to 26000 feet. In conclusion, the farther you are away from the runway the lower noise may occur. In addition, according to Federal interagency committee on aviation noise (1992) stated that the level of sound from a distance of 1000 feet from Boeing 747 aircraft is 102.5 decibels.
2-3-1-2 Noise Impact on Housing Prices of Airport Expansion

McMillen (2004) did a study of how noise can affect the properties values near Chicago’s O’Hare airport. He used the popular way to determine noise in the USA which is the annual energy mean sound level (Ldn). McMillen used it to determine the noise for a year and he assigns 10 dB penalty if the noise occurs during the night. McMillen concluded that selling houses is decreasing 9.2% in areas with Ldn levels of 65 or more. While The Federal Aviation Administration’s (FAA) stated that residential areas are incompatible with areas that have Ldn levels of 65 or more.

Nelson (2004) conducts “a meta-analysis of airport noise and property values. The study consists of 33 estimates of noise discount for 23 airports in Canada and the U.S., combining the findings of various prior studies. His results indicate that the noise discount is between 0.50 and 0.60 per decibel (dB). Properties would sell at about 10–12% less if located at 75 dB instead of 55 dB” (p. 16). While Salvi (2003) applies “a hedonic regression specified as a spatial error component model for single family housing data in the Zurich Switzerland airport area. He finds that airport noise decreases housing values by up to 4% for noise levels of 55 dB and under, and up to 27% for noise level of about 68 dB. Although spatial autocorrelation is found to exist, its effect on the estimated coefficients and their standard errors is minimal.”
Jud & Winkler (2006) did a study to figure out the influence of the effect of airport expansion of building new airports on housing prices. The authors stated that “housing property prices in a 2.5 mile band from the Greensboro/High Point/Winston Salem metropolitan airport declined approximately 9.2% in the post-announcement period. In the next 1.5 mile band, house prices declined approximately 5.7% in the post-announcement period” (p. 91).

2-3-1-3 The maximum allowable noise in residential areas:

<table>
<thead>
<tr>
<th>the intensity limit of sound in decibels</th>
<th>Residential area</th>
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<tr>
<td>evening</td>
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<td>50 - 40</td>
<td>60 – 50</td>
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<tr>
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<td>Rural residential suburbs</td>
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<td>Residential suburbs with weak movement</td>
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<td>Residential areas in the city</td>
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<td>Residential areas on the highway</td>
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</table>

Table 1: The maximum allowable noise in residential areas

Source: Girgis, 2002.

From Table (1), one can see that the maximum sound of noise allowed in all the residential types is 60 decibels and it is only allowed in the morning. In the afternoon, the maximum noise allowed all residential types is 55 decibels. While the maximum allowed noise in the evening is 50 decibels in all residential types.
To be specific, the type of residency such as rural suburbs has a maximum level of noise that equal to 45 decibels in the morning.

2-3-1-4 Ways to Address Noise Levels

There are five environmentally recommendations which are: 1) organizing the take-off and landing, 2) reduce air moves in the upper atmosphere as much as possible, 3) place a measured point to each airport to maintain standards, 4) continuous replacement of the old model of aircrafts with new ones that are resistant to noise, and 5) improve existing aircraft engines to reduce noise. In addition, there are five planning recommendations to reduce noise levels which are contoured mapping for the noise path to be away as much as possible from residential areas, study the optimal planning of routes with the direction of the wind, set certain standards for buildings in residential areas near the airport to be resistance to noise, good planning for factory sites and residential areas, and assign green spaces next to airports (Girgis, 2002).

2-3-2 Environmental Impact Assessment

King Abdul-Aziz international airport received 53% in the environmental impact assessment because it is near the residential areas and the Red Sea (Table 2). Whereas the Kansai international airport received 100% in all the elements with the exception of the site element because it is far from the city
which come up with a total of 99.8% in the environmental impact assessment (Table 3). Therefore, the Kansai international airport is an appropriate case study to follow in order to accomplish airports that compatible with the environment (Alzahrani, 2007).

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<td>Water pollution</td>
<td>Noise</td>
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Table 2: The environmental impact assessment of King Abdul-Aziz international airport


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<td>99.8%</td>
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</tr>
</tbody>
</table>

Table 3: The environmental impact assessment of Kansai international airport

2-4 Safety Issues

2-4-1 Height Limitation

The height limitation map is created by both Jeddah Municipality and the Civil Aviation Authority. This height limitation map must be taken into account while designing buildings. The height according to the map is rising 1.6% as we move away from the runways (Figure 8).

Figure 8: Height limitation map
Source: Civil Aviation Authority, 2008.
2-4-2 Hazard Areas

According to Texas Department of Transportation, Aviation Division “the area that can be zoned for airport compatible land uses is called the “controlled compatible land use area” and is applicable to any instrument or primary runway. An instrument runway is defined in the Airport Zoning Act (AZA) as a runway of at least 3,200 feet in length for which there is an existing or planned standard instrument approach procedure” (p. 25).

Figure 9: Hazard regulations

Source: Texas Department of Transportation, Aviation Division. 2003.
The Texas Department of Transportation, Aviation Division conducted:

“a primary runway is defined as a runway also at least 3,200 feet in length on which a majority of an airport’s operations take place. To be eligible for compatible land use zoning under the AZA, an instrument and/or primary runway must have or be planned to have a paved surface. These eligibility criteria can, and often do, apply to the same physical runway. Future runways may also be zoned if they are identified on an approved airport layout plan (ALP) or other planning document and meet the above eligibility criteria. The controlled compatible land use area extends 5 miles beyond each end of an eligible runway and 1.5 miles on each side of the extended runway centerline (Figure 9). These are the maximum limits of the area that can be zoned, not necessarily the limits of the areas that must be zoned” (p. 25-26).

2-5 Conclusion

After all, there are several criteria that will benefit Jeddah if it is applied near King Abdul-Aziz International Airport. First, land uses that are compatible with King Abdul-Aziz International Airport are hotels, shopping centers, warehouses, cargo agencies, and restaurants. Secondly, transportation to King
Abdul-Aziz International Airport can be determined by reviewing the master plan of the new expansion. By doing such, King Abdul-Aziz International Airport will need to provide a public transportation that has its own lane to reach the airport. Thirdly, land uses must be 1.5 miles away from the runway to be away from aircraft noise. The runway of King Abdul-Aziz International Airport is 2.5 miles away from the edge of the airport land, which is above the standard distance of noise. Fourthly, studies have proven that aircraft noise affects the housing and properties values. For instance, one study shows that the selling price of housing is declining 9.2% in areas that had level of noise of 65 or more. Fifth, researchers have proposed some ways to reduce noise, one of which is by improving the aircraft engines to be less noisy. Sixth, height in Jeddah is divided into six categories that vary from 0, which is near the runway, to 40000 feet in areas that are located in front of the sea. Finally, according to the literature review, the first land use should be 5 miles away from the runway to nit be considered a hazardous area. This does not apply to King Abdul-Aziz International Airport because the first land use is 2.5 miles away from the runway.
3-1 Introduction

The methodology of my study is the case study approach. I will follow two case studies to see what impact happened on land use and traffic. These case studies will be guidelines to figure out how the local government decreased the negative impact on the two aspects of my study, and how they took the advantages of the positive impact.

3-2 Dubai International Airport

The first case study I want to follow is Dubai International Airport. The reason for choosing Dubai International Airport is because the expansion of Dubai airport started in 2000 and it will be completed at the end of 2013. Moreover, Dubai International Airport is in the United Arab Emirates, which is the neighbor country of Saudi Arabia and both countries share and have many similarities.
The Dubai international airport is located in the north east of Dubai city.

The total area of Dubai international airport is 8,640 acres according to dubaiairport.com. Dubai airport has three terminals and these terminals are linked together by a transit system. The airport serves 135 airlines with almost total passenger of 51 million in 2011 (Dubai Civil Aviation Authority).
Dubai is rich with diversity of land use planning due to its goal to be a global tourist destination. However, the land uses around the Dubai international airport are divided into five uses. Firstly, there are industrial areas in the west and north of Dubai airport. Industrial uses around airports are considered compatible with airports. Secondly, there are educational uses that vary between higher education such as universities and public education which spread around Dubai airport. Educational institutions around airports are considered

Figure 10 Land use map
Source: Dubai Municipality, 2004
sensitive to aircraft noise according to the Federal Aviation Authority. Thirdly, there are governmental sites that surround Dubai airports at each direction. Governmental uses are considered compatible with airport because they are necessary to be around airport to control airports. Fourthly, there are two hotels in the north east of Dubai airport and one hotel inside the airport. Hotels are definitely compatible with airports because they serve the needs of passengers. Finally, there are residential areas that located around Dubai airport. Residential areas are not compatible with airports because they are sensitive to noise (Figure 10).

After all, one can see that land uses around Dubai airport include uses that are not compatible with airports such as educational uses and residential uses. Whereas there are uses that are compatible with airports such as industrial uses, warehousing, governmental, and hotel uses.

3-2-2 Transportation to Dubai Airport

Dubai is one of the fastest growing cities in the world. Due to its rapid growth, five million car trips are generated daily which make a traffic jam a regular thing in the life of Dubai residents (Jürgen Kaiser, 2008). Therefore, local governments in Dubai have developed freeways, bus, and metro networks to decrease traffic congestion and make the transit network in Dubai more efficient.
One way to access Dubai International Airport is by using the freeway system in Dubai. The airport road D89 is the main access to Dubai airport and it takes 10 minutes to reach the airport from the city center. The airport road D89 freeway also runs from west to east of Dubai which help move people to these areas. The D89 also links the two north south highways E11 and E311 to the airport, which give easy access to people who wants to go either north or south. All these highways and freeways don’t have any traffic lights and all the intersections are free (Figure 11) (Dubai Roads and Transportation Authority).

![Image of Dubai road network](image_url)

**Figure 11:** The airport road D89

The bus network system in Dubai is very large and consists of 58 routes (Dubai Roads and Transportation Authority). The bus network system provides a 24 hour service to Dubai airport. The bus network system reaches Dubai international airport at all three of its terminals. Terminals one and three can be reached by using bus routes 4, 11, 15, 33, and 44 whereas terminal two can be reached by bus route 2. Passengers may access the Dubai bus system through the airport ground transportation and the arrivals. Dubai airport may be reached from the central business district within 30 minutes during rush hour (Jürgen Kaiser, 2008).

From Figure 12 below, one can see that Dubai city is covered by the bus network and the bus system goes to each direction in Dubai. In addition, the bus network system in Dubai provides express service lanes that mainly serve from the central business district to the south and from the central business district to Jebel Ali in the west. Express bus service goes to Dubai Airport at terminal one through express route X28 and X35, and to terminal two through express route X28. Moreover, the bus network system provides three night bus services that go to Jebel Ali bus Station in the west side, to Rashidiya bus station in the south, to Alqusais bus station in the east, and to Mina Alsiyahi in the north. Night bus goes to Dubai airport at terminal 1 & 2 through bus routes N1, N2, & N3.
Figure 12: Dubai network system

Another way to go to Dubai airport is by using Dubai Metro. Dubai Metro was first operated on 9 September 2009. The Metro now has two lines, the red line and the green line, that have been completed and are operating service to the public. More Metro lines are proposed and expected to be operated by 2030. The total is expected to cover a length of 421 kilometers and to have 197 stations (Dubai Roads and Transportation Authority).

The existing two lines, red line and green line, combined have 44 stations and a length of 46.4 miles. The Metro red line has 28 stations and a length of 32.4 miles and it takes around 60 minutes to go from the first station to the last station. The Metro green line has a length of 14 miles and 16 stations with an average daily ridership of 120,000 (Dubai Roads and Transportation Authority).

From Figure 13 below, one can see that the Metro red line and green line meet in two stations. Also, one can see that only the Metro red line goes to Dubai airport while the green line doesn’t. Therefore, users of the Metro green line must transfer to the Metro red line in order to reach Dubai airport. The Metro red line has two Metro stations at Dubai airport, one of which is in terminal one and the other is at terminal three. It takes an approximate two minutes and a half to reach terminal three from Rashidiya south station. It takes an approximate 42
minutes to reach Dubai airport from the west station Jebel Ali (Dubai Roads and Transportation Authority).

Figure 13: Dubai Metro map

Source: Dubai Roads and Transportation Authority, 2011.
Kuala Lumpur International Airport in Malaysia

The second case study that I want to follow is Kuala Lumpur International Airport in Malaysia. Explaining why Malaysia should be used as a model for the expansion of King Abdul-Aziz airport is an important thing to focus on. In fact, Malaysia is the only developed country that has many similarities to Saudi Arabia. Therefore, Malaysia should be a perfect model for the three similarities that are shared in both countries. Altasan, 2011 conducted:

One similarity is the religious view in both Malaysia and Saudi Arabia. The majority of people in both countries are Muslims. This aspect is very important to take in consideration while measuring the effects of expansion King Abdul-Aziz airport. Religion will be involved in almost every element of design. For instance, prayer rooms should be provided at bus stations.

Another similarity is the traditions in both countries. The people of Malaysia and Saudi Arabia share many traditions that are very common. Traditions such as customs, people from different races, and social integration in both countries are very similar. These traditions were taken into consideration while Malaysia was planning their public transport system. Specifically, when Malaysia was developing their public transit
system, they designed it to fit people from different income groups not only for a certain income group of people.

A final similarity is the main source of income. Malaysia used to depend only on exporting oil three decades ago. As a result of their transportation system, Malaysia found different sources of income. Nowadays, Malaysia’s non-oil exports are earning an amount of 100 billion dollars per year which is seven times more than Saudi Arabia’s non-oil exports (Qatari, 2007). In addition, the area of Kuala Lumpur international airport is 100 square kilometers, which is similar to the area of King Abdul-Aziz airport.

In summary, Saudi Arabia and Malaysia have three similarities. One similarity is the religious view. A second similarity is their common traditions. A final similarity is the historical reliance on oil for income. By taking these similarities into consideration, Kuala Lumpur airport in Malaysia is an appropriate case study to follow.

Kuala Lumpur international airport is located in the south east side of the capital city of Malaysia and it is 50 kilometers away from the capital. Kuala Lumpur airport has only one main terminal with one satellite terminal. In 2010, Kuala Lumpur airport has more than 34 million passengers and cargo that reached more than 660,000 tons (Malaysia Department of Civil Aviation).
3-3-1 Land Use near Kuala Lumpur Airport

Kuala Lumpur is as rich with different land uses as any other city in the world. According to Kuala Lumpur Structure Plan 2020, the land uses in Kuala Lumpur are divided into 10 classifications. These 10 uses are residential, commercial, industrial, institutional, open spaces, community facilities, undeveloped land, squatters, infrastructure, and utilities. The residential use is the most common use among other land uses in Kuala Lumpur covering 22.66% of the city.

From Figure 14 below, one can see that Kuala Lumpur international airport is surrounded by huge green areas that works as a sound buffer from noise. These huge green areas are actually agricultural lands which are considered compatible with airports. These green areas are kept in their place in order to preserve the rain forest and to work as sound proofing (www.klia.com.my). Other uses such as industrial, hotels, warehouses, and residential are located in the east and northeast of Kuala Lumpur airport which is also compatible with airports because it is more than five miles away from Kuala Lumpur international airport.
Figure 14: Kuala Lumpur International Airport

Source: Google Earth.
3-3-2 Transportation to Kuala Lumpur Airport

Malaysia is one of the world’s developed countries; therefore it has several developed modes of transportation. There are three main modes of transportation that are being used by the people of Malaysia which are rails, buses, and cars. Eventually, Malaysia has an integrated transportation system that is very efficient and well developed.

The main mode of transport in Kuala Lumpur is roads as in many other cities in the world. The Kuala Lumpur International airport can be reached from the city center of Kuala Lumpur by two highways. One way is by taking the main access road to the airport which is the north-south central link expressway. This expressway has no intersections and the whole journey takes one hour from the downtown to the airport. The other way to reach the airport is by taking the eastern route which connects the airport to the Nilai interchange (http://www.worldtravelguide.net/malaysia/kuala-lumpur-international-airport).

Bus services in Kuala Lumpur are currently operated by four companies. These companies are only providing services in the city center of Kuala Lumpur. As a result, the city center of Kuala Lumpur is suffering more traffic congestion. In addition, bus services don’t reach the Kuala Lumpur airport, but they reach the rail line that goes to Kuala Lumpur airport. However, there is a private company that operates bus service to connect Kuala Lumpur airport to the capital city. This
private company provides one route only from the main terminal to KL Sentral which is the main station of the railway system in Kuala Lumpur. This bus service route is operated every 30 minutes and it takes two hours to reach the final destination, which is KL Sentral and it costs around $ 3.20 (Figure 15) (Kuala Lumpur Structure Plan 2020).

![Figure 15: Bus network system in Kuala Lumpur](image-url)

Kuala Lumpur has a very efficient rail service that covers all the city. The rail transport in Malaysia is divided into four categories which are the heavy rail, light rail transit, monorail and a funicular railway line. The heavy rail has a length of 1,699 kilometers and it consists of two lines, the east coast line and the west coast line. The light rail consists of three lines and has a length of 113 kilometers. The monorail is an elevated public transportation consisting of one line only and has a length of 8.6 kilometers. Finally, the funicular railway consists of one line only and has a length of 1.2 kilometers. It is used by the tourists and the residents who live in hills (Malaysia Department of Civil Aviation).

Kuala Lumpur international airport can be reached by the railway system in two ways. One is the KLIA transit line which began operation in 1998. This line connects the KL Sentral to the main terminal of Kuala Lumpur airport passing three other stations. This line has a length of 57 kilometers and it takes 36 minutes to reach the airport. This line operates every half an hour and it costs $11.20 from the first station to the last station. The other way is the KLIA express rail line that starts operations in April of 2002 which provides a nonstop service from KL Sentral to the airport. It takes 28 minutes for the whole journey with a service frequency of 20 minutes and it costs $11.20 for a one way trip (Figure 16) (http://www.kliaekspres.com).
Figure 16: Rail line to Kuala Lumpur airport

Source: [http://www.kliaekspres.com](http://www.kliaekspres.com).
3-4 Lessons Learned

Dubai and Kuala Lumpur have done many things in order to ease the transport to the airport and to create compatible land use. These two case studies were focused on land use and transportation in order to see what they have done in these two aspects.

Firstly, Dubai has some compatible land uses around its airport. They have industrial areas near the airport that have warehouse. There are also governmental areas around the airport that do works related to the airport. On the other hand, Kuala Lumpur is surrounded by huge agricultural lands that works as a sound proof. These green areas are also rain forests that are aimed to be preserved.

Secondly, both Dubai and Kuala Lumpur have good access to their airports. They both have highways that lead to the airport and all the intersections are free. In addition, both cities have a good transit system that is linked to the airport. Bus network and rail system are linked to the airport in both cities in order to give an express access to the airport. To be specific, Dubai’s rail line has two stops at Dubai airport in terminals one and three. Kuala Lumpur also has two rail lines that go to the airport, one of which is an express lane that starts at the central station and doesn’t have any stops except at the airport.
Jeddah can benefit from what Dubai and Kuala Lumpur have done in their transportation to their airports. Firstly, Both Dubai and Kuala Lumpur have a rail and bus network that goes to their airports. Local government in Jeddah is now developing a rail and bus network that will go to King Abdul-Aziz International Airport. Secondly, all the roads that lead to Dubai and Kuala Lumpur airports are freeways. However, the roads that lead to Jeddah airport aren’t freeways and they intersect with other roads. Therefore, what Dubai and Kuala Lumpur have done in their roads to their airports will be done in the roads to Jeddah’s airport in order to accomplish a freeways transport to Jeddah’s airport.
Chapter Four: Current Situation of Areas near Jeddah’s Airport

4-1 Introduction

In order to propose recommendations for the areas surrounding King Abdul-Aziz Airport, these areas must be analyzed and examined. Since this research is focusing on both land use and transportation, this research will analyze one mile of each of the four streets that lead to the airport. In addition, this research will analyze the land use of each road with a distance of 400 feet from each side of the roads.

4-2 The Existing Situation of Areas Surrounding King Abdul-Aziz Airport

4-2-1 The Relation between the Old Location of the Airport and the Growth of the Built Environment

In 1945, the airport was 4.2 km away from the city center. The airport has an area that was same as the area of the city center. In 1951, the built environment of Jeddah started to grow in all directions due to oil income. As a
result, the airport was expanded and had an area that is six times larger than the city center and it was 2.2 km away from the city center (Figure 17). In 1956, the city of Jeddah continued to grow horizontally and vertically due to the increase of oil income. In 1961, the growth rate in Jeddah decreased due to the inflation that occurred during this period (Figure 18). In 1966, the built environment in Jeddah continued to grow and had an area of 5200 acres. In 1971, the built environment grew and was approximate to the old location of the airport (Figure 19). In 1977, the built environment grew and exceeded the old airport location which made the local government propose a new site for the airport. In 1981, King Abdul-Aziz airport was moved to the north of Jeddah and it is 15 km away from the city center (Figure 20) (Jeddah Municipality, 1990). The land of the old airport was vacant till past year when the local government sold a piece of the land for a housing subdivision. However, the majority of the location is still vacant.
Figure 17: Old location of the airport

Figure 18: The built environment exceeded the old airport
Figure 20: Growth of the built environment

Figure 19: The location of King Abdul-Aziz airport
4-2-2 The Airport Plan before and after the Expansion

King Abdul-Aziz airport was built in 1981 and it has an area of 40 square miles. The situation of the airport before the expansion was as follows. The airport has three runways for taking off and landing. In addition, there are four terminals, one of which is the southern terminal which is designated for Saudia airline use only. The second terminal is the northern terminal which is designated for foreign airlines. The third terminal is the royal terminal and it is designated to be used by the royal family and rulers of other countries. The fourth terminal is the Hajj terminal which is designed to for the pilgrims. There is only one road that leads to the all four terminals which is Al-Madinah road (Figure 21).

Figure 21: The current plan of King Abdul-Aziz airport

Source: Saudi Civil Aviation Authority.
The expansion of King Abdul-Aziz airport will contain building a new terminal that combined both the old north and south terminals in one terminal. The royal terminal and the Hajj terminal will stay at their same locations. In addition, there will be four new accesses to the airport from four roads and these four roads will end on a new collector street that will be built within the airport boundary (Figure 22). The three runways will stay at their same location and no changes will occur to them (Figure 23).

Figure 22: The four new accesses to the airport
Source: Google Maps.
4-2-3 The Built environment around the Airport

The areas that surround King Abdul-Aziz International airport are currently almost built with residential use. Moreover, one can see that the built environment is surrounding the airport from all directions. In addition, the airport is also close to the Red Sea and it is three kilometers away. Lastly, there are some vacant lands in the areas that are east of the airport (Figure 24).
The four roads that lead to the airport are Prince Majed road, Prince Mteab road, King Fahad road, and Al-Madinah road. These four roads are currently intersected with other roads and have traffic lights. Land uses in these four roads will be analyzed within a distance of 400 feet from each side of the roads.
Prince Majed road, which will be the main access to the airport after the expansion, has a variety of uses located on it. The residential use is the most common use among other uses. In addition, the commercial use is located directly on the road. Moreover, one can see that there is an industrial use in the north of the street and some vacant lands. This industrial area is considered as a development opportunity because the local government decided to move this industrial use to another area. The vacant land is considered as a development opportunity as well because it can be purchased to develop it (Figure 25).

The Prince Mteab road is rich with several uses and the most popular use is the residential use. In addition, one can see that there is a huge unplanned (slum) area. All unplanned areas in Jeddah will be developed as one of the goals of Jeddah Municipality. Moreover, there is an industrial area that will be removed to another site in Jeddah (Figure 26).
King Fahad road has no vacant lands as one can see from the figure below. In addition, one can see that the most common use of this road is residential use. There are commercial stores along the street while there is a shopping center at the north of the street near the airport. Moreover, there is a huge unplanned area (slums) that will be removed (Figure 27).

Al-Madinah road is considered the most developed road among the three other roads that will lead to the airport. That is because this road was the only road that led to the airport for more than 30 years. As a result, one can see that this road has the services that go along with airports such as warehouses.
4-3 Future Projects in Jeddah

The government of Saudi Arabia has approved a train network in Jeddah that will help link Jeddah to the two holy cities, Mecca and Al-Madinah. This train is called the two holy city train. Since many visitors of the two holy city arrive at Jeddah’s airport and seaport, this train will help reduce the traffic congestion on the highways that go to these two holy cities. This train will also shorten the time that needs to travel to the two holy cities from Jeddah. The railroad length will be 480 kilometers and it will have five stations. One station is in Al-Madinah city near the holy mosque and the second station will be in the economic city in Rabigh. Jeddah city will have two stations, one is at King Abdul-Aziz International airport and the other is in the city center. The last station will be in Mecca near the holy mosque (Figure 29). The journey from Jeddah to Mecca by the train will be less than half an hour. Moreover, the journey from Jeddah to Al-Madinah by the train will be two hours and a half (Figure 30) (Saudi Railways Organization).
Figure 29: The train station in Mecca
Source: Okaz Newspaper, 2010

Figure 30: The route of the two holy city train
Source: http://www.jazan.org/vb/showthread.php?t=182323
In addition, the local government in Jeddah has approved a transit system in Jeddah that consists of light rail lines and Bus network. The light rail lines will consist of three lines with total length of 108 kilometers and total stops of 46. The three lines are the orange line with a length of 67 kilometers, the blue line with a length of 24 kilometers, and the green line with a length of 17 kilometers. The blue line is one that will go to King Abdul-Aziz International Airport (Figure 31) (Jeddah Municipality, 2013).

Figure 31: The rail line system

Source: http://www.aleqt.com/2013/03/12/article_738549.html
The other transit system that will be established in Jeddah is the bus network system. The bus network will cover a total length of 750 kilometers in Jeddah and it will consist of 816 buses and 2950 stops. This bus network will have a route that goes to King Abdul-Aziz International Airport. This route will be through one of the new roads that will lead to the airport which is King Fahad road. This rapid transit system in Jeddah is expected to be done no later than 2020 (Figure 32) (Jeddah Municipality, 2013).

Figure 32: The proposed bus network in Jeddah

Source: http://www.aleqt.com/2013/03/12/article_738746.html
4-4 Conclusion

In order to propose recommendations, it is necessary to review and analyze the areas that will be affected by the expansion of King Abdul-Aziz International Airport. Therefore, this chapter has started with presenting the reasons of changing the old location of the airport to its current location. The reasons are the growth of the built environment around the old location. The close distance to Jeddah’s city center is another reason. This chapter has also presented the old plan of the airport before the expansion and the plan after the expansion. This will help in knowing the changes that will occur after the expansion so we can address the new changes. The old plan of the airport before the expansion shows that the airport has only one road that leads to it. However, the new plan after the expansion shows that there will be four roads that will lead to the airport. Therefore, this chapter has analyzed the land use and the transportation system in these new four roads in order to see if it will handle the expected increase in the traffic. Analyzing these four roads showed that there are many opportunities that can be an advantage to develop these four roads. One opportunity is that there are vacant lands that can be developed with uses that are compatible with airports. Another opportunity is that there are many unplanned areas that will be planned by the local government which will contain uses that are fitted with airports such as hotels and office buildings.
Chapter Five: Recommendations and Conclusion

5-1 Introduction

Proposing recommendations after the announcement of expanding King Abdul-Aziz International Airport is a critical thing to be taken into consideration. This recommendation will be based on the analysis of the current situation of the areas surround the airport to see the opportunities and constraints of that areas. Eventually, this research will propose a set of recommendations of how the land use and transportation should look like in one of the roads that lead to the airport.

5-2 Recommendations

Reviewing the current situation of the four roads that will lead to the airport will help us propose recommendations that fit the existing situation. Also, Since the local government are planning for a rapid transit system in Jeddah. Also since the new four accesses to the airport are not freeways and there is not a significant evidence for improvements for the new accesses to the airport, three proposals will be suggested to ease the traffic and to provide land uses that are
compatible with airports. The three proposals will be proposed in this research for only one road which is Prince Majed road, the new main access to the airport, and the appropriate proposal may be applied to the other three roads.

The land use plan that is proposed along the sides of the roads are commercial, suite apartments, and hotels. The land use in the three proposals will be the same because of the following reasons. First, this research will propose land use for 400 feet from each side of the road. Secondly, the value of the lands that are located along the street are high; therefore, the land use proposals must provide a revenue. Finally, the three proposed land uses are compatible with airports and grant income.

5-2-1 The First Proposal

The three proposed land uses are commercial, suite apartments, and hotels. In all proposals the land use will be the same. A commercial use will be between shopping malls and stores. The suite apartments use is a furnished apartment that have several bedrooms and rented on a daily basis. Suite
apartments are a very common use in Muslim countries. That is because Muslims usually have large families and a hotel room doesn't fit them. Therefore, a suite apartment is a must use since many Muslims come to the holy city through King Abdul-Aziz airport. The height of each use has taken in consideration to fulfil the Saudi Civil Aviation Authority regulations (Figure 33).

Since this road lead to the airport, a traffic jam is expected. One way to ease traffic is by making all the intersections free of conflicting traffic. In order to make all intersections in this road free, a tunnel is proposed to ease the traffic movement. This tunnel will have one entrance and one exit at the airport. Therefore, this tunnel will be used only by the passengers (Figure 34).

Figure 34: The proposed tunnel

Source: Jeddah Municipality.
5-2-2 The Second Proposal

As mentioned in the first proposal, the three proposed land use will be the same because it complies with airports and it meets the demand of the visitors. In addition, it meets the required height of the Saudi Civil Aviation Authority regulations (Figure 35). However, after the expansion of King Abdul-Aziz International airport, the traffic is expected to increase. Therefore, a bridge will be proposed in this proposal to ease the traffic. This bridge will not have any exits to the streets that intersect it. That is because this bridge will be only used by the passengers so passengers' movement doesn't interact with other movement (Figure 36).

Figure 35: The second proposal.

Figure 36: The proposed bridge.
5-2-3 The Third Proposal

The three land uses in this proposal will be commercial, suite apartments, and hotels. This three land uses in this proposal are similar to the land uses in the first and second proposals because of the reasons mentioned in the first proposal (Figure 37). However, the traffic on the roads that will lead to the airport will increase. That is because the current number of passengers is 18 million per year and it will be 30 million per annum after the expansion. One way to decrease the traffic jam is by expanding the road. In this proposal the current road will be expanded through the road’s shoulders and the width of the sidewalks will be expanded through the setback (Figure 38).

Figure 37: The third proposal.

Figure 38: Increase road width (in foot).
5-3 Choosing the Appropriate Proposal

In order to choose among the three proposals, the three-point Likert scale will be applied to each proposal to see which proposal gets the highest point. The way that we use the Likert scale in Saudi Arabia is different than the way it used in the USA. The reason of following this specific scale is because in Saudi Arabia a researcher uses the Likert scale in order to evaluate the alternative proposals. In addition, the researcher evaluates each proposal by himself to measure which proposal is meeting the needs of his subject. The three-point Likert scale has three ways to rate each element which are good, fair, and poor. The way that three-point Likert scale works is as follows, if two elements in one proposal got a rate good, we multiply the number of elements that got a rate good by three because a rate good is equal three. In addition, if several element got a fair rate, we multiply the number of elements that got a fair rate by two because a fair rate equals two. Moreover, if numbers element got a poor rate, we multiply the number of elements that got a poor rate by one because a poor rate equals one. After doing such, we measure the weighted arithmetic mean for each proposal. The weighted arithmetic mean measures as follows, from 1 to 1.66 is poor, from 1.67 to 2.33 is fair, and from 2.34 to 3 is good. After, the proposal the get the highest weighted arithmetic mean is the appropriate proposal.
After applying Likert three-point scale, one can see that the first proposal, which has the tunnel, got the highest weighted arithmetic mean (Table 4).

Whereas the other proposals share the same weighted arithmetic mean but it is less than the first proposal (Tables 5 and 6).

<table>
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<th>Relation to the airport</th>
<th>Meets the city needs</th>
<th>Optical character</th>
<th>Cost</th>
<th>Total</th>
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</tr>
<tr>
<td>Landmark</td>
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<td>🌒</td>
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<tr>
<td>Transportation</td>
<td>🌒</td>
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<td>🌒</td>
</tr>
</tbody>
</table>

Good= 3   Fair= 2   Poor= 1

Weighted Arithmetic Mean = \( \frac{3*3 + 2*2 + 1*0}{3 + 2 + 1} = 2.16 \)

Table 4: The assessment of the first proposal.
Table 5: The assessment of the second proposal.

<table>
<thead>
<tr>
<th>Use</th>
<th>Relation to surrounded areas</th>
<th>Relation to the airport</th>
<th>Meets the city needs</th>
<th>Optical character</th>
<th>Cost</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Suite apartments</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Hotels</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Landmark</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Transportation</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
</tbody>
</table>

\[
\text{Weighted Arithmetic Mean} = \frac{(3*2) + (2*3) + (1*0)}{3 + 2 + 1} = 2
\]

Table 6: The assessment of the third proposal.

<table>
<thead>
<tr>
<th>Use</th>
<th>Relation to surrounded areas</th>
<th>Relation to the airport</th>
<th>Meets the city needs</th>
<th>Optical character</th>
<th>Cost</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial</td>
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<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Suite apartments</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Hotels</td>
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<td>o</td>
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<td>o</td>
<td>o</td>
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<td>o</td>
</tr>
<tr>
<td>Transportation</td>
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<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
</tbody>
</table>

\[
\text{Weighted Arithmetic Mean} = \frac{(3*2) + (2*3) + (1*0)}{3 + 2 + 1} = 2
\]
5-3-1 A Detailed Plan for the Appropriate Proposal

After evaluating each proposal, the first proposal, which has the tunnel, got the highest evaluation. Therefore, the first proposal will be presented in a detailed plan for how it will look like if it was adopted. Firstly, each land use will be designed and shaped to in a way that attracts people. The commercial use will have bridges for pedestrians to help move people from one side to another. The suite apartments use will be shaped and designed as an arc to enhance the street character (Figure 39).

![Figure 39: A detailed plan for each land use.](image)

At the entrance of the airport, a landmark gate is proposed to be a landmark for Jeddah city. The reason for choosing a gate to be a landmark is because Jeddah is always called the gate of the holy city Mecca. Jeddah is the
gate of Mecca because anyone who wants to go to Mecca must first arrive to Jeddah and then go to Mecca. In addition, the commercial use will have the formal Arabic store design in order to preserve the historic Arabic design. Moreover, the commercial use will be outdoor shopping stores (Figure 40).

![Figure 40: A detailed plan for the landmark and the commercial uses.](image)

The suite apartments use will have an arc shape design in order to enhance the character of the road. Moreover, the suite apartments use may have shops in the first floor, whereas the above floors will be residential. In addition, the hotels use will have the old Arabic buildings design. This will help attract people and give the road a perfect look (Figure 41).
The tunnel on this road will be used only by the people who want to go to the airport. Therefore, there will be no entrance and exits on the tunnel. This action will help decrease the traffic on the main road by not letting people going to the airport use it. In addition, any street that intersects with the main road of the airport will have a bridge. That is because it will help ease the traffic and free all intersections (Figure 42).
Figure 42: Detailed plans for transportation.

Figure 43: A detailed design for windows, doors, and lighting inspired by Arabic design
5-4 Conclusion

An initial step of this paper is defining the problem statement and the objective of this research. In addition, an overview of Saudi Arabia is a must to explain to be familiar with the situation in Saudi Arabia. Since this research is about airports expansions, it will be critical to present the definition of airports, types of airports, and the importance of airports. For King Abdul-Aziz international airport both the current and future situations must be presented in order to get the full picture of the case study of this paper. As well as presenting the methodology and the outline.

A second step of this paper is to review the previous literatures that focused on the same subject of this research. The literature review of this paper was divided into three main issues. Firstly, the planning issues, which include literature about compatible land uses and transportation to airports. Secondly, environmental issues that focus on related airport's noise and how it impacts the surrounded built environments. Finally, safety issues, which includes literatures on height limitation near airports and regulations of hazard areas.

A third step of this paper is the approach of this research which is the case studies. This research examined two case studies to how the airport impacted the land use and traffic. These two case studies are Dubai international airport and Kuala Lumpur International airport. These two case studies were chosen
because Dubai is a neighbor city and Kuala Lumpur shares many similarities with Saudi Arabia. What both Dubai and Kuala Lumpur have done in land use and transportation near airports will be a guideline to follow in the expansion of King Abdul-Aziz international airport in Jeddah. Dubai and Kuala Lumpur have a rail and bus network that go to their airports. Local government in Jeddah is now developing both a rail and bus network that will be accessing Jeddah’s airport.

Both Dubai and Kuala Lumpur have freeways to their airport while Jeddah’s airport doesn’t. Therefore, the freeway network system in Dubai and Kuala Lumpur has been followed in order to make all the roads to Jeddah’s airport freeway roads.

A fourth step of this paper is to present the history of the growth of the built environment near King Abdul-Aziz airport. In addition, looking at the plan of King Abdul-Aziz airport before and after the expansion is critical to determine the future needs. Moreover, examining the existing situation of land use and the roads near King Abdul-Aziz airport is necessary in order to see what are the opportunities and what are the constraints.

A final step of this research is that it has presented three proposals for one of the roads that lead to King Abdul-Aziz airport airport. These three proposals were evaluated by the three-point Likert scale in order to choose the appropriate proposal. Researchers in Saudi Arabia use the Likert scale differently than how it
use in the USA. Researchers in Saudi Arabia use the Likert scale to evaluate the different proposals and they do the evaluation by themselves. After the evaluation, a detailed plan and designed were presented in this research in order to help give a full picture of how the shape will be after the expansion of King Abdul-Aziz airport.
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