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DEVELOPMENT OF EFFICIENT TRANSPORTATION SYSTEM IN JEDDAH (TRAM SYSTEM: AL-MUNTALAQ MULTIMODAL STATION)

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Abstract

Jeddah is a busy city, where the road networks are expanding and developing. High quality and reliable public transportation is required to address the public commuting problem. This study proposes a project with the potential to integrate intelligent transportation systems into various sectors of the city, according to the city capacity, traffic densities and major flows of commenting within the heart of the city. There are three main case studies and three thematic of railways stations are considered in this project in order to facilitate the unique idea of the project. The space program and site evaluation were conducted to select the suitable location for the project. The site evaluation criteria that considered in this project are located in a liveable area, accessible by the surrounding neighbourhoods, overlooking a pleasant view, close to commercial centers or axis and also close to the center of the city. The selected site is Old Jeddah (Al-Nazlah Al-Yamaniyah), 40000sqm with the advantages of accessibility, future development, surrounding and visibility.

Keywords -- Tram System, Public Transportation, Intelligent Transportation Systems

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INTRODUCTION

An Intelligent Transportation System (ITS) makes transport more efficient, faster, easier and reliable [1]. The focus is on smart solutions to integrate passenger and freight flows across transport modes and provide sustainable solutions to infrastructure bottlenecks affecting roads, railways, sky, sea and waterways. (ITS) encompasses a broad range of wireless and wire line communications based information and electronics technologies [2]. For example, A system that collects real-time traffic data and transmits information to the public through dynamic message signs and other methods, a slope meter to improve traffic flow on highways, and a system that synchronizes traffic signals to adjust to traffic conditions [3, 4]. When these technologies are integrated into the infrastructure or vehicles of a transportation system, they can alleviate congestion, increase safety, and increase productivity.

Public transportation is essential for integration into urban development because it has valuable benefits and provides different types of services. The public transportation system has improved the city's environmental, economic and social conditions. The ultimate goal of applying such a system is also to help maximize the number of commuters, travellers and tourists moving in the city, especially those who cannot afford to buy or rent a car [5]. At the city level, the system is sustainable and economically acceptable as it helps minimize vehicle traffic during peak hours [6].

The application of the rapid transportation system in the new transportation system will bring special appeal to people passing by. Having professionally built radio stations is one way to achieve this kind of entertainment. The railway station mainly provides two functions: access to the bus channel platform and the customer's bus information [7]. Therefore, every part of the station should be carefully considered to meet the main purpose of its existence and play a role in improving the surrounding communities. This study proposes a project that integrated with the smart transportation system to improvement of quality and efficiency of transport operations.

CASE STUDIES

There are six railway stations are chosen for case studies, three for main case studies and another three for thematic case studies. These railways stations are chosen based on the uniqueness in term of the design style and location. The chosen railway stations for main case studies are:

a) Flinders Street railway station, Australia
b) Rotterdam Central Station, Netherlands
c) Southern Cross railway station, Australiaand the other three railway stations for thematic case studies are:
d) Tram stop in Alicante, Spain
e) Washington D.C.'s Union Station, US
f) Metro Station 20, Bulgaria

Flinders Street railway station, Australia

The master plan will enable the station to better integrate with the tram network on Flinders Street (Figure 1). It is recommended to seriously consider connecting the Elizabeth Street tram network to Flinders Street to provide a more comprehensive tram network. The proposal leaves the administrative building unchanged. This will release the proposed junction of the Melbourne Metro Tunnel (MMRT). Similarly, future platform expansion is still feasible. The proposal also made room for bicycle lanes leading to the Southern Cross Station and the dockside area next to the viaduct. [8].

Rotterdam Central Station, Netherlands

Rotterdam Central Station is one of the most important transportation hubs in The Netherlands (Figure 2). There are as many passengers at the public transport hub station as Amsterdam Airport Schiphol. In addition to the European High Speed Train (HST) network, Rotterdam Central Station is also connected to the light rail system, which is expected to increase to approximately 323,000 by 2025 [9, 10]. The Rotterdam high-speed train is the first stop from the south of the Netherlands. It is located in central Europe. Schiphol is only 20 minutes away, and Paris is only two and a half hours away [10]. The magnificent entrance on the side of the city is obviously the gateway to the high-rise city center. Here, the station acquires a new international style from the hall made of glass and wood.

Moreover, the roof of the hall is covered with stainless steel, forming the iconic feature of the building and pointing towards the city center[10]. The garden in front of the station is a continuous public space. The tram station has been moved to the east side of the station, so the platform has been enlarged. Buses, trams, taxis and short-term parking areas have been integrated into the existing urban structure without causing obstacles [10].

Southern Cross railway station, Australia

Southern Cross Station (formerly still commonly known as Spencer Street Station) is Melbourne's main train station in Docklands (Figure 3). It is located on Spencer Street between Collins Street and La Trobe Street on the western edge of the Central Business District. The station is a state regional rail network operated by V / Line, a land rail service to Adelaide and a terminal station for NSW Train Link XPT service to Sydney[11]. It is also served by a suburban railway service operated by Metro Trains, one of the five stations on City Loop (most of the stations around the central business district are underground railways).

Nicholas Grimshaw uses a novel roof shape at Southern Cross Station in Melbourne, Australia, to expel diesel smoke from the train below. The design of the roof shape can accomplish many things, including helping to exhaust diesel fumes from the train station below, protecting the occupants from the weather, connecting the new and old areas of the city, and providing the city's main civic destination. The results were visually convincing and achieved these goals. [12].

Figure 1. Flinders Street railway station [8]

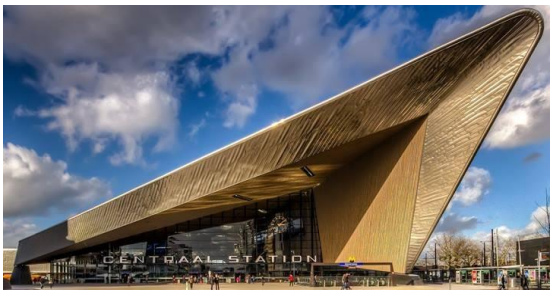

Figure 2. Rotterdam Central Station [10]

Figure 3. Southern Cross railway station [13]

Tram stop in Alicante, Spain

The frontal passage through the platform can be reached in 32 possible ways, these paths through a system of small-path paths scattered around the existing vegetation. Above them, there are two hollow boxes, 36 meters long, 3 meters wide and 2.5 meters high. An empty box floated above the traveller's head. Its proportion is closer to trams than trams [14]. At night, it becomes two powerful lamps that light up the platforms directly (Figure 4). The bench is related to the path, allowing passengers to wait for contact with vegetation to lighten the route gently [14].

Washington D.C.'s Union Station, US

Union Station in Washington DC is the second busiest train station in the United States, after New York 's Pennsylvania Station, but since it was completed in 1907, there has been little improvement (Figure 5). At the end of July, Amtrak announced ambitious plans to overhaul the station to bring it into the next century's high-speed rail service while undergoing major green upgrades. HOK worked with Parsons Brinkerhoff to design a master plan for the renovation of the railway station, which may cost up to $ 6.5 billion. The renovation project also includes the addition of more than 3 million square feet of new residential, commercial and public open space on the northern track [15].

In addition to improving traffic conditions, the train station will be covered with a new glass train shed roof to provide passenger protection and daytime lighting. A series of undulating green roofs will become the focal point of the train shed and work hard to collect rainwater. After the shed, the train will enter a brand new residential and commercial development area, as well as a new style park that is similar to New York's High Line. The connection with the city's existing public transportation network and surrounding public spaces will be improved. At present, the train station in the District of Columbia has been wasted space, but the master plan can transform it into a glorious multi-functional ecological development project that helps protect historical buildings and advance the station to the next high-speed rail era [15].

Metro Station 20, Bulgaria

The new underground Metropolitan Station 20 is located in Sofia, Bulgaria (Figure 6). It is located between the historic city and the developing city Centre. It covers an area of 6000-meter-square. It is working as an iconic element in the city that connects the underground platforms and attracts the people for its public spaces by creating the sense of excitement in both above and below the ground [16].

Metro Station 20 was designed by ZNA (ZeybekogluNayman Associates, Inc.), which uses the relationship between the street and the station below. The two worlds standing on the ground and underground have achieved great coherence. A glass spine is created, which is centralized and it controls traffic. The station is composed of high angled white walls, and sculptural skylights capturing the natural light [16].

Figure 4. Tram stop in Alicante [14]

Figure 5. Washington D.C.'s Union Station [15]

Figure 6. Metro Station 20 [16]

SPACE PROGRAM

There are five main zone in the project namely mall, admin area, common area, multi-level car parking area and platform. Table 1 demonstrates the detail of space program, where the GFA is 34330m² and the build area is about 30%, which is 11464m².

Table 1. Zone detail area

Zoning	Percentage (%)	Floors level	Total Area (m²)
Mall	34	3	11800
Admin Area	4	1	1360
Common Area	16	3	5580
Multi-level car parking	37	4	12600
Platform	9	2	2990
Total	**100**		**34330**

The general requirements for the circulation are direct and easy to go through especially for the first time users and avoid placing too many entries or exits to avoid passenger's confusion and therefore impede flow might happen. Next, provide queuing areas and enough spacing ahead of any barrier or changing direction to avoid the crowd and avoid the dead end corridors, cross flows, and turns greater than 90 degrees for security reasons. In addition, the location of the meeting point, seats and rest areas should ensure that they do not interfere with pedestrian traffic. In addition, guidance is added, and customer safety and security of all circulating components use different colours, textures, tactile guidance, and line of sight.

The general design considerations are utilise the natural light and ventilation whenever it is acceptable and separate the accesses for the operational areas for security arrangements from the public areas, and place an eye hall in order to let the staff know who is in there before letting anybody to access. Next consideration is a dedicated area for the equipment, fixtures and fittings to ensure the safety, security and efficiency of operating the station. Also, enhance the natural and artificial surveillance around the station to avoid the vandalism and to ensure the protection of the passengers.

The passenger's facilities are the primary function of any transit station; its purpose is to ensure the comfort and convenience of the passengers. Different type of facilities can be provided, depends on the type of station and its location. The basic facilities should provide in each station for all ages and abilities. Also, provide access facility for pedestrian and bicycles and provide bicycle parking. Furthermore, functional and enjoyable station platforms can be considered and the shelters for public outdoor sitting areas.

In addition, there are mandatory facilities the station needs to satisfy, such as the toilet facilities, rubbish bins, public telephones, seating and waiting areas. On the other hand, there are optional facilities that enhance the overall travelling experience, such as retail shops, open public areas, restaurants, and commercial vending machine. These optional facilities should only be provided when the station can accommodate them without interfere the circulation of passengers or affecting their safety.

SITE SELECTION AND ANALYSIS

Three sites in Jeddah are proposed for site selection and analysis (Figure 7). Site 1 is Shati (Corniche) with site area of 30000 sqm. Site B is Tahliah with site area of 30000 sqm. Site 3 is Old Jeddah (Al-Nazlah Al-Yamaniyah) with site area of 40000 sqm. Table 2 demonstrates the site assessment in term of city connectivity system access and traffic, potential of development and commuting. Table 3 presents the site evaluations result of each site. The criteria used to evaluate the site are access / traffic, shape/proportional, topography, future development, surrounding, views and visibility.

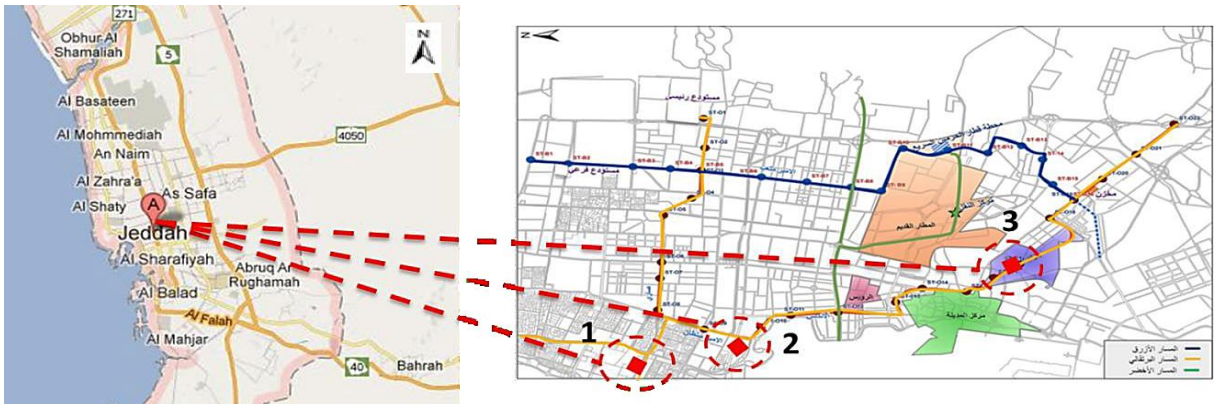

Figure 7. Proposed Site 1 [17], Site 2 [18] and Site 3 [19]

Table 2. Different assessment of sites

Criteria	Site (1) Shati (Corniche)	Site (2) Tahliah	Site (3) Old Jeddah
City connectivity system Access / Traffic	Sari Street / Corniche	Tahliah / King Abdullah Road	King Khaled/ old makkah
Potential of development	Entertainment	Commercial activity	Tourist
Commuting	Privet cars/ pedestrian	Public traffic/ Privet cars	Public traffic/ pedestrian

Table 3. Site Evaluation

Criteria	WF	Site (1) Shati (Corniche)	Site (2) Tahliah	Site (3) Old Jeddah
Access / Traffic	3	12	15	10
Shape/Proportional	2	8	10	6
Topography	1	4	5	4
Future Development	3	15	12	15
Surrounding	2	8	10	6
Views	2	10	10	6
Visibility	2	6	8	6
Total		**63**	**70**	**53**

After the selection of three sites in different districts in Jeddah, a comprehensive evaluation was conducted. The selected location is Site 3, which is Old Jeddah King Khaled Road/ old Makkah (Al-Nazlah Al-Yamaniyah) with site area of 40000 sqm. Note that site 3 was selected based on the suggested proposal map of metro Jeddah line that has been published by Jeddah Municipality.

At the location of selected site, the temperature all year round typically varies from 18°C to 39°C and is rarely below15°C in winter or above 41°C in summer. The humidity varies all year around from 30% (Dry) to 89% (very humid) and is rarely below 17%(dry) and above 96% as (very humid).The wind varies all year around from 0 m/s to 8 m/s (calm to fresh breeze) and it rarely exceeds 11 m/s (fresh breeze). The lowest average wind is 3m/s which are around the month of October. The average daily maximum wind speed is 7 m/s (moderate breeze). The site climatic diagram is shown in Figure 8.

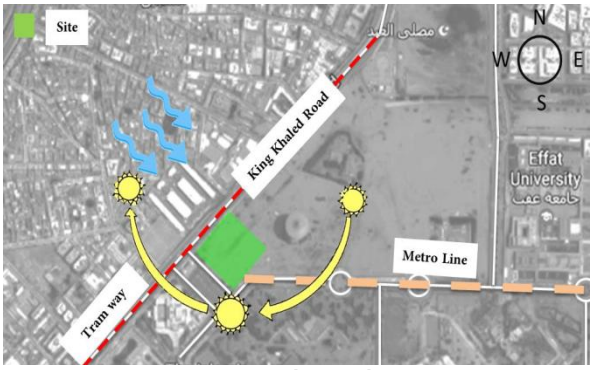

Figure 8. Site climatic diagram

PROJECT ZONING AND DESIGN

Figure 9 and Figure 10 demonstrates the final site zoning diagram and circulation respectively. The design concept was to focus on the movement and speed. Powerful and speedy shape is containing taking the motifs from flow of speed and wave-cross image of the railway. The design expresses the vitality. The void and skylight is implemented to allow flow of natural ventilation inside the building. The shading devices were designed in the specific shape to allow air flow and sun rays to flow between them and give aesthetic form. Also, use the recycled grey water to irrigate the roof garden and landscape. In addition, the dancing fountain is taking place in the center of the plaza to maximize benefits from air movement to cooling the place in hot weather and also aesthetic form.

The building orientation is designed according to the cool wind which coming from western north and minimize heat gain. Figure 11, 12, 13 and 14 demonstrate the external view, metro station, mall and roof garden of the project respectively.

Figure 9. Final zoning

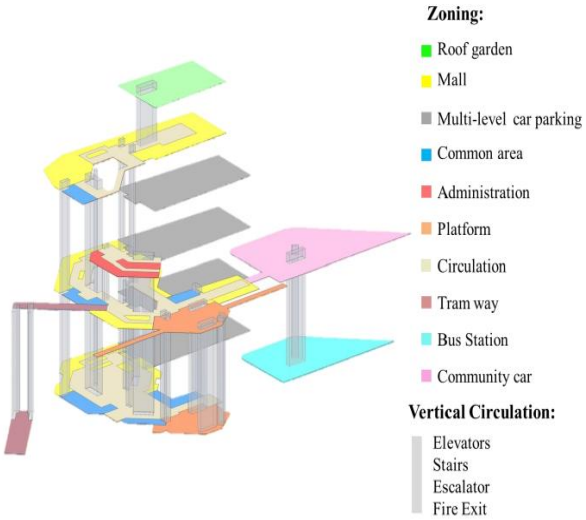

Figure 10. Zoning and Circulation

Figure 11. External view

Figure 12. Metro Station

Figure 13. Mall

Figure 14. Roof Garden

CONCLUSION

This study applied the intelligent transit system to the new transportation system, which has a special attraction for people. Having professionally built radio stations is one way to achieve entertainment and attract people. The railway station mainly provides two functions, namely access to the transportation channel platform and customer transportation information. Therefore, every part of the station, such as shopping malls, administrative areas, parking lots and platforms, should be seriously considered to meet the main purpose of its existence and to play a role in improving the surrounding communities. The selected site for the project is Old Jeddah (Al-Nazlah Al-Yamaniyah) with a site area of 40000sqm and the draw the advantages of accessibility, future development, surrounding and visibility.

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