TRANSIT-SUPPORTIVE STRATEGIES FOR A SUCCESSFUL NEW PUBLIC TRANSPORTATION SYSTEM IN RIYADH

A RESEARCH PAPER

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INTRODUCTION

As an urban planner, I strongly believe in the significance of having a functional public transportation system in any city or urban area. When an urban area has a population of more than one million, a comprehensive public transportation system is a necessity, making it a public right for the people of that area. Riyadh is the capital of Saudi Arabia, and it is also its largest city, with more than 5.3 million people. Urban expansion had already reached 1297 km$^2$ in 2012, at which point the city still had no integrated public transport. “Better late than never”, the city started the construction of a comprehensive public transportation system in 2014 with a budget of more than 22 billion dollars. This is a relief, because the city is expected to reach a population of 8 million people by 2030. With a huge budget like this one, neither the government nor people want this project to fail. In this type of project, the number of end users is the simplest criterion of success. In other words, this project must be used by people to achieve the goals behind creating it, one of which and most importantly is to ease the unbearable traffic jams in Riyadh.

Many public transportation systems are struggling around the world. High operating costs, poor locations of stations and lines, and a general preference for private vehicles over any other transportation mode are some reasons for this. Riyadh is also likely to face some local challenges in terms of public transportation. The extreme hot weather in most months of the year, when temperatures frequently exceed 100° F, is a particularly important challenge. This severe weather is combined with a pedestrian-unfriendly urban environment as the city was built
completely for cars. Another special challenge for public transportation in Riyadh is the special
traditions and cultural norms of a conservative society where privacy is always desired.

These challenges, both the general and the specific, can lead to a fear of failure when
introducing public transportation. Consequently, every possible strategy to increase the likely
success of this project must be explored.
ABOUT THE NEW PUBLIC TRANSPORTATION SYSTEM IN RIYADH

The High Commission for the Development of Arriyadh elaborated an all-inclusive public transport plan that includes provisions for the Riyadh city public transport project, which includes a bus and metro network that will work in tandem. The plan intends to provision the entire population with appropriate public transport services. In so doing, it will efficiently and suitably expand transport options in the city, while maintaining private vehicular traffic so long as it falls within the prescribed limitations.

According to Arriyadh Development Authority (ADA, 2015), the project aims to assist various aspects of Riyadh in addition to traffic, including social, environmental and economic aspects. In addition, the project will result in a large-scale public transport system that is not only adequate for the Riyadh of today, but also for the Riyadh of tomorrow.

- **Riyadh Metro**

The central aspect of Riyadh’s public transport system is the metro network. As shown in figure 1, the network comprises six lines and 85 stations, and covers a total distance of 176 cumulative kilometres. As planned, the metro system will reach the majority of public facilities, educational institutions, medical facilities, commercial enterprises, and densely populated neighbourhoods. The metro system will link downtown Riyadh with the King Khalid International
Airport, all major university campuses, the public transport centre, and the King Abdullah Financial District.

The design of the metro system integrated a range of top modern technology. For example, trains will operate without the assistance of a driver. Instead, operations will be automatic and highly specific, administered via a central control room. The cars themselves also take advantage of world-class technology. Internal separation is possible to allow for different classes of service within each car. Communication and information exchange is also facilitated within each car.

The metro stations themselves are visually connected through a unique set of architectural characteristics. Stations will prioritise passenger comfort and safety. To this end, each station will be appointed with air conditioning, internet access, and a passenger information mechanism. Some stations will go even further, and will provide passengers with shopping and car parking facilities. As claimed by ADA (2015), solar cell technology will be utilised to ensure stations reduce their required power consumption by up to 20 percent. One major component of the Riyadh metro project are the four main stations, which can be found at transport connection locations and densely populated areas. These stations will facilitate connection to the bus network and are vital to the Riyadh city public transport system’s success. These stations will host a variety of services including customer services, car parking, ticket sales and shopping. Five stations will act as transfer stations, and will connect directly to the bus network. These stations enable Riyadh passengers to smoothly pass between different forms of public transportation.
The metro network will be supplemented by 21 Park-and-Ride locations that can hold between 200 and 600 vehicles. The Park-and-Ride locations can be found throughout the network, and connect passengers on the public transport system with private vehicles.

*Figure 1: Riyadh’s Metro network*

*Note:* Retrieved from "King Abdulaziz Project for Riyadh Public Transport, About the Project". By Arriyadh Development Authority, 2015
• **Riyadh Bus Project**

Acting as the main input to the Riyadh metro network, the Riyadh bus network will include 6,765 stops and will cover a total of 1,200 kilometres. Because of its ubiquity, bus network will serve as the primary transportation mode within and between Riyadh’s different districts. As stated by ADA (2015), a select list of criteria was referenced when devising the bus routes:

- Connection to the metro network
- Harmony with future municipal construction plans
- Ability to connect Riyadh districts with business and commercial activity
- Diminished vehicular traffic in the city
- Reduction of energy use and environmental pollution
- Reduced time spent by Riyadh citizens in traffic

There are four service levels of bus service according to the design (see Figure 2):

- **Level 1 – Axial Network:** Incorporating 103 stations and an overall distance of 77 kilometres, the level one network refers to dedicated (bus-only) lanes.
- **Level 2 – Supporting Circle Network:** There are two major lines considered as part of the level two network which consist of 83 kilometres. The 67 stations on these lines service Riyadh’s major residential areas.
- Level 3 – Secondary Arterial Network: Level three might be considered the ordinary bus routes. These lines link neighbourhoods in Riyadh city with one another. The level three network covers 444 kilometres with 17 lines.

- Level 4 – Local Network: Level four bus lines act as neighbourhood-level feeder lines to the arterial networks. With 600 kilometres of bus line service, level 4 will access residential districts and service the majority of Riyadh.

Figure 2: The four service levels of bus service

Note: Retrieved from “King Abdulaziz Project for Riyadh Public Transport, About the Project”. By Arriyadh Development Authority, 2015.
In addition to bus lines, the bus network project also includes four styles of bus station to suit each service level’s function, capacity and style. As reported by ADA (2015), in an aim to make the network more effective, these stations provide for bus tracking (allowing passengers real-time updates) and deliver passenger guidance and information, in particular information regarding scheduling. All public transport systems in Riyadh will be linked through a unified ticketing service which will apply to both busses and metro.

Four Park-and-Ride facilities, which can host between 200 and 600 vehicles, were instituted to ensure passengers had easier access to the bus network. The King Abdulaziz Project for Riyadh Public Transport (metro and bus) includes 35 park-and-ride facilities.
SIGNIFICANCE OF THE STUDY

1. Frustrating Examples From Around the World

Public transportation systems generally are not always the most successful systems nowadays, especially from an economic perspective. Historically and before the high prevalence of private vehicles around the 1960s, subsidies were not needed in the majority of the public transportation systems because operating costs were lesser than revenue (Lave, 1991). However, Bly, Webster and Pounds (1980) indicated in their study in fifteen different countries that the need for subsidies in these systems increased rapidly from 1965 to 1976. According to Pucher (1982), while users’ fares paid 99 percent of operating cost in 1965 in the U.S.A.’s transit systems, this percentage decreased to less than 42 percent in 1980.

Looking at the ratio of fares to operating costs in many transit systems from different cities around the world in recent years, most of them are far from self-supporting, with the exception of a few Asian cities (see Table 1). Government intervention through subsidies is therefore usually required to cover costs to some degree.
Table 1: The ratio of fares to operating costs in selected transit systems from different cities around the world in recent years

<table>
<thead>
<tr>
<th>Region</th>
<th>Ratio</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atlanta (MARTA)</td>
<td>31.8%</td>
<td>2007</td>
</tr>
<tr>
<td>Austin (CMTA)</td>
<td>9.0%</td>
<td>2007</td>
</tr>
<tr>
<td>Boston (MBTA)</td>
<td>43.7%</td>
<td>2002</td>
</tr>
<tr>
<td>Chicago (CTA)</td>
<td>50.0%</td>
<td>2009</td>
</tr>
<tr>
<td>Cleveland (GCRTA)</td>
<td>21.5%</td>
<td>2002</td>
</tr>
<tr>
<td>Detroit (Ddot)</td>
<td>13.9%</td>
<td>2002</td>
</tr>
<tr>
<td>Harrisburg, PA (CAT)</td>
<td>35.0%</td>
<td>2005</td>
</tr>
<tr>
<td>Las Vegas Monorail</td>
<td>56.0%</td>
<td>2006</td>
</tr>
<tr>
<td>Long Island (MTA)</td>
<td>26.6%</td>
<td>2009</td>
</tr>
<tr>
<td>Los Angeles (LACMTA)</td>
<td>30.6%</td>
<td>2004</td>
</tr>
<tr>
<td>Maryland</td>
<td>26.3%</td>
<td>2002</td>
</tr>
<tr>
<td>Miami</td>
<td>16.1%</td>
<td>2002</td>
</tr>
<tr>
<td>New York City (MTA)</td>
<td>36%</td>
<td>2009</td>
</tr>
<tr>
<td>New York/Connecticut (MTA)</td>
<td>36.2%</td>
<td>2009</td>
</tr>
<tr>
<td>New York/New Jersey (PATH)</td>
<td>41.0%</td>
<td>2002</td>
</tr>
<tr>
<td>New Jersey (NJT)</td>
<td>56%</td>
<td>2001</td>
</tr>
<tr>
<td>Orlando (Lynx)</td>
<td>26%</td>
<td>2006</td>
</tr>
<tr>
<td>Philadelphia (SEPTA)</td>
<td>58.6%</td>
<td>2002</td>
</tr>
<tr>
<td>Pierce County, WA</td>
<td>13.0%</td>
<td>2009</td>
</tr>
<tr>
<td>Philadelphia/New Jersey (PATCO)</td>
<td>61.4%</td>
<td>2002</td>
</tr>
<tr>
<td>Puget Sound Region (King County Metro)</td>
<td>19.1%</td>
<td>2006</td>
</tr>
<tr>
<td>Puget Sound Region (Sound Transit)</td>
<td>22.2%</td>
<td>2007</td>
</tr>
<tr>
<td>San Francisco Bay Area (BART)</td>
<td>45%</td>
<td>2007</td>
</tr>
<tr>
<td>San Francisco Bay Area (Caltrain)</td>
<td>41%</td>
<td>2006</td>
</tr>
<tr>
<td>Staten Island (MTA)</td>
<td>15.2%</td>
<td>2002</td>
</tr>
<tr>
<td>Washington, DC (WMATA)</td>
<td>61.6%</td>
<td>2002</td>
</tr>
<tr>
<td>Canada</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edmonton (ETS)</td>
<td>39.4%</td>
<td>2007</td>
</tr>
<tr>
<td>Montreal (STM)</td>
<td>57.1%</td>
<td>2006</td>
</tr>
<tr>
<td>Ottawa (OC Transpo)</td>
<td>43.2%</td>
<td>2007</td>
</tr>
<tr>
<td>Toronto (TTC)</td>
<td>65.2%</td>
<td>2008</td>
</tr>
<tr>
<td>Toronto, Hamilton and area (GO Transit)</td>
<td>83.6%</td>
<td>2008</td>
</tr>
<tr>
<td>Vancouver (TransLink)</td>
<td>54.1%</td>
<td>2008</td>
</tr>
<tr>
<td>Asia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hong Kong (MTR)</td>
<td>149%</td>
<td>2007</td>
</tr>
<tr>
<td>Osaka (Hankyu Railway)</td>
<td>123%</td>
<td>1991</td>
</tr>
<tr>
<td>Osaka (OMTB)</td>
<td>137%</td>
<td>1991</td>
</tr>
<tr>
<td>Taipei (MRT)</td>
<td>119%</td>
<td>2006</td>
</tr>
<tr>
<td>Teito RTA (now Tokyo Metro)</td>
<td>170%</td>
<td>1991</td>
</tr>
<tr>
<td>Europe</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brussels</td>
<td>28%</td>
<td>1991</td>
</tr>
<tr>
<td>Copenhagen</td>
<td>52%</td>
<td>1991</td>
</tr>
<tr>
<td>London Underground</td>
<td>100%</td>
<td>2004</td>
</tr>
<tr>
<td>Milan</td>
<td>28%</td>
<td>1991</td>
</tr>
<tr>
<td>Munich</td>
<td>42%</td>
<td>1991</td>
</tr>
<tr>
<td>Paris (RATP)</td>
<td>43%</td>
<td>1991</td>
</tr>
<tr>
<td>Stockholm</td>
<td>44%</td>
<td>1996</td>
</tr>
<tr>
<td>Vienna</td>
<td>50%</td>
<td>1991</td>
</tr>
<tr>
<td>Zurich</td>
<td>66%</td>
<td>1991</td>
</tr>
</tbody>
</table>

It is important to note that there is a huge debate surrounding the justifications for transit subsidies. Supporters of public transit, mostly urban planners rather than economists, see it as crucial to the liveability of any city, and recognize the many social, environmental and economic benefits of having a public transit system, especially in big cities. Litman (2013) provided some examples of those benefits as summarized in Table 2. Even from a solely economic perspective, however, numerous studies have shown the many indirect economic benefits of public transit. Nevertheless, the high cost of transit systems compared to the direct economic return they produce is a concern in most cities around the world.

**Table 2**: Many social, environmental and economic benefits of having a public transit system.

<table>
<thead>
<tr>
<th>Type of Benefit</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social</td>
<td>Helps foster a sense of community. For example, people traveling together are more likely to feel a community connection than those traveling in cars in isolation.</td>
</tr>
<tr>
<td></td>
<td>Encourages people to have a more active healthy lifestyle, particularly if they are walking or cycling to their station or stop.</td>
</tr>
<tr>
<td></td>
<td>Helps reduce injuries and fatalities caused by car accidents.</td>
</tr>
<tr>
<td></td>
<td>Provides accessible transport for people regardless of demographics such as income or age.</td>
</tr>
<tr>
<td></td>
<td>Is less stressful. Rather than driving in traffic or wasting time looking for an elusive car park, public transport passengers can relax and listen to music, play computer games or read a book.</td>
</tr>
<tr>
<td>Economic</td>
<td>Travel is cheaper than owning and operating a car.</td>
</tr>
<tr>
<td></td>
<td>Reduces the need for building vast car parks on valuable land that could have otherwise been used as highly prized office or retail space.</td>
</tr>
<tr>
<td></td>
<td>Reduces reliance on rapidly decreasing oil supplies.</td>
</tr>
<tr>
<td>Environmental</td>
<td>Reduces pollution and road congestion - the more people who travel by train, tram or bus, the fewer cars on the road.</td>
</tr>
<tr>
<td></td>
<td>Requires less land use than road infrastructure.</td>
</tr>
</tbody>
</table>

*Note: Adapted from “Benefits of public transport”. By Litman, T., 2013*
2. Serious Special Challenges and Barriers

It is important to understand the challenges and barriers that affect potential users of public transit and decrease take up; some of these, we can do little or nothing about. The extreme heat is definitely a major challenge that may affect the success of the Riyadh’s new public transit. Extreme heat is defined as temperatures between 90° F and 100° F (Easterling et al., 2000; Chicago Metropolitan Agency for Planning, 2013). The average maximum temperature in Riyadh in the summer months (June to August) is 107.6° F, well above this; while temperatures still range from 90° F to 102° F in spring and fall months (BBC Weather, 2015). In her study on public transportation ridership in the Chicago Metropolitan Area, McCormack (2015) discovered that extreme heat had a negative effect on the number of riders of public transit. Knowing this effect and considering the average excessive temperature in Riyadh for most months of the year raises concerns about how many users the new transit project can attract.

The inconvenient hot weather coexists with a completely auto-oriented urban environment. Riyadh was mostly developed in the 1950s, which was the golden era of highway systems in the U.S.A. due to the prosperity of the private vehicle industry at that time. Riyadh’s planners were influenced by that fashionable trend in the U.S.A. and the rest of the world. The city is not only divided into many parts by broad streets and huge highways, but the densities, land uses, and buildings heights were all determined based on an auto-oriented model. Even if the city wanted to make every possible effort to change this situation by adding as many sidewalks as possible and changing the policies, ordinances, and even land use to support the
TOD model, it is impossible to completely change a developed city from an auto-oriented to transit-pedestrian-mode.

The unique and different culture of Saudis is another factor that is likely to affect the use of the Riyadh’s public transit. While academic studies that show a connection between culture and use of public transportation are scarce, there is evidence that points to at least an indirect connection. Many anthropologists confirms that personality is partly obtained through culture. Triandis and Suh (2002), for example, state that culture has an impact on personality development. Personality has been proven to be an important factor in terms of peoples’ choices in using public transit (Bamberg, Hunecke and Blobaum, 2007). Consequently, culture is very likely to affect public transportation use.

As the Riyadh’s new public transportation system is the first of its kind in the entire country, the Saudi culture has not been tested by a similar project. Many of the region’s unique cultural and tradition norms, which include sex segregation and an intense tendency to privacy, are not congruent with the environment of public transit, making it difficult to be optimistic about the Saudi culture’s response to the Riyadh transit project. One rare study on travel behaviour in Saudi Arabia conducted by Al-Atawi and Saleh (2014) confirmed that privacy is a major factor in Saudi people’s choice of modes of transportation.
3. The Current Economic Situation in Saudi Arabia

There was a dramatic change in the Saudi economic situation from when the project was announced in April 2012 to the beginning of 2016. This radical change must be considered as a critical point for the future Riyadh’s public transit system. The economy of Saudi Arabia is petroleum-based; indeed, Saudi Arabia is one of the world’s largest producers of oil. According to the United Nations Development Program (2015), about 90 percent of export earnings in the country are generated by the oil industry. However, the oil price fell sharply, down from around $103 per barrel in April 2012, when the Riyadh’s public transit project was adopted, to below $28 in January 2016. It is reasonable to assume that this dent to the Saudi economy has meant that the government’s interest in the success of the costly Riyadh’s transit project has become even greater.
The goal of this study is to explore the incentives, tools and strategies to enhance the opportunity for success of the Riyadh’s new transit system. Success in terms of a new public transportation system simply means that people will accept this system as a mode of transportation and will use it. In Riyadh’s case, where the public transit is a brand new project, the targeted users obviously are not new creatures, but they are the same people who are using the only available mode of transportation presently, private vehicles. This means that the introduction of the system needs to make people undergo a mode shift, from cars to public transit.

According to Slack, Rodrigue and Comtois (2013), when there is a comparative advantage of one mode over another mode in the same place, the shift happens naturally. In the case of transportation choices, many studies have discussed the factors that can give comparative advantages to one mode over another mode. Table 3 shows those factors as reported by Kittleson and Associates (as cited by Litman, 2012, p. 15).
Table 3: Factors that can give comparative advantages to one mode over another mode

<table>
<thead>
<tr>
<th>Factors</th>
<th>Using These Factors To Increase Ridership And Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convenience</td>
<td>Increase transit service coverage and frequency.</td>
</tr>
<tr>
<td>Information</td>
<td>Provide information on where, when and how to use transit.</td>
</tr>
<tr>
<td>Price</td>
<td>Keep fares low and offer targeted discounts, such as commuter passes.</td>
</tr>
<tr>
<td>Speed</td>
<td>Provide express commuter services and transit priority measures.</td>
</tr>
<tr>
<td>Accessibility</td>
<td>Develop more accessible land use patterns and more diverse transportation systems.</td>
</tr>
<tr>
<td>Integration</td>
<td>Provide park &amp; ride facilities, transit service to major transportation terminals.</td>
</tr>
<tr>
<td>Comfort</td>
<td>Provide adequate service so transit vehicles are not crowded.</td>
</tr>
<tr>
<td>Security</td>
<td>Insure that transit vehicles, facilities and service areas are considered secure.</td>
</tr>
<tr>
<td>Prestige</td>
<td>Treat transit riders with respect, and promote transit as a desirable travel option.</td>
</tr>
</tbody>
</table>


The significance of each of these factors varies from place to place and from person to person, depending on natural (e.g. weather), social, and economic situation. Strategies and incentives that seek a modal shift therefore have to manipulate these factors.

As the private vehicle is doubtless the most desirable transportation mode not only in Riyadh but also in most places around the world, a range of strategies and incentives have been utilised to facilitate the use of other transportation modes, mostly public transit(for different economic, social, and environmental reasons) by many cities throughout the world. In some cities the focus was on a single strategy or incentive which was believed to be the most effective while on other cities the approach was to use a package of different incentives and strategies which collectively aim to steer motorists away from their cars and toward transit. Some cities even use further complicated programs to manage their transportation systems and the shares of different modes. These programs are known as Transportation Demand Management (TDM), Mobility Management or Travel Options. Transportation Demand Management is “a general term for
strategies that increase overall system efficiency by encouraging a shift from single-occupant vehicle (SOV) trips to non-SOV modes, or shifting auto trips out of peak periods. This supports the Urban Mobility Plan’s focus on moving people and goods rather than motor vehicles. TDM seeks to reduce auto trips – and hopefully vehicle miles travelled – by increasing travel options, by providing incentives and information to encourage and help individuals modify their travel behaviour, or by reducing the physical need to travel through transportation-efficient land uses” (Seattle Department of Transportation, 2008a).

Table 4 outlines the strategies that can promote the use and growth of public transport identified by the European Commission on Transportation Research (1996). Those strategies were categorised into two major groups: direct and indirect. Each group was further subdivided into subgroups according to the effective factor of the strategy (e.g. price and quality). The direct strategies are more connected to the transit system itself, such as the fare and quality, while the indirect strategies relate to wider general factors related to the public polices and city planning. It interested me that this study found that indirect strategies play a crucial role. According to the study, the direct strategies alone cannot effectively increase the use of public transit. The study emphasised the significance of using both direct and indirect strategies to achieve a successful public transit system.
Table 4: Strategies that can promote the use and growth of public transport

<table>
<thead>
<tr>
<th>DIRECT STRATEGIES</th>
<th>SERVICE PATTERN</th>
<th>SERVICE QUALITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRICING</td>
<td>Extensiveness of Routes</td>
<td>Vehicle Characteristics</td>
</tr>
<tr>
<td>Fare Levels</td>
<td>Distance to/from Stops</td>
<td>Bus/Rail Stop Quality</td>
</tr>
<tr>
<td>Ticketing Regimes/Fare Structure</td>
<td>Service Frequency/Travel Time</td>
<td>Interchange Quality</td>
</tr>
<tr>
<td>Ticketing Technology</td>
<td>Operating Hours</td>
<td>Quality/Number of Staff</td>
</tr>
</tbody>
</table>
| Subsidy Regime    | Fleet Size | INFORMATIO
| PRIORITY MEASURES | REGLATORY REGIME | Information Provision |
| Link Priority/Right-of-Way | Market Regulation | Publicity/Promotion |
| Junction Priority | Operational Regulations | |
| OTHER             | Quality Regulations | |
| Park-and-Ride     |                 | |
| Integrated Approach |                | |

<table>
<thead>
<tr>
<th>INDIRECT STRATEGIES</th>
<th>CAR USE, AREA-SPECIFIC</th>
<th>OTHER</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAR OWNERSHIP</td>
<td>Traffic Calming</td>
<td>Information on Traffic Conditions</td>
</tr>
<tr>
<td>Taxation of Car Ownership</td>
<td>Access Restrictions</td>
<td>Land Use Planning</td>
</tr>
<tr>
<td>Restrictions on Car Ownership</td>
<td>Road Pricing</td>
<td>Telecommuting/Tele-Shopping</td>
</tr>
<tr>
<td>CAR USE, GENERAL</td>
<td>Parking Availability</td>
<td>Flexible Working Hours</td>
</tr>
<tr>
<td>Fuel Tax</td>
<td>Cost of Parking</td>
<td>Increase in Road Capacity</td>
</tr>
<tr>
<td>Restrictions on Car Use</td>
<td>Parking Enforcement</td>
<td>Improvements to Non-Motorized Modes</td>
</tr>
<tr>
<td>Car Vehicle Specification</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Reprinted from "Effectiveness of Measures Influencing the Levels of Public Transport Use in Urban Areas". By The European Commission on Transportation Research, 1996.

The Transit Cooperative Research Program Report 111 (TCRP 111. 2007) reviewed the most successful strategies for increasing ridership of public transit at the expense of SOVs (single-occupant vehicle) in 17 cities in Europe and other places. Like the European Commission study, this research differentiated between direct and indirect strategies, however, it applied different labels: internal and external strategies. The report concluded that the successful strategies focused on:

- Internal strategies: Giving great attention to the comfort, reliability and convenience of the transit system.
• External strategies: Implementing policies to restrict SOVs and increase the transit system’s opportunities to compete with private vehicles. These polices include parking limitations and high fuel prices.

• External strategies: Implementing policies in regard to urban planning (land use and development polices) to be more consistent with the transit system and transit planning.

The report clearly acknowledged the importance of the external (indirect) strategies in shifting transportation modes. Parking pricing and management, increased fuel prices, and policies regarding urban patterns were stressed as the most effective means of giving public transit an advantage over SOVs.

Victoria Transport Policy Institute’s (2015a) comprehensive encyclopaedia on TDM provided 13 strategies that can encourage public transit ridership by giving those with access to both private vehicles and transit incentives to choose transit. Table 5 summarises and explains those strategies.
Table 5: Strategies that can encourage public transit ridership

<table>
<thead>
<tr>
<th>Strategy</th>
<th>explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improve Transit Service</td>
<td>Improve speed, frequency and comfort.</td>
</tr>
<tr>
<td>Improved Stops and Stations</td>
<td>Including a range of features which improve comfort and convenience such as internet access, refreshments, toilet facilities, information services, seating and shelter.</td>
</tr>
<tr>
<td>Transit-Oriented Development</td>
<td>Dense and pedestrian- friendly Mixed-use development around transit stations</td>
</tr>
<tr>
<td>Reduce fares and offer discounts</td>
<td>Such as discounts for students and employees</td>
</tr>
<tr>
<td>More convenient fare structures and Payment Systems</td>
<td>Such as using mobile applications and smart cards.</td>
</tr>
<tr>
<td>Amenities</td>
<td>Such as providing free internet</td>
</tr>
<tr>
<td>Improve rider information and Marketing programs</td>
<td>By launching carefully researched marketing campaigns in television, radio, online and print.</td>
</tr>
<tr>
<td>Park &amp; Ride facilities</td>
<td>Providing sufficient parking for transit users in transit stations</td>
</tr>
<tr>
<td>Improve walkability around transit stops and stations</td>
<td>By building connected and safe pedestrian sidewalks especially around stops and stations</td>
</tr>
<tr>
<td>Create a Multi-Modal Access Guide</td>
<td>Provide information on how to reach a specific destination using transit in the form of contact numbers, schedules and maps.</td>
</tr>
<tr>
<td>Commuter Financial Incentives - Parking and Road pricing</td>
<td>Make transit much cheaper than using private vehicles</td>
</tr>
<tr>
<td>More integrated transport policies and planning</td>
<td>Integration of transport information, physical integration of the services, integration of ticketing and fares, integration of management; and integration with land use planning.</td>
</tr>
<tr>
<td>Other TDM Programs that encourage use of alternative transportation modes.</td>
<td>Such as Employee Trip Reduction Programs</td>
</tr>
</tbody>
</table>

*Note: Adapted from “Public Transit Encouragement”. By Victoria Transport Policy Institute, 2015.*

While the study did not differentiate between internal (direct) and external (indirect) strategies, it is evident that these strategies combine elements of both. Therefore, and according to the study, these strategies should be implemented not only by transit agencies but also by governmental entities.
Taylor et al. (2002) summarised the results of two interview studies conducted in 1995 and 1998 by The Transit Cooperative Research Program. The results summarised strategies that can increase transit ridership, as reported by more than 50 transit agencies managers around the US. These strategies, according to the study, were sorted in five major groups:

1. Strategies related to service adjustments: such as improving passenger amenities, improving the frequency of service, and redistribution of service to the most popular routes.
2. Strategies related to fare and pricing: such as increasing outlet sales and increasing the provision of discount passes.
3. Strategies related to planning orientation: such as community-based planning.
4. Strategies related to marketing and informational initiatives: such as creative and aggressive marketing to target specific groups (e.g. advertising around sports to attract 25-50 age group)
5. Strategies related to service coordination, consolidation and market segmentation: such as coordination with universities.

Despite the fact that these groups of strategies were based on the answers of transit agencies managers, who are obviously more connected to internal strategies, the external strategies were recognised and mentioned in groups three and five. Group three in particular presents planning orientation strategies which are beyond the scope of the agencies’ managers but under the authority of government bodies.

As a part of the city’s transit master plan, the Seattle Department of Transportation (2008b) conducted a study to explore the best TDM strategies to shift travellers from SOV to
other modes, mostly public transit. This studied was based on the lessons learned from the experience of other US and European cities. The city’s study identified a number of internal and external strategies to support transit, however, it was primarily focussed on external strategies which require much effort beyond the transit agency or the system itself. It is noteworthy that this study provided strategies which were connected with successful real examples. Table 6 summarises these strategies, the best practice of each strategy as stated in the study, and provides a brief explanation about each one.
### Table 6: The best TDM strategies to shift travelers from SOV to other modes

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Explanation</th>
<th>Best practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improve pedestrian environment and access to transit</td>
<td>Researchers have found that areas with low levels of transit have less walking. The pedestrian environment includes bus stops, signage, travel information, building awnings, lighting, benches, curb ramps, level boarding features, platforms and the width and texture of sidewalks.</td>
<td>Safe Routes to Transit Program, New York city; Pedestrian Access and Bus Stop Improvements, Portland; Transit Access Guidelines, Denver.</td>
</tr>
<tr>
<td>Improve bicycle amenities and access to transit</td>
<td>Attract new transit passengers by enhancing bicycle and rail integration (connectivity between modes) and creating a safe and comfortable bicycling environment to enhance the overall travel experience. (E.g. bicycle boulevards and lanes, cycle tracks, external and on-board bike racks, bike parking, end-of-trip facilities such as showers and storage, bike-share programs). According to the Portland Bureau of Transportation, the capture area of investment in transit can be increased twelve-fold by the provision of improved access for cyclists.</td>
<td>Portland and Vancouver</td>
</tr>
<tr>
<td>Road space allocation and the Complete Streets concept</td>
<td>The development of bus-only lanes, cycle lanes and public plazas through the reallocation of space. And reassigning right-of-way to accommodate all users (cyclists, pedestrians and transit users).</td>
<td>New York City</td>
</tr>
<tr>
<td>Transit passes programs in coordination with employers and universities</td>
<td>Unlimited access to public transit or low-cost tickets can be provided through cooperation with residential neighbourhoods, developers, employers and universities. Car usage can decrease between 4 percent and 22 percent.</td>
<td>FlexPass for employers and U-PASS for the University of Washington, Seattle; and Eco-Pass for employers and neighbourhood associations, Denver</td>
</tr>
<tr>
<td>Toll and congestion pricing</td>
<td>Economic incentive to take transit by imposing fee to: drive on congested roads or enter congested subareas. In many cities, congestion pricing has been proven to increase transit ridership up to 15-30 percent and raise revenue for the transportation system.</td>
<td>Singapore, London, and Stockholm</td>
</tr>
<tr>
<td>Transit priority treatments</td>
<td>Manage city streets to optimise transit speeds with the least possible negative impacts on other road users (e.g. buses queue jump with advanced stop bar, and median transit lanes).</td>
<td>Ottawa, Richmond and Cleveland</td>
</tr>
<tr>
<td>Parking pricing and management</td>
<td>Many researches confirmed that the decision to utilise a personal vehicle rather than public transit is partly based on the provision of cheap or free parking at the final destination.</td>
<td>San Francisco and Seattle</td>
</tr>
<tr>
<td>Land use management &amp; transportation land-use linkages</td>
<td>Strict land-use policies to support transportation policies (prioritise cycling, walking and transit for space and spending and develop downtown neighbourhoods which are walkable, dense and mixed use).</td>
<td>Vancouver</td>
</tr>
<tr>
<td>Improve transit information using new technologies.</td>
<td>Improve travel times and passenger experience by using the latest and best available technologies such as multi-use contactless smart cards and mobile phone transit passes.</td>
<td>Los Angeles and San Francisco</td>
</tr>
<tr>
<td>Provide park-and-ride facilities (incentive parking)</td>
<td>Increases transit use in regions where access to transit is otherwise difficult by encouraging commuters to make a short trip to the park-and-ride rather than a longer one to the final destination. The effectiveness of park-and-ride services decreases with proximity to the destination.</td>
<td>Seattle</td>
</tr>
<tr>
<td>Employers parking cash-out</td>
<td>Giving the employee the choice to give up his subsidized parking space for cash or bonus.</td>
<td>State of California</td>
</tr>
</tbody>
</table>

*Note: Adapted from “Seattle Transit Master Plan Briefing Book”. By Seattle Department of Transportation, 2008.*
CASE STUDIES OF SUCCESSFUL EXAMPLES

After reviewing the research and studies on the incentives and strategies that can support travellers’ shift to public transit and increase its users, in this chapter I will shed light on some promising real experiences from different parts of the world where cities successfully applied different incentives and strategies to make the desired shift to public transit and boost its ridership numbers. I believe that presenting real world numbers that show positive changes in transit ridership due to the implementation of various pro-transit strategies can be very encouraging for Riyadh authorities to adopt some of those strategies, the most effective and suitable for Riyadh and its new public transportation system.

When we examine the big picture of public transit in the US for example, it is evident that public transit has been struggling since the 1970s, with an average mode-share below 5 percent (American Public Transportation Association, 2010). However, we can still find great examples in many American cities where they successfully increased their transit ridership numbers using different strategies and incentives. There are also greater successful stories in other parts of the world such as in Canada, Australia and Europe where various incentives and strategies have been implemented in many cities to rise the number of people for whom public transit is their main mean of transportation.

The Transit Cooperative Research Program (TCRP) conducted several studies to identify the internal and external factors and incentives that positively influence the number of public transportation users in several cities around the US. Stanley (1995) conducted a study for the
TCRP which analysed the policies and strategies implemented between 1991 and 1993 and successfully increased the ridership numbers for transit agencies in the United States. 40 US transit agencies and their strategies and ridership numbers were analysed for this study. One successful example identified in this study is the 21.8 percent rise in transit ridership in the Champaign-Urbana metro area. According to the study, this increase resulted from number of strategies including: (a) parking management, especially in the University of Illinois which is the core of the area; (b) the construction of park-and-ride facilities; (c) introducing the university pass program; and (d) a marketing campaign directed at university students and employees. Blacksburg, Virginia, used similar strategies and its ridership numbers increased by 17.3 percent. It is worth noting that both Urbana and Blacksburg are university-dominated cities.

Stanley (1998) conducted a follow-up study for the TCRP to identify the pro-transit strategies that were instrumental in the increases of ridership in 50 US transit agencies between 1994 and 1996. According to the study, Orlando increased the number of travellers who use public transportation by 38 percent. In addition to the acknowledged rapid regional growth in the area during that period, the study recognised several strategies that supported the use of the transit system: (a) aggressive marketing & public relations program; (b) business partnerships and collaborations; and (c) emphasis on customer service/amenities. Tallahassee, Florida, was also cited in this study as a successful case study in using incentives to support public transportation. The city increased its transit ridership by 11.7 percent in two years through the implementation of the following strategies: (a) partnerships with universities (special passes); (b)
Stanley and Hyman (2005) undertook a follow-on study to the two previous studies. This study was the third such investigation into factors which increase ridership numbers in US cities. This study covers the period between 2000 and 2002 and discuss the initiatives and strategies which contributed to the ridership increase in the regions which saw the greatest growth. Salt Lake City was noteworthy in this study as the transit ridership number rose 13.9 percent. In addition to the introduction of a light rail service, the strategies that are believed to be behind this increase, according to the study, are: (a) promotional free-pass offer; (b) increased emphasis on quality of service; (c) development of a region-wide Transportation Demand Management (TDM) program; and (d) reorganisation of the Utah Transit Authority. Another interesting case in this study was in the city of Gainesville, Florida. The number of public transportation users increased by 37 percent due to two main incentives (in addition to expand the service to serve University of Florida): first, access agreement for U of F students; and second, downtown area land use policy directing developer support for pedestrians and public transportation.

One of the most acknowledged and admired places in the US in terms of managing public transportation systems is Portland. The Portland region became a national model for public transit due to its successful implementation of a number of pro-transit programs, plans and strategies. According to a study by the Victoria Transport Policy Institute (2014), a Transit-Oriented-Development planning approach, enhanced walking and cycling facilities and various other pro-transit policies had significant cumulative effects which tripled the use of Portland’s
transit between 1970 and 2002. Ellis et al.’s (2005) more analytical study on Portland’s transit found that transit mode share increased by 11.6 percent in Portland between 1990 and 2000. The study found that this success is on account of a number of specific strategies that local jurisdictions were required, by Metro (the regional government for Portland metropolitan area), to follow to reduce the use of the private vehicles. These strategies included: (a) adopt and implement ordinances and plans for street connectivity; (b) adopt maximum parking ratios and implement certain parking requirements; (c) create transportation management associations (TMAs); (d) adopt free-zones transit policies in regional centers; and (e) Implement other transit strategies such as the development of a transit system map which met Metro requirements; placing and designing buildings in such a way to encourage transit use; and supporting transit use through improving pedestrian facilities and infrastructure.

By moving north of the US, Canadian cities from Calgary to Winnipeg, Ottawa, Vancouver, Montreal and Toronto all provide bold examples on how transit-supportive strategies can impressively boost transit’s success and increase its share among other travel modes. In Calgary, for example, according to Freemark (2014), transit user numbers skyrocketed by 90 percent from 1996 to 2013, much more than the 50 percent increase in population, which means that transit’s mode share dramatically increased at the expense of private vehicles. Freemark (2014) and the Victoria Transport Policy Institute (2015) attributed this growth to the following strategies: (a) heavy investment in transit infrastructure; (b) strict parking policies especially in downtown; (c) minimising private vehicle access to downtown (no freeways leading to downtown); (d) park-
and-ride facilities providing sufficient number of parking spaces; and (e) managing urban form through thorough policies.

In Vancouver also there was a significant rise in public transit use, particularly in the period between 2002 and 2004. Ridership numbers increased 24.6 percent. A customer survey showed that 42 percent of the SkyTrain’s (the metro system) users have shifted to transit from the private vehicle mode (Litman, 2011). With the acknowledgment of the high population growth and the heavy investment in the transit system, TransLink (Metro Vancouver’s regional transportation authority) (2013) stated that a number of strategies have contributed to that gaining. These strategies include: (a) adding more TOD development; (b) policies to make driving more expensive; and (c) parking management and pricing.

Generally speaking, public transportation in European cities is much more successful than in US cities. For example, in Germany people use transit five times more than Americans do despite its famous car industry and excellent highway network (Buehler and Pucher, 2012). Freiburg city is an excellent example of transit’s success in Germany as stated by another research study by Buehler and Pucher (2011). According to the study, in response to the increase in the use of private vehicles all over the world between 1950 and 1970, Freiburg adopted several strategies to rectify the situation and move people back to transit and other sustainable modes. Consequently, between 1982 and 2007, the automobile share among other transportation modes decreased from 38 percent to 32 percent (contrary to the trend all over the world at that time); and the transit mode share increased to 18 percent from 11 percent. According to the
study, the following supporting strategies were adopted: (a) integrate land use and transportation planning (mix land uses development along transit corridors); (b) policies to limit car access (car-free zones in selected parts of downtown and other areas, and traffic-calmed neighbourhood regulations); and (c) parking management policies (waive the minimum parking requirement, parking cash-out, reserve parking in neighbourhoods for residents, and limited in duration and highly priced on-street parking).

Moving to another continent, transportation in most Australian cities is dominated by the automobile as the majority of Australian cities are built in a car-oriented form. Perth, with its sprawling size (80km by 100km), is not an exception. However, the city successfully embraced various strategies to encourage public transit use. According to Richardson and Burgess (2005), those strategies were: (a) policies prioritising public transportation (bus priority system, and reducing automobile lanes in favour of transit); (b) a marketing program focusing on behavioural changes; (c) building more park-and-ride facilities; and (d) applying parking policies (control parking in the CBD, identify other parking management areas to control parking within them, apply maximum parking regulations, and regulations to impose parking licenses with fees for all non-residential motorists). Consequently, the public transit mode share in the city witnessed a remarkable jump from 10 percent in 2000 to 49 percent in 2012 (TravelSmart Workplace Program, 2013).
DISCUSSION AND RECOMMENDATIONS

The previous two chapters presented clear evidence on how transit-supportive-strategies are crucial to achieving a successful and well-used transit system. The discussed researches and case studies in this paper provide a range of strategies that can be adopted by Arriyadh Development Authority (ADA) to ensure the success of Riyadh’s new public transit system.

These strategies generally can be divided into two types: system-related strategies and complementary external strategies. The first category is more connected to the operation of the transit system itself, while the second one concerns outer incentives that can help to increase the system’s users. The investigated strategies in this paper can be divided between these two groups as follows:

A. System-related strategies:

1. Optimize service patterns:
   - Increase frequency
   - Decrease travel time (duration)
   - Optimal allocation of routes
   - Optimal allocation and number of stops (stations)
   - Extended operation hours

2. Optimize the fare structure and ticketing system:
   - Use the latest technology in the payment system (e.g. smart cards and mobile apps)
- Develop innovative fare structure options (e.g., time-of-day-based fares and frequency-based fares)
- Offer discounts and promotions for selected target groups

3. Optimize the service quality, convenience, comfort and amenities:
   - In vehicles (e.g., cleanliness, comfortable seats, the number of staff, and customer service)
   - In stops (stations): (e.g., shelters, seating, washrooms, rider information, and Wi-Fi)

4. Ensure the system’s reliability: An on-time service and able to operate in difficult conditions (e.g., severe weather)

5. Optimize the service coordination and consolidation between all the modes of public transportation

6. Conduct comprehensive operational analyses on a regular basis

B. **Complementary external strategies:**

1. Transit priority treatments:
   - Right-of-way and junction priority
   - Reduce automobiles lanes in favor of transit

2. Improvement to non-motor modes:
   - Improve walkability, especially around transit stops and stations
   - Improve bicycle amenities and access to transit
   - Adopt and implement ordinances and plans for street connectivity
3. Raise gasoline prices

4. Implement road pricing schemes:
   - Tolls in roadway
   - Lane charging (e.g., high-occupancy toll lanes (HOT) and express-toll lanes)
   - Cordon tolls

5. Establish programs, partnerships and coordination:
   - Government and private employers
   - Universities

6. Implement parking management and pricing policies:
   - On-street parking regulations and pricing
   - Off-street parking regulations
   - Provide adequate park-and-ride facilities

7. Implement transit-supportive urban planning:
   - Transit-oriented development (TOD) planning
   - Integrated transit/land use planning

Unlike in the cases of cities with old transit systems that likely need to consider in depth the system-related strategies to improve their dilapidated systems, Riyadh’s system was only announced in 2012, therefore, the ADA was able to build it to meet the best and latest up-to-date technologies in all aspects such as planning, operation, rider information and ticketing to
ensure the best quality, convenience, comfort and reliability. The allocation of routes, stations and stops was based on a comprehensive analytical study. The system will include approximately 190 trainsets (the speed is approximately 90km/h), and 956 buses. Therefore, the frequency, the trip-duration, and consequently the reliability in the service will probably be very satisfactory. Both the vehicles and the stations were designed to be very comfortable and convenient with all the necessary amenities. The public transportation system, including the metro and buses, will be operated under one management, thus the system will have a high level of integration and coordination. In summary, Riyadh’s new transit system is likely to not require any additional attention or concerns to be paid to the first group of the system-related transit encouragement strategies.

On the other hand, the ADA haven’t shown serious and adequate attention to the second category of the transit encouragement strategies (the complementary external strategies). However, as reviewed in the literature review and case studies of this paper - and according to many other researches and studies - the external factors and strategies are even more important and influential than the system-related ones. Taylor et al. (2002) stated in their executive summary of their study on the most successful transit systems, that “our analysis finds that the most significant factors influencing transit use are external to transit systems. This finding was consistent throughout our review of the research literature, our analysis of nationwide data, our survey of successful transit systems, and our detailed interviews with transit managers.” In his summary of the TCRP’s study on the Examination of Successful Transit Ridership Initiatives, Stanley (1998) stated that “External forces continue to have a potentially greater effect on
ridership than system and service design initiatives.” The European Commission Transport Research Report (1996) concluded that the majority of direct (system-related) strategies do not have a noticeable influence on public transportation’s mode value if implemented alone, and therefore should be adopted alongside indirect (external) strategies in order to have a marked impact.

The ADA obviously needs to seriously consider and pay great attention to the complementary external strategies to increase the likelihood of success for its new public transportation system. In the following section I will discuss each of the external strategies and their suitability for Riyadh’s case.
1. **Transit Priority Treatments**

   As mentioned in this paper, and in many other researches regarding public transportation encouragement, increasing public transportation’s users in any place mainly occurs by attracting travelers from the dominant travel mode - the private vehicle. To attract those motorists, public transit should have every possible comparative advantage over the private vehicle. Therefore, when public transit operates in a mixed-traffic environment with automobiles, public transit should enjoy priority treatments. In Riyadh’s case, while the metro, by character, won’t intersect with other traffic, the bus network will share the same environment with automobiles, with some exceptions, such as in the dedicated lanes of the BRT (Bus Rapid Transit). Therefore, transit priority treatments can be implemented to serve the buses.

   There are numerous varieties of transit priority treatments which could be adopted in transit-served cities. Either, they can be adopted in a long section of road, or only at intersections. The most common forms of transit priority treatments are:

   1. **Reserved bus lanes (in addition to the completely separated lanes of BRT):**

      These are created by dedicating one or two of the general traffic lanes to buses; either they are available for use at specific times of the day – such as peak, or sometimes for twenty-four hours. These segments usually enable the flow of all traffic turning in either direction, and/or entry and exit. To maintain satisfactory speed and efficiency of the buses, it is vital to ensure clearly-marked signage and road designations, as well as user-knowledge (Danaher, 2010).

   2. ‘Queue jumpers’ at intersections:
As shown in figure 3, queue jumper is “Striping the roadway to allow buses to bypass vehicles waiting at red lights by permitting them to advance to the front.” (Seattle Department of Transportation, 2008b.)

3. Transit Signal Priority (TSP):

TSP is an operational technology strategy that modifies traffic signal timing at intersections in favor of public transit modes; either BRT, buses in reserved lanes, or even buses in mixed traffic.

![Figure 3: Queue jumpers at intersections](Note: Retrieved from “Seattle Transit Master Plan Briefing Book”. By Seattle Department of Transportation, 2008)

According to the Seattle Department of Transportation (2008b), in comparison to big corridor-transit ventures, transit priority treatments are not particularly costly, and are able to lessen delays and enhance the quickness of public transit. In Riyadh’s case, there is no reason not to adopt this low-cost, non-lengthy and easy-to-apply strategy. I believe the ADA should seriously consider this strategy and start working and preparing for the different elements of this strategy to be totally ready by the time the operation of Riyadh’s transit system begins.
2. Improvement to Non-Motor Modes

Non-motor modes are mainly walking and cycling, and are usually part of any trip. In particular, public transit trips mostly begin and end with walking or cycling because public transit doesn’t usually pick up the traveler from home and take them to their exact destination, so walking or cycling is required to complete the trip. Hence, plenty of studies confirmed the important role of non-motor built environments on the success of public transportation systems.

According to a study by the Seattle Department of Transportation (2008b), the standard of the pedestrian facilities, especially around transit stops, helps travelers decide whether or not to use transit, and may even deter some from using public transit at all – especially when they have the ability to travel by car. Furthermore, high standard and safe cycling environments enhances the connectivity between the different travel modes and thus increase transit ridership. Ryan (2009) conducted a research to explore the relationship between transit ridership and the quality of the pedestrian environment around stations. The results suggest a small, but nonetheless clear link between the two. Moreover, Singleton and Clifton (2014) found that “Increases in urban area bicycle commuting were positively associated with transit ridership.” Nawrocki, Nakagawa, Matsunaka and Oba (2014) stated that station area walkability in the USA has a measurable effect on light rail transit (LRT) ridership. Additionally, according to an analytical study regarding bus usage in Atlanta by Digioia, Guthart, Hamed, Queen and Wang (2014), “there is a close connection between walk and transit trips. Significant correlation was found between the availability of pedestrian amenities, including sidewalk, crossing, and shelter, with stop usage. Sidewalk coverage is important for walk and transit mode shares.”
Unfortunately, Riyadh is one of the poorest cities in terms of its walking and cycling environment and infrastructures. Although the city, according to the Riyadh General Directory for Parks (2016), has recently completed several good walkway projects in different streets and neighborhoods in the city - with a total length of 60 km and still working on an additional 47 km, these walkways are totally isolated from each other, and there is no connectivity between them. I believe the ADA should think about pedestrians and bicycle infrastructures as an inalienable part of the city’s new public transportation project, and thus they should generously spend money on improving them. The good thing is that improving walking and cycling facilities is not very expensive when compared to other elements of public transportation systems. According to the Washington Metropolitan Area Transit Authority (2015), one of the most cost-effective strategy to raise public transportation usage and lower congestion levels is by enhancing the walkability and by providing better transit’s access for pedestrians and cyclists. Park, Choi and Lee (2015) also confirmed that enhancing the pedestrian environment is a cost-beneficial way to encourage walking to public transit stations.

I suggest that the ADA should start improving non-motor modes facilities in areas around Metro stations and bus-stops, and then continue to the other parts of the city in order to build a connected pedestrian and bicycle network that covers most areas within Riyadh.
3. **Raise Gasoline Prices**

Even with the recent 50 percent increase in gasoline prices at the beginning of 2016, the gasoline price in Saudi Arabia (0.24$/liter) is the second-cheapest in the world, is still subsidized, and is not market-based. However, there is a vast array of literature on the positive relationship between gasoline prices and transit use. Although the research in this subject (depending on their chosen case studies and the different research methodology used) show different results ranging from a strong to a modest connection between transit ridership and gasoline prices, a simple fact is that in 2008 - when gasoline price in the US was at its historically high peak of 4.11$/liter - public transportation use reached its highest level since 1957 (Maley and Weinberger, As .(2009 we are talking numbers, Lane (2012) analyzed the changing cost of gasoline in thirty-three American cities from January 2002 through to March 2009, before contrasting these fluctuations to the data pertaining to transportation usage in those particular cities. In each of these he analyzed bus usage, and in twenty-one of them he also assessed railway usage, for example in DC, Chicago, and Los Angeles. His findings revealed a clear correlation between these fluctuating costs and changes in transport usage – for every ten percent rise in the cost of fuel there was a bus usage rise of as much as four percent, while for rail usage this was as much as eight percent.

This positive elasticity between transit use and gasoline price has not only been proven in the USA. In Australia, Currie and Phung (2008) found that for every 10 percent rise in gasoline prices, transit ridership rises 2.2 percent. In Taiwan, Chao, Huang and Jou (2015) explained how the cost of petrol has markedly impacted bus and metro usage
Based on these studies and many others confirming the great influence of automobile gasoline prices on using transit modes, and based on the extremely low prices of car fuel in Saudi Arabia, it is not an exaggeration to say that it might be impossible to entice motorists from their cars to ride Riyadh’s public transit. The government should realize this and gradually remove, or at least decrease, the subsidies of gasoline in Riyadh City.
4. Implement Road Pricing Schemes

Road pricing is the process of using a scheme to charge motorists for using selected (mostly the busiest) roads or areas (zones) within an urban area. The main goal for the concept of road pricing is not to boost public transit - even though it is mentioned as one of the objectives in many road pricing projects around the world - but rather it is to remedy traffic congestion. However, in Riyadh’s case we must not forget that Riyadh’s severe traffic congestion was the main intent behind creating the public transit project. Thus, road pricing serves two governmental aims: easing congestion and encouraging the use of the new transit system.

As proven in the literature and several case studies in this paper, road pricing is one of the most effective strategies to transition travelers from their automobiles to using transit. In fact, the European Commission on Transport Research (1996) concluded that road pricing is the most successful strategy to attract motorists to transit.

Although the cost of implementing road pricing is relatively high compared to the other transit encouragement strategies, road pricing has two other important advantages for the transit system besides being an incentive for the modal shift towards transit. First, road pricing benefits public transportation vehicles, particularly buses, by easing traffic congestion for them, and consequently enhances their speeds and service reliability. Second, road pricing can generate funds that can be used to support the operational cost of public transit. In London, for example, the road pricing program generates about $240 million annually, which legislatively shall be spent on public transportation (DeCorla-Souza, 2009). The same law exists in Singapore and Stockholm (King, Manville and Shoup, 2007). One might doubt if a country like Saudi Arabia, with a
centralized financial system, can possibly adopt a similar law (of allocating road pricing revenue to public transportation), yet a recent example confirms this possibility. New legislation announced only this year in Saudi Arabia in regard to imposing an annual fee on undeveloped urban lands states that these fees must be spent on housing projects.

Another concern that might arise regarding road pricing in Saudi Arabia is the public response. However, Al-Atawi and Saleh (2013), in their research’s survey about travel behavior in Saudi Arabia, found that most Saudis would support congestion pricing and, more interestingly, they concur such funds should be utilized on enhancing public transit.

There are different schemes to implement road pricing, the most commonly are:

1. Tolls in roadways: imposing a fee to drive on entire selected roadways. Fees can be flat or variable (the fee increases or decreases according to congestion).
2. Lane charging: imposing a fee to drive segmented lanes on one road, for example, on a high-occupancy toll (HOT) or an express-toll lane. In this scheme, a variable fee is more common than a fixed fee.
3. Cordon tolls: these can be either flat or fluctuating fees allowing one to drive in or enter a busy area, typically the center of a city.

Most of the megacities around the world have at least one of the three types of road pricing, if not all of them. While all three methods - if properly allocated and managed - have
demonstrated some degree of success in different cities around the world, cordon toll schemes - according to more than one study - have most efficaciously lowered single occupancy vehicle usage, and raised transit usage (Ellis et al., 2005; DeCorla-Souza, 2009). Similar schemes in London, and cities in Norway and Germany, showed a modal change between 7 and 15 percent - in favor of transit - for the locations with pricing, while research in the USA suggested a possible modal change and lowering of VMT at 28 percent in Boston to 4 percent across the country in Los Angeles (Ellis et al., 2005).

I believe Riyadh, with its approximately six million inhabitants and a projected population by 2030 of 8.2 million, the severe traffic congestion, and the new comprehensive public transportation system, are in dire need of a road pricing strategy to incentivize the use of the public transit system, and to achieve the original goal behind creating this system, which is facilitating traffic congestion. The ADA will need to conduct a comprehensive study to choose the most appropriate road pricing schemes and the appropriate locations for them.
5. Establish Programs, Partnerships, and Coordination with Universities and Employers

Much evidences in the case studies and the literature of this paper demonstrates a crucial role for employers/university-based pro-transit strategies in the success of public transit systems. According to Stanley’s (1995) analytical study on forty transit systems in the US, the majority that raised their ridership levels did so through an improved effort at attracting particular groups. Taylor et al. (2002) confirmed that transit programs targeting universities are one of the most successful pro-transit strategies in America. The study also reported that in twelve successful transit systems in different places around the United States, employer-based programs were essential for their ridership growth. Brown, Hess, and Shoup (2001) published the findings of a study of thirty-five university-based ‘transit pass’ schemes in America, and which showed these schemes can raise transit usage and reduce empty seats. The raise in the usage was seen to extend from seventy-one percent to two hundred percent during the initial phase of the scheme, with the yearly expansion after this extending from two to ten percent.

In my opinion, this is must-have strategy for Riyadh’s new transit system. Riyadh is the capital of Saudi Arabia and thus it contains the lion’s share of employers (governmental and private) in the whole country. Riyadh also has numerous universities and colleges. Although the ADA realized the importance of allocating transit stations near the three main universities in Riyadh (KSA, IMSIU and PNU) and near the high-density job locations, special programs to attract people in those groups to use transit are substantial.

I believe that the key to implementing the employers/universities-based pro-transit strategies is by working on two directions: First, offering reduced-price passes in large quantities
to such universities and employers (both governmental and private) to be distributed to their students/employees; or charging those large organizations an annual lump sum based on the number of students/employees, and students/employees showing their student/employee IDs in order to use public transit. Second, to apply a package of incentives and deterrents in order to shift students/employees from commuting by cars to using the transit. These incentives and deterrents may include:

1. Parking cash-out: Shoup (1997a) tested the impact of his brilliant idea (parking cash-out) that became law in California. The California Health and Safety Code Section 43845 (as cited by Shoup, 1997a) stated the “Parking cash-out program’ means an employer-funded program under which an employer offers to provide a cash allowance to an employee equivalent to the parking subsidy that the employer would otherwise pay to provide the employee with a parking space.” In his study, Shoup outlines the details of eight companies that have adopted this cash-out incentive, comprising a total of 1694 workers. Of these, there was a seventeen percent decrease in the number of sole-occupancy drivers following the cash-out, while car-sharing grew by sixty-four percent, with the number of transit users rising by fifty percent.

2. Universities/employers providing free and private shuttles from the nearest transit stations to their campuses or workplaces.

3. Providing private bike-share systems (using student/employee IDs) so students/employees can ride bikes from nearest transit stations to their campuses or
workplaces. One example of this point is what I saw for myself in Louisville’s B-cycle, which is only available to Humana associates.

4. Giving students/employees the assurance and confidence to decide to make public transit their first travel choice by providing a limited number of days of free parking in each month, and which can be used in non-routine days; and by providing a guaranteed-ride-home scheme (GRH) (using employer’s vehicles or paid taxi rides) for the employees’ emergencies situations and unplanned trips.

5. Enhancing awareness and information among students/employees to encourage transit use by offering facts regarding the other options to sole-occupancy driving – for example, via a specific Employee Transportation Coordinator, the utility of published advertising – including through university outlets – information desks, online, and finally through worker-based seminars explaining the available alternatives.
6. Implement Parking Management and Pricing Policies

Riyadh is one of the very rare cities with a population over 1 million that has zero management over car parking. Because it is out of my research scope, I am not going to talk about how extremely important it is to manage parking, especially in large cities, and how many economic, environmental and social benefits are missing by not having parking management practices. However, I will focus only on the crucial rule of managing a city’s parking on its transit’s successfulness. In this paper’s literature and case studies, parking management and pricing was the most mentioned pro-transit strategy among all other strategies.

Shoup and Pickrell (1980) were the first to persuasively address the strong relationship between parking and travel choice. In their research, the most accurate approximation is that one in five who are sole drivers and have free parking will choose to use car-sharing or start using public transportation to get to work if they needed to pay. Stanley (1998) studied the parking policies of twenty central cities and metropolitan areas in the US and found that those with restrictive rules such as increased parking prices often have a more effective public transportation system with elevated usage, whilst fluctuations in aspects connected to parking fees have a bigger impact on modal decisions than aspects connected to the transit service itself. Taylor et al. (2002) confirmed that parking fees impact the appeal of travelling via public transport when contrasted to using a car, thus it has a big impact on the modal share. According to the Seattle Department of Transportation’s (2008a) research on TDM (transportation-demand-management), “the supply of free or inexpensive parking at the final destination is a key decision factor cited for choosing to drive a personal auto rather than taking a bus, bike, walk or
carpool”. Willson (2005) stated in his lessons-learned research’s conclusion regarding parking policy for TOD, that despite planners frequently placing importance on feeder buses provisions, streetscaping and urban design, they must not fail to consider the rules regarding parking which are equally vital in generating increased transit usage.

My recommended parking-related pro-transit strategies that can be implemented in Riyadh can be categorized into two groups:

- **Strategies for on-street parking:**
  - Implementing parking meters in all congested areas in Riyadh, starting with the CBD, Riyadh’s "commercial strip" along the area bounded by King Fahad and Olaya Roads, and also in the city’s two major commercial streets: Al-Tahliah and King Abdullah. Then, expanding parking meters to cover all congested destinations within the city is recommended. It is very important to price on-street parking appropriately. A common problem in many cities around the world is that on-street parking pricing is underpriced (not market-based), and consequently doesn’t function well in being an effective deterrent for using automobiles (Shoup, 1997b). The ADA should skip the old method of having low fixed-price meters and take advantage of the new technology meters with variable parking prices that fluctuate with demand. Parking rates should surpass transit fares by 20 – 30 percent to effectively shift motorists to transit (Bianco, 2000). Riyadh can benefit from the experiences of San Francisco and New York City as pioneers of this new variable parking rate technology in order to manage on-street parking.
• Issuing and managing on-street parking permits to serve the goal of encouraging transit use and discourage car use: if parking meters are implemented in Riyadh, Riyadh, with its grid urban form and wide residential local streets, will be subject to spillover parking. Therefore, parking in residential local streets in congested and parking-priced areas should be restricted to the residents of these areas through the use of parking permits. On the other hand, wide residential local streets around transit stations in the suburbs, city’s edges and non-congested areas can be freely used as parking for transit users (acting as park-and-ride). The latest approach was introduced in Dublin City in 2007 but has not been implemented yet (Kelly, 2007). In short, a parking permit program in Riyadh’s residential streets that is directed in favor of a transit mode (and against the private vehicle) can be a powerful incentive to shift motorists to transit.

• Saudis have never paid to park. Therefore, in order to succeed in the previous on-street parking pro-transit strategies, a high level of enforcement is required. Just like in the successful “Saher” system (a system of radars and cameras used in Riyadh to observe and have power over traffic violations and to give tickets), the ADA can authorize a third party to enforce on-street parking policies in exchange for a certain percentage of the violations’ revenues.

- Strategies for off-street parking:
  • Decreasing minimum parking requirements: just like most cities elsewhere, Riyadh’s zoning ordinances dictate minimum number of parking spaces that can accommodate the
highest demand in the busiest times, whilst generating an oversupply for most of times (such as the huge parking lots in many of Riyadh’s shopping centers that are designated to accommodate the high demand in holiday times). This minimum parking requirement that lead to the high supply of free parking in the different land-uses and institutions, is a strong incentive for using private vehicles (Shoup, 1999). Now, as Riyadh will have this new comprehensive public transportation system that can accommodate a high percentage of the high demand for the different high-seasons for the different land-uses and institutions, the ADA should change zoning ordinances and decrease its minimum parking requirements to around the typical nonpeak-time demand. Complemented with the next strategy (imposing maximum parking requirements), decreasing minimum parking requirements can therefore be an effective pro-transit strategy, especially in the long-term Stanley (1998).

- **Imposing maximum parking requirements:** In order to have a substantial effect on the parking supply in Riyadh, the ADA should limit the number of parking a developer can supply. Parking maximum is a policy that “specifies the maximum number of parking spaces per unit of floor space a developer may provide” (Stanley, 1998). While usually the parking maximum is more suitable in CBDs, more important is to link these parking maximums with the availability of transit. For example, The City of Portland, Oregon - which is considered as a role model city in terms of managing public transportation - has created maximum parking stipulations for all new buildings in every business center. Furthermore, it has also implemented maximum parking rules for any new development.
across the whole greater metropolitan area of Portland. These are established according to the supply of the transit system, with the decreased maximums founded on a quarter-mile walk from bus stops, or a half-mile walk from transit stops. In the main ‘downtown’ location, the maximum is 0.7 parking spaces per 1000 square feet, up to a maximum of two and a half in the neighboring business centers (Metropolitan Transportation Commission, 2007). Sherman (2010) compared public transit work trip between areas with maximum parking policy and areas without this policy in San Francisco, and found that people in areas with maximum parking requirements make more transit trips.

- Ensuring that there is an adequate supply of park-and-ride facilities: providing a sufficient supply of park-and-ride facilities is very important for transit success, especially in low density cities such as Riyadh (Turnbull, Pratt, Evans and Levinson, 2004). For example, insufficient parking around transit stations is harming Los Angeles’s overall public transportation system, costing them approximately fifteen hundred users each day on just its Red Line. Despite billions of dollars being pumped into the city’s transit system across the last two decades, new users are deterred by the parking shortage (Nelson and Weikel, 2014). While there will be twenty-five park-and-ride facilities within Riyadh’s new transit system, the ADA should keep an eye on the demand for these facilities and be willing to provide more if needed.
To achieve the goal of promoting transit in Riyadh through the previously-mentioned parking-related strategies, those strategies should be implemented all together because they are complementary to one another. For example, the minimum or maximum parking strategies might result in parking spillover. Thus, implementing parking meters and parking permit programs can prevent that.

A final thought about parking-related pro-transit strategies is that these strategies can generate revenues, such as parking meters, park-and-ride fees, permit fees if applicable, and violations revenues. Just like in the case of road pricing strategies, this revenue, or at least part of it, can be spent on transit operating costs and improvements.
7. Implement Transit-supportive Urban Planning

Although transit-supportive urban planning strategies have not been mentioned in this paper’s literature and case studies as much as other pro-transit strategies (such as parking management and gasoline price rising), many researches have proven the great impact of the urban form on transit ridership. According to the leading researcher in this topic, Robert Cervero, “Land-use patterns and built environments shape the demand of travel, and indeed can reduce the need for motorized trip making” (Cervero, 2001).

Stemming from this belief, Smart Growth and New Urbanism planners call for a high density, mixed-use, and walkable transit-oriented development model for transit-served cities. Cervero (1993) found in his research in California that people who live in TOD areas within half a mile of a transit stop are six times more likely to ride transit compared to people who live more than three miles away from the nearest transit stop.

The good news about Riyadh in regard to this specific strategy (making any further recommendations about this strategy unnecessary) is that the ADA has already put this pro-transit strategy under consideration and is currently undergoing a comprehensive TOD study conducted by one of the leading urban planning firms in the world (World-Architects Project, 2016).
CONCLUSION

Despite excitement with Riyadh’s new comprehensive public transportation system, it remains doubtful whether the system can sufficiently entice Riyadh’s residents away from using their affordable, convenient private cars. As the United States Environmental Protection Agency (1992) has pointed out, “Most evidence suggests that it is not sufficient simply to provide new transit services and expect that there will be a large rider response. Effective, transit-oriented transportation strategies must consider complementary policies that can make transit work.” In cities such as Riyadh, that suggestion is particularly applicable. On top of the general difficulty of competing against the many advantages of private vehicles—comfort, independence, security, control, and flexibility—in any city, Riyadh poses specific challenges, including extremely hot weather and a culture that tends toward privacy and observes gender segregation.

When the Saudi government announced the public transportation system during 2012’s oil-fueled economic prosperity, it was arguably acceptable for the government to substantially, if not fully, subsidize the system’s high operating costs, even if demand for the system was forecasted to be low. At present, however, the Saudi economy suffers from a setback of low oil prices. As a result, it is crucial to ensure that the public transportation system will attract wide use and that ridership rates can sufficiently generate a reasonable farebox recovery ratio.

By examining government studies, academic research, and real-life examples in case studies of different cities worldwide, this study investigated the most effective transit-supportive strategies to ensure the success of Riyadh’s new public transportation system. Recommended strategies were categorized as either system-related or complementary external strategies;
whereas strategies in the first group relate more to the system’s operation, those in the second concern external factors that can help to attract users to the system:

A. **System-related strategies**
   1. Optimize service patterns
   2. Optimize the fare structure and ticketing system
   3. Optimize the service quality, convenience, comfort, and amenities of the system
   4. Ensure the system’s reliability
   5. Optimize the service coordination and consolidation of all modes of public transportation
   6. Conduct comprehensive operational analyses on a regular basis

B. **Complementary external strategies:**
   1. Transit priority treatments
   2. Improvement to non-motor modes
   3. Raise gasoline prices
   4. Implement road pricing schemes
   5. Establish programs, partnerships, and coordination with universities and employers
   6. Implement parking management and pricing policies
   7. Implement transit-supportive urban planning

Unlike in cities with older public transit systems that need to profoundly reconsider system-related strategies to improve their dilapidated systems, Riyadh’s system was announced only in 2012, meaning that Arriyadh Development Authority (ADA) was able to use the latest technologies in planning, operations, rider information, and ticketing to ensure that the system
had the best quality, comfort, and reliability. Accordingly, this research has focused more on the second type of pro-transit strategies—the complementary external ones—each of which has been studied and investigated to explore its effectiveness and suitability for Riyadh. Future research on the topic is thus advised to conduct in-depth analyses of the most appropriate parts of Riyadh in which to implement some of these strategies - such as identifying the exact locations of road and parking pricing schemes.
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