

Article

Transit-Oriented Development in Saudi Arabia: Riyadh as a Case Study

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Abstract: Transit-oriented development (TOD) in Saudi Arabia is becoming a significant priority for the government and developers to create a sustainable and quality living environment. TOD is an integrated transport and urban planning method that aims to reduce car use and urban sprawl, increase the use of public transport, and enhance sustainable mobility. To meet the global goals as per the Paris Accord, Saudi Arabia's policymakers must prioritize the integration of TOD in urban planning. This study was carried out with the main aim of identifying the environmental, social, and economic benefits of implementing TOD in Riyadh, Saudi Arabia. A mixed-study research method was used, and data were collected using a questionnaire survey and semi-structured interviews. The quantitative data were analyzed using SPSS version 21, and qualitative data were analyzed using NVivo software. The findings of this study show that TOD in Riyadh City would positively impact economic, environmental, and social aspects. TOD would reduce travel time, allow its people to have an active lifestyle, and reduce congestion. TOD would help reduce mental health disorders and improve physical activity. TOD would positively impact the environment of Riyadh City and assist in reducing greenhouse gases. Overall, the study results provide a reliable perspective on the benefits of TOD. Most participants assumed that the implementation of TOD in Riyadh City would increase automobile mobility, provide more employment opportunities, and reduce travel time, positively impacting the environment and economy of Riyadh City.

Keywords: transit-oriented development; sustainable transportation; TOD; Riyadh; KSA



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1. Background

Over the last few decades, the significant increase in private vehicles has led to chronic traffic congestion and has become a substantial problem due to the impact on economic growth, air quality, and sustainable living [1]. The transportation system is the primary source of urbanization and infrastructure development and is essential for a country's economic growth and viability [2]. The development of a public transportation system is vital for a sustainable environment. Transport is one of the highest energy-demanding sectors and a leading contributor to greenhouse gas emissions. In 2019, the GCC countries contributed to approximately 18% of total carbon emissions [3]. In Saudi Arabia, the transport sector contributes 22% of the overall carbon emissions [4]. The development of a robust transportation system and its associated policy is beneficial for the entire environment, and most countries across the globe are focusing on it to bring more attention to it. However, due to the high growth of these economies, public health has now emerged as a significant concern for these countries. Hence, eco-friendly transportation has become an integral and significant part of the development of communities and is emerging as a significant element in overall economic well-being [5]. Recently, transit-oriented development (TOD) has been given great importance and is considered by many countries worldwide for achieving environmental sustainability [6]. TOD is generally defined as an integrated method of land and transport use planning that makes transit use, cycling, and walking desirable and convenient and maximizes the existing transport system efficiency

by concentrating on development. TOD aims to produce pedestrian-friendly and practical urban neighborhoods, incorporating schools, lodging, travel, and other monetary and social improvements, thus benefiting different linked groups accordingly [6].

Saudi Arabia is one of the most urbanized countries in the world, as 80% of the country's population lives in urban areas [7]. Due to high urbanization and development, transportation usage has been significantly increasing, increasing environmental problems and the consumption level. In 2017, the energy consumption from the Saudi Arabian transport sector was almost 20%, mainly based on fossil fuels [8]. TOD gained immense appreciation, especially in Riyadh, Saudi Arabia, because of the recent development in the city. With the expectation to reduce carbon emissions, the Riyadh metro system was developed to combat climate change and transportation-related carbon emissions. In addition, Riyadh is also implementing a bus network and changing the urban framework through transit-oriented development [9]. The most significant advantage of this integrated public system, or TOD, is reducing the per capita energy consumption in the city and ultimately reduce traffic congestion, which has a direct and positive impact on the economic and environmental sustainability of the country. Transit development aims to attain the core production of practical, effective, and blended neighborhoods that incorporate a high and efficient level of travelling [9]. Lodging, social parks, and other significant monetary enhancements are some of the significant elements covered under the umbrella of TOD [10]. One of the most important things associated with TOD is its arrangements in urban sprawl and arranging systems for green building scenarios by providing access to make transportation more viable and competitive [10]. In other words, TOD is an initiative for Riyadh City to move toward greener options and become competitive and feasible. This study was carried out with the main aim of determining the benefit and need of transit-oriented development in Saudi Arabia, with a specific focus on Riyadh. This study will help the government of Riyadh make informed decisions about the development and planning of the transport system.

2. Literature Review

Peter Calthorpe introduced the TOD concept with a specific focus on transit planning [11]. TOD has mainly been categorized as one kind of sustainable urban transport that creates a high level of human interaction. Bernick and Cervero have strongly focused on the three Ds' (design, diversity, and density) role in TOD [11,12]. During the 1980s, after observing suburban congestion, researchers and urban designers focused on alternatives, such as developments around transit areas, with the main objective of reducing motorized trips. During the Paris Agreement in 2015, the kingdom (KSA) showed its commitment to reducing the emissions of greenhouse gases and adhering to the mitigations related to climate change [13]. The kingdom has demonstrated its dedication and capacity to reduce more than 130 million tons of carbon dioxide by the end of 2030 [13]. The vision of 2030 is set out in the country's national determined contribution (NDC), which is aligned with the United Nations' concept on the issue of climate change. This NDC can bring a high level of economic diversification and become highly adaptive to the impact of climate change [13,14]. According to Noland et al. (2017), both transportation and infrastructure are considered significant forms of urbanization [15]. In the current economic times, urban-based transportation is gaining close attention. It is a significant pillar for travelers' mobility that focuses specifically on expanding these areas. Statistics revealed that 80% of the country's population lives in urban areas, which shows that urbanization is at its peak in the country [15]. Papa and Bertolini (2015) indicated that since Riyadh is becoming a financial hub for Saudi Arabia, and the current king is looking forward to expanding its position in the context of the goal for 2030, the congestion problem may increase rapidly [16]. Thus, the country desperately needs TOD to achieve sustainable transportation that aims to minimize or eradicate environmental problems, maximizing the quality of life by enhancing social-based inclusions. Wey and Chiu (2013) conducted a study in which the benefits related to TOD were mentioned [17]. The study was conducted

in Turkey, in which the sustainable tourism factor was highlighted. The researcher used quantitative measures to complete the research, using quantification for the same purpose. The researcher used a sample of 404 individuals and found that countries can achieve social benefits by implementing TOD. The analysis found that social indicators include the status of human health, community-based livability, and the equity factor. The researcher revealed that TOD is helpful for the people of Turkey to obtain affordable, green, and sustainable transport that could positively increase their social well-being [17].

There was another study conducted in the same domain, and the research was conducted by Renne (2009). The researcher identified that one of the main benefits of TOD is the achievement of environmental sustainability using environmental indicators. Environmental sustainability includes overcoming pollution, creating a better environment for wildlife, and creating a manageable vehicle system. These elements are achievable, and the researcher has identified them before [18]. Endorsing the same idea, Zandiatashbar, Hamidi, Foster, and Park (2019) revealed that, apart from environmental indicators, certain indicators of economic well-being are directly and indirectly connected with TOD [19]. These economic indicators help gain immense benefits and viability in the transportation system and benefit the overall community [19]. The studies covered above were generally conducted in the European areas, and very few studies have been conducted specifically in Saudi Arabia, especially in Riyadh. Therefore, this study was carried out to determine the benefit of TOD in Riyadh City.

3. Methods

3.1. Study Setting

In the Arabian Peninsula, the Saudi Arabian kingdom is the largest nation, with a population of more than 30 million and an area of 2.14 million km². The geographical focus of this research study was Riyadh City, the capital of Saudi Arabia, with a population of 5.5 million (Figure 1). Currently, the spatial area of Riyadh City is almost 3000 km, covering 209 districts and 13 municipalities. In 2014, the city initiated the integrated transport system, with a budget of more than USD 23 billion. This was important, as the city's population is expected to reach 10 million by 2030.

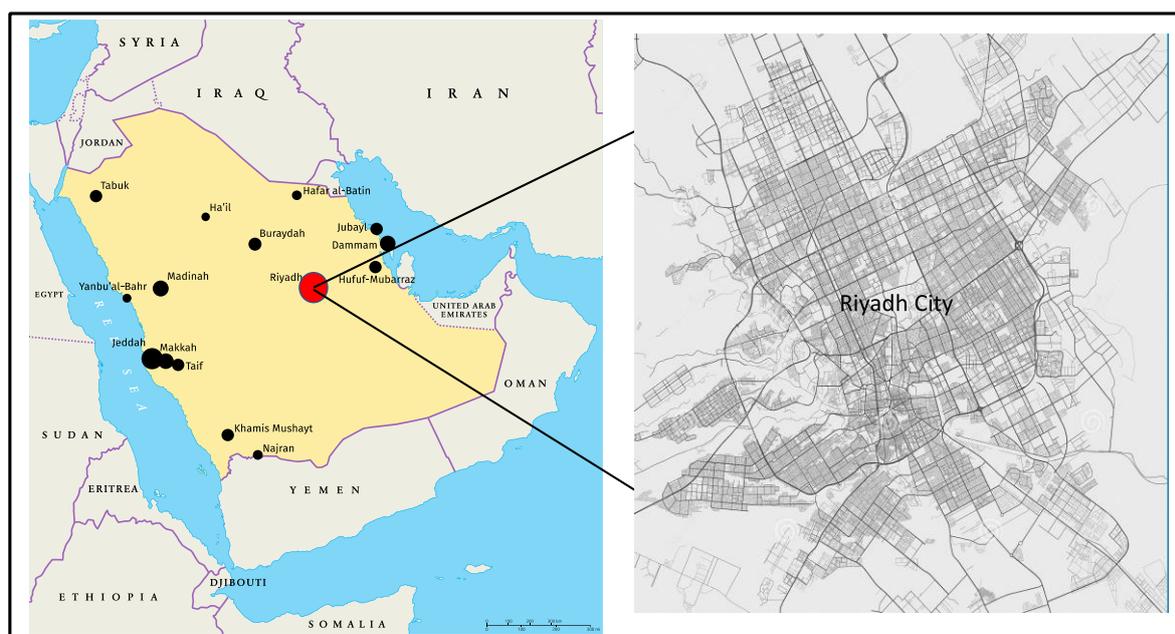


Figure 1. Riyadh City Map.

3.2. Research Method

The focus of this study was to evaluate the benefits of transit-oriented development in Riyadh, Saudi Arabia. For the present study, both qualitative and quantitative methods were adopted to determine the TOD benefit in Riyadh City.

3.3. Data Collection

The data were collected in two phases. In phase 1, quantitative data were collected using the questionnaire. In phase 2, qualitative data were collected by conducting interviews. Purposeful sampling was used based on the participant's willingness to participate in the questionnaire survey. The questionnaire was distributed among 120 individuals, among which only 95 were duly filled. Five in-person semi-structured interviews were conducted for the qualitative data to obtain valid and reliable data related to their research objectives, as shown in Figure 2. In addition, this allowed researchers to collect more complex data and comprehensively represent the research area. Semi-structured interviews were conducted with stakeholders, including transport experts, financial consultants, and environmental specialists. The semi-structured interview comprised unstructured and structured interviews where themes and question lists were used to collect data.

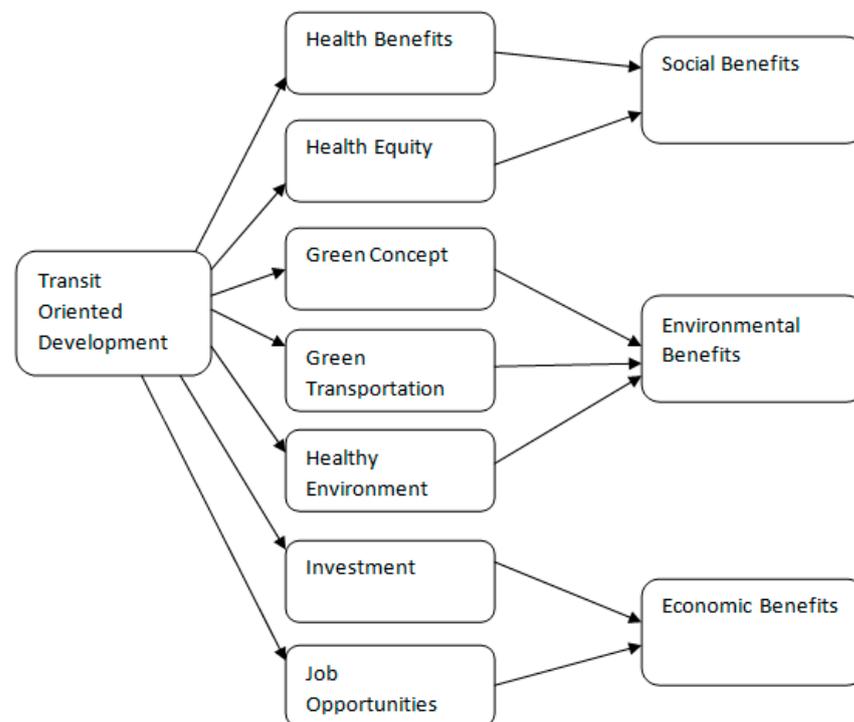


Figure 2. Framework for the Data Collection.

Protocol of Interview

The interviews were carried out in person. Before conducting the interviews, the documents related to the interviews were sent to all participants via hardcopy or email. All participants were asked the same questions; each interview was 30–40 min long. After providing the participants with the details of the study, permission was obtained to record the interview. In this interview, closed and open-ended questions were used to address the research question and to have appropriate data addressing the research objectives. The interview mainly focused on the selected aspect of TOD, as shown in Table 1. Thus, participants were requested to demonstrate to what extent these aspects would be beneficial by implementing TOD intervention in Riyadh City.

Table 1. Protocol of Interview.

| Section | Purpose | Contents |
|---------|---|---|
| Opening | Details of the research study objectives are provided to the participants, and permission is taken to record the interview. | Start of the interview / Rapport is built |
| 1 | To investigate the benefits of TOD in terms of economic, environmental, and social benefits. | What benefits do you think TOD implementation will provide in terms of economic, environmental, and social aspects? |
| 2 | Measure participant's opinions for the necessity of implementing TOD in Riyadh City. | To what extent do you agree or disagree with the implementation of TOD in Riyadh City? |

3.4. Data Analysis

The qualitative data collected from participants were transcribed and then documented. The NVivo software was used, and analysis was performed using grounded theory. Based on the study question designs and results interpretation, the 'majority' or 'most' of the participants here indicate 75% or more participants with a similar belief. 'Many' refers to 75 and 50%, 'some' indicates between 25 and 50% of the participants having similar beliefs, and 'few' indicates less than 25% of the participants. The quantitative data were analyzed by using SPSS version 21 to determine the mean score.

4. Results

The main aim of this section is to present the findings to address the research question. This section presents information on the benefits of transit-oriented development in Riyadh, Saudi Arabia.

4.1. Semi-Structured Interview Findings

4.1.1. Economic Benefits

Most participants stated that transit-oriented development would add significant economic value to the economy of Riyadh City. One participant indicated that TOD is expected to reduce unemployment by providing job opportunities for Saudi citizens and would improve city mobility. Most participants stated that presently, the roads of Riyadh City are over-congested, which negatively impacts household mobility and businesses, so they hoped TOD would reduce urban sprawl and increase public transport efficiency. Another participant stated that transit ridership would increase by implementing TOD, further increasing fare revenues and bringing additional revenues into the transit system and localities. Most participants stated that TOD would increase public transportation usage, leading to the economic efficiencies of these systems and improving the city's business productivity. Few participants stated that TOD would increase property value. Most participants indicated that TOD would help reduce transportation and infrastructure costs, such as garbage pickup, the cleaning of roads, and the reduction in external fuel cost consumption and air pollution.

4.1.2. Environmental Benefits

In Saudi Arabia, a high flow of motor vehicles has been observed due to economic growth and increased urbanization. Most of the participants in this study stated that transit development would help attain benefits to the quality of the urban environment, such as increased public transportation usage and land use reformation. Most of the participants felt that TOD would positively impact the environment of Riyadh City. For example, according to one participant, almost 18 L of fuel is burned daily due to increased reliance on private vehicles, so TOD would help in reducing this amount and therefore positively affect the Riyadh City environment. The majority of the participants felt that TOD could assist in reducing greenhouse gases by almost 10–24%. One of the participants stated that

TOD could reduce GHG by almost 35%, smog by 20%, and respiratory disease by 7.9% through proper transportation planning. The plan includes reducing the use of automobiles and increasing access to transportation.

4.1.3. Social Benefits

The majority of the participants stated that TOD would provide more destinations that could easily be assessed by bicycling and walking. According to one participant, TOD would influence physical activity in various ways, allowing people to walk to transit stops to access banks, restaurants, and grocery stores. Some of the participants stated that a reduction in the use of private vehicles would result in fewer accidents; however, it depends on the TOD design and how it is connected to the transportation system. Furthermore, it was stated by the interviewees that TOD would help in the reduction in mental health disorders. For example, one of the participants stated that driving on a congested road is mainly a great source of stress that the use of efficient TOD could reduce, as it would provide a more non-motorized mode of transportation.

Most of the participants in this study stated that TOD would positively impact the community by offering the benefits associated with this development. One of the participants indicated that TOD would provide more efficient and faster trips. Most participants indicated that TOD would benefit the community by reducing travel time and allowing people to adopt an active lifestyle. For example, according to one of the participants, TOD would reduce congestion and result in less parking costs. Another participant stated that TOD comprised good public transit, affordable housing, and cultural facilities that would help improve the livable communities' concept.

4.2. Questionnaire Findings

The quantitative data were collected using a questionnaire. Table 2 lists the findings of the TOD environmental benefits in Riyadh City from a general and personal perspective. From a personal perspective, the TOD benefit in terms of enhancing the city's aesthetic beauty and quality of city design obtained the highest mean score of 3.26. On the other hand, from a general perspective, the findings show that the maximum environmental benefit that could be achieved is that TOD would help in reducing traffic congestion, which would reduce noise and air pollution.

Table 2. Environmental Benefits of TOD.

| | Findings | Mean Higher Value |
|----------------------|--|-------------------|
| General Perspective | TOD reduces traffic congestion and helps in improving air quality and noise pollution. | 4.10 |
| | TOD contributes to the land's more efficient use. | 3.09 |
| Personal Perspective | TOD enhances the quality of city design and improves aesthetic beauty. | 3.26 |

Table 3 lists the findings of the TOD economic benefits in Riyadh City from a general and personal perspective. From a personal perspective, the economic benefit of TOD in terms of providing business opportunities obtained the highest score of 4.2. On the other hand, from a general perspective, the findings show that the maximum economic benefit that could be achieved is that TOD would encourage the use of public transport.

The findings of the TOD social benefits in Riyadh City from a general and personal perspective are shown in Table 4. From a personal perspective, the TOD benefit in providing services that enhance transit community mobility attained the highest mean score of 3.08. From a general point of view, the findings show that the maximum benefit that could be achieved is that TOD would provide options for mobility to older and young people who do not have cars.

Table 3. Economic Benefits of TOD.

| | Findings | Mean Higher Value |
|----------------------|---|-------------------|
| General Perspective | TOD encourages the increased use of public transport. | 4.08 |
| | TOD provides increased access to retail and local business. | 4.20 |
| Personal Perspective | TOD increases property value. | 3.81 |
| | TOD would reduce the need for the construction of roads' cost associated with the long-term maintenance of roads. | 3.95 |

Table 4. Social Benefits of TOD.

| | Findings | Mean Higher Value |
|----------------------|---|-------------------|
| General Perspective | TOD provides various mobility options for older and young people who do not have their own car. | 4.10 |
| Personal Perspective | TOD has various service characteristics that increase automobile mobility. | 3.08 |

5. Discussion

The present study used a mixed methodology to determine the benefits of transit-oriented development in Riyadh City, Saudi Arabia. The findings of this study show that TOD in Riyadh City would positively impact economic, environmental, and social aspects. One of the important findings of this study is that TOD would increase property value, which has been accepted at large. Previous studies have demonstrated that TOD has a positive effect on home values and land prices. For example, a study was carried out in Hong Kong, where it was found that TOD increased the housing price between 5–35% [20]. In another study carried out by Zhang, (2020) in Wuhan, China, it was found that properties that lay within 100 m of transit showed an increase of 17% in value, whereas those within 100–400 m showed an increase of 8% in their property value [11].

The study findings show that TOD would provide health benefits due to increased bicycling and walking. Considering this benefit, a study was conducted in Washington, which demonstrated that an increase in walking and cycling helps in reducing obesity. Many problems are related to obesity, such as diabetes, heart disease, cancer, and high blood pressure. Through TOD implementation, urban development and lower pollution can be achieved, which results in health benefits. The findings of this study demonstrate a relationship between physical activity and TOD. This finding is in line with studies conducted around the world [11,20]. A number of studies have demonstrated that transit-oriented development correlates with physical activity, irrespective of whether people live near TOD [21–23]. Studies have shown that transit travelers take walking trips more to access different services [21–23]. The findings of this study, along with the previous studies, clearly show that TOD increases walking activities. Considering these health benefits, further studies that involve medical records and direct measurements are needed to determine the actual health benefits associated with TOD implementation.

In the last few years, the reduction in the use of private vehicles has been the major focus of research because of the negative effect on the environment as well people's social life. The findings of this study show that implementing TOD would be beneficial in mitigating these issues. These findings are in line with previous studies, where it was demonstrated TOD would improve comfort and convenience by increasing access to activities and services, such as economic benefits, medical services, and financial savings, as well as enjoyment from being able to attend recreational activities [24,25].

In economic terms, TOD would bring economic benefits to Riyadh City. The findings of this study revealed that TOD would support the economy of Riyadh City by creating jobs. These findings align with previous studies, which stated that investing in TOD supports economic activities [26,27]. In one study, it was found that people living closer to the public transit service usually work more days every year as compared to those who lack

access to this transit service [28]. Transit ridership would increase by implementing TOD, bringing additional revenues into the transit system and localities. This finding is in line with previous studies [26,27]. One study demonstrated that TOD would reduce the need for the construction of roads as well as the cost associated with the long-term maintenance of roads [28]. In another study, it was found that TOD would reduce the transportation cost of highways and externalities, such as infrastructure expenses, road maintenance, and fuel consumption costs [29]. The results of this study generated a general hope among most participants that implementing TOD would reduce household spending as they change their mode of transportation by switching to use public transport. Moreover, TOD would improve the accessibility of the city and save time and, at the same time, improve automobile mobility and reduce congestion costs.

From the point of view of environmental benefit, the findings show that TOD would help reduce environmental pollution by reducing the use of private vehicles. Most participants argued that TOD is needed to improve the city's air quality. Increasing awareness of TOD-related environmental considerations is important, as it would help discourage people from using private vehicles. These findings show that investing in TOD would provide the administration of Riyadh City with an opportunity to change their current system of transportation and to reduce the consumption of energy, which ultimately helps in creating an environmentally friendly city. Another study by Li et al. (2019) found that transit-oriented development is linked with environmental benefits [30]. It can be stated here that the more efficient the TOD in the Riyadh region, the more environmental benefits can be gained for the city, such as reducing pollution, enhancing air quality, and reducing congestion. Each of these benefits was found to be very important in the sustainable development of Riyadh City. Based on these findings, it is recommended that policymakers make strong policies so that the city can achieve environmental benefits and enhance the air quality with the implementation of TOD. The country is looking forward to diversifying its operations from an oil-oriented economy to a tourism-friendly economy and achieving the objective of environmental benefits.

Another important finding of this study is that social benefits are expected to increase for Riyadh City due to the implementation of TOD. Similar results were found in a study by Pendall et al. (2012), in which researchers linked transit-oriented development with social benefits and found that the more efficient the TOD, the more social benefits could be increased for the city [31]. Similar findings were found in another study by Higgins and Kanaroglou (2018), which found that TOD provides more efficient and faster trips by reducing travel time and allowing people to have an active lifestyle [32]. These findings imply that TOD is also important for the social well-being of people in Riyadh City, as it can help provide its citizens with all the fundamental rights. Based on the findings and previous studies conducted in the same domain, it is recommended that policymakers consider the concept of TOD in their region to bring more viability to their city, as this outcome would help achieve the 2030 vision.

6. Conclusions

This study aimed to evaluate the importance of transit-oriented development for the city of Riyadh, KSA. A mixed-study research was carried out. TOD is essential to strengthening Riyadh's social, environmental, and economic well-being. Regarding social benefits, TOD would help provide more mobility options for those without a car, the elderly, and the young. In terms of environmental benefits, TOD would improve the urban design quality and increase the urban landscape's aesthetic beauty. From an economic point of view, TOD would provide accessibility to alternative transport means that would increase the volume in terms of the mobility of people by a single system. This study's outcome provides useful insight into the benefits of TOD. There is a need to incorporate the combined action of various stakeholders to achieve the 2030 vision of a sustainable environment. To achieve significant transport development in Riyadh City, government

authorities must show political commitment and form a comprehensive policy to integrate TOD into the urban transport system.

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