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Impact of implementing transport key performance indicators (KPIs) on the preparation process of transport strategic plans for small cities in Egypt - Case study: (Samannoud City- Gharbia Governorate)

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ABSTRACT

The transportation sector is a crucial aspect of urban development at all planning level. City transportation planning is a complicated topic that is an inherent aspect of the urban planning process and urban development, as well as the long-term planning of both highways and urban transport on the one hand and urban development on the other. Egyptian cities have numerous challenges caused by the indiscriminate growth of the transport and mobility sector, also the impacts of such indiscriminate growth cannot be quantified when developing strategic plans for roads and mass transportation, and thus are not reflected in the vision of the existing situation and decision-making in the strategic plan. The contribution of this research of lies in monitoring the performance of urban transport systems in a small Egyptian city. It intends to establish applicable development strategies in order to optimize the developmental benefits of strategic plans across several sectors and achieve sustainable development. There is a clear correlation between transportation networks, roads, and many other sectors, including the economy, infrastructure, services, and urban development. This research paper discusses the application of Transport Key Performance Indicators (transport KPIs) to assess urban transport network efficiency, analyzing international experiences and applying some of these indicators to the city of Samanoud. The goal is to measure the effectiveness of strategic plans for roads and urban transport using these indicators. The study then proposes recommendations and mechanisms to address the identified gaps in the analysis. The research concludes by evaluating the application of these indicators to formulate strategic plans, outlining the main obstacles to implementation, and providing recommendations to improve the use of these indicators in similar cases. Finally, it offers suggestions for future research to enhance the application of these indicators in the Egyptian context overall.

Keywords: Key Performance Indicators (KPIs) - Urban Transport Planning - Small Cities - Samanood City.

INTRODUCTION

Transport is a key component of developing urban sustainability. Passenger transport networks are often considered the "backbone" of the city and play a critical role in driving sustainable urban development. This importance is evident when comparing different areas of focus within urban sustainability monitoring frameworks, where transport is consistently a central element. Transport Key Performance Indicators (transport KPIs) can help urban communities identify significant changes needed across all decision-making levels related to sustainability, including land use, infrastructure, and transport, not just economic policies. Creating a unified framework of sustainable urban mobility indicators to monitor transport system progress is challenging due to the diverse capabilities and contexts of each urban environment. As a result, various studies have been developed, each assigning different importance to various dimensions of sustainable development and using different

methodologies, leading to different sets of indicators. Currently, there is no consensus on the definition of a sustainable city, nor is there a single method to assess city sustainability [(1)]. Sustainable urban mobility results from a comprehensive strategy that includes sound spatial planning, effective traffic and parking management, functional and flexible public urban transport, infrastructure that promotes light transport modes, and the use of new technologies to protect the environment, reduce pollutant emissions, and ultimately improve the quality of life in urban areas.

Small cities face the challenge of sustainable development by balancing limited local resources with the needs of modern communities which presents an interesting area for spatial planning and sustainable urban development projects [(2)]. Small cities can use a variety of transport KPIs to measure the performance of their transport systems. These indicators should be chosen based on the organization's goals and must be actionable. For small cities, it is crucial to evaluate the success of urban mobility programs using a structured framework to develop transport KPIs.

Effective evaluation of strategies, policies, and actions towards a sustainable urban transport system relies, among other factors, on the use of appropriate indicators that reflect the elements and dimensions to achieve sustainable mobility that emphasizes maintaining or even increasing mobility levels in the city without causing negative environmental and social impacts, protecting mobility as it relates to the city's social dimension [(3)]. These indicators must be measurable, relevant to the objectives, and adaptable to the city's size. Additionally, this indicator system should be supported by a valid and compatible transport data set to provide an effective tool for assessing sustainable mobility conditions in the studied city [(4)].

In Europe, passenger transport contributes about 44% of total transport-related greenhouse gas emissions and is a major factor in determining urban quality of life, directly linked to the environmental, social, and economic sustainability dimensions. These reasons have made sustainable urban transport development a widely researched topic over the past decades, leading to the development of various sustainability indicator sets for its measurement and monitoring [(5)].

Although nearly half of the world's population lives in small and medium-sized cities, the tools mentioned are rarely developed for this category of cities. At the same time, sustainability indicators and measurement systems are one way to hold individuals and organizations accountable and monitor progress. Most developed frameworks for urban sustainability monitoring claim to be applicable to cities of all sizes. However, local stakeholders in Norway believe they do not adequately consider the needs of small and medium-sized cities [(6)].

Research Problem

The effects of the indiscriminate growth of the transport and road sector cannot be measured in the Egyptian city where it faces many problems due to this indiscriminate growth of the transport and movement sector.

Research goal

This work aims to analysis the efficiency of strategic plans for roads and urban transport, by using Transport Key Performance Indicators (transport KPIs) which help in assessing the performance of transport networks and movement. Based on the analysis, we propose recommendations and mechanisms to address the gaps identified. The results will help decision-makers to enhance their final strategic plan for roads and urban transport in small cities.

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1- Transport Key Performance Indicators (transport KPIs):

1.1 How do KPIs differ in small cities compared to large cities

The current research does not provide a direct comparison of transport KPIs for small versus large cities. However, one study compares the optimal subsidies for public transport in a representative bus corridor in a small and a large city in Sweden. The study found that the optimal subsidy is higher in small cities due to the greater positive externalities from reduced waiting times and schedule delays, while the negative externalities of congestion are more significant in the large city [(6)].

Another study examines the applicability of transport sustainability indicators, selected from international frameworks, to evaluate public transport sustainability in small towns and cities in Norway. The study indicates a real need to adapt sustainable transport indicator frameworks to the realities and requirements of these urban forms. Research on sustainable transport and its indicators tends to focus on large cities, raising the question of whether indicators designed for large cities are suitable for smaller urban settlements [(7)].

There were no transport sustainability monitoring frameworks specifically designed for small and medium-sized cities. In small urban areas, the challenges faced by municipalities and transport service providers differ from those in large cities. Traffic congestion is rare, but high car dependency and the low market share of public transport are pressing issues, especially in the context of climate change and the need to decarbonize passenger transport globally [(6)]. Thus, it can be concluded that transport KPIs in small cities may focus more on reducing waiting times and schedule delays, while transport KPIs in large cities may focus more on mitigating congestion-related externalities. Additionally, the applicability of current transport KPIs to small cities may need to be adapted to the realities and requirements of these urban environments.

1.2. Transport KPIs for small cities: Case studies

Transport Key Performance Indicators (transport KPIs) are essential for measuring the performance of transport systems in small cities. There are hundreds of transport KPIs that can be measured, but it's crucial to focus on the most important and actionable ones for the organization. Examples of such KPIs include cost per mile, on-time delivery percentage, and asset utilization metrics, which can serve as a transport dashboard [(8)]. Here's a brief review of key case studies that have examined and evaluated transport KPIs and their impact on strategic planning decisions:

1.2.1 Small and Medium-sized Cities - Greece

Greece has been integrating sustainable urban mobility into political priorities, with the Ministry of the Interior and Communications introducing the "Proposed Urban Mobility Strategy in Jurisdiction Matters" in 2008. The Ministry of the Interior's Green Fund is expected to allocate €9 million to finance Sustainable Urban Mobility Plans (SUMPs) in 150 Greek municipalities. The current research examines the assumptions and prospects for achieving a sustainable urban transport system in small cities, focusing on the methodology applied in Polykastro. The importance of measuring transport Key Performance Indicators (KPIs) in formulating strategic urban transport goals, enabling cities to better understand their transport systems' efficiency and effectiveness, leading to more informed decision-making and strategic planning [(4)]. The impact of measuring Transport KPIs on Urban Transport Strategy Goals in Polykastro, Greece as shown in

Table 1.

Table 1. Summary of the Impact of Measuring Transport Key Performance Indicators on Urban Transport Strategy Goals in Polykastro, Greece

Key Issues Related to Urban Mobility and Transport	Main Goals in the Strategy for a Sustainable Urban Transport System
Lack of Public Transport	Enhance Accessibility for Residents and Visitors, Including People with Disabilities
Absence of Bike Lanes	Promote City-Scale and Environmentally Friendly Modes of Transport, Such as Walking and Cycling
Insufficient Planning and Safe Crossings for Pedestrians and People with Disabilities, as well as Designated Parking Spaces	Improve Smooth Traffic Conditions in Neighborhoods and on Main Roads
Very High Car Usage for Local Travel Within the City, with Noticeably Low Vehicle Occupancy	Investigate the Possibility of Organizing a Municipal Urban Transport System
High Rate of Road Accidents - Relatively High Levels of Traffic Noise	Reduce Car-Related Disruptions

Studying Goals in the Strategy for a Sustainable Urban Transport System in Polykastro indicating that this strategy addresses the needs of all residents and promotes a more efficient, inclusive, and environmentally friendly transport system.

A research on sustainable mobility in a medium-sized Greek city indicted there was a lack of reliability and consistency in available data, and highlighting the need for specific measurements to fill essential gaps [(9)]. The study used the Sustainable City Index (SCI) to assess the overall state of mobility in terms of sustainability for the city. In Serres, the SCI result indicated a low level of sustainable mobility conditions, highlighting the need for measures towards sustainability. The indicators related to the sustainability of the public transport system received the lowest scores, indicating the importance of improving the quality of public transport services. The composite analysis of all categories of indicators suggested a need to focus on available infrastructure for active transport, such as traffic calming measures and bicycle networks. The research emphasizes the need for an urban mobility observatory under a European Union framework [(9)].

1.2.2 Norwegian small and medium-sized cities

The international indicator frameworks for assessing sustainable city development and passenger transport were not suitable for small and medium-sized cities in Norway [(1)]. A group of local and regional stakeholders participated in a joint evaluation of four international frameworks for monitoring sustainable cities and a set of transport KPIs for assessing urban transport sustainability. The findings suggest the usefulness of sustainability monitoring frameworks for small and medium-sized cities in Norway [(1)].

A workshop was conducted with 26 participants, who worked in four groups to evaluate urban sustainability monitoring indicators. The workshop provided insights into how key stakeholders in urban planning and development in several small and medium-sized Norwegian cities perceive the selection of indicators presented by four international frameworks. The workshop results partially confirmed the initial hypothesis, revealing that while the four urban sustainability monitoring frameworks evaluated were not entirely irrelevant to the small and medium-sized Norwegian cities represented, they could benefit from improvements [6].

Table 2. Summary of the Impact of Measuring Transport Key Performance Indicators on Urban Transport Strategy Goals in Norwegian small and medium-sized cities.

Key Issues Related to Urban Mobility and Transport	Main Goals in the Strategy for a Sustainable Urban Transport System
• There are no transport sustainability monitoring frameworks specifically designed for small and medium cities.	• Monitoring frameworks for cities should diversify indicators to meet the needs of small and medium-sized cities. • Currently, no transport sustainability monitoring frameworks exist specifically for small and medium-sized cities.
Norwegian Transport KPIs Applicability in Small and Medium Cities • Ten out of 27 indicators rated low due to congestion, delays, or transport-related fatalities. • • These factors are irrelevant in Agder context.	• Transport KPIs should include more specific indicators for monitoring the sustainability of passenger transport in these cities. • These indicators should consider geographical characteristics and modern technologies.

1.2.3 Urban Mobility Plans in European Cities:

This study aims to validate key indicators for monitoring Sustainable Urban Mobility Plans (SUMPs) in Sanok, Poland. With high population density in the EU, addressing congestion and transport-related greenhouse gas emissions is crucial. The study provides a methodological framework for determining baseline values for road safety, public transport access, greenhouse gas emissions, and air quality. It also forecasts future emission trends, providing direction for sustainable urban mobility planning. The research's practical applications are crucial for local authorities and policymakers, offering actionable insights to improve urban mobility systems and align with EU sustainability and climate goals [10].

Another study advocates for a standardized approach to sustainable urban mobility planning. The significant advantage of adopting a unified approach, such as the Sustainable Urban Mobility Indicators (SUMI), lies in its ability to promote comparisons between cities based on comprehensive databases. This facilitates the identification and application of best practices across cities with similar characteristics. As EU cities, urban regions, and individual cities in Bosnia and Herzegovina embark on developing SUMPs, standardization becomes imperative. It ensures well-documented processes, transforming achievements and implementations into practical and effective outcomes for cities and their residents [11].

Recognizing the importance of data collection, cities in Bosnia and Herzegovina need to be aware of the systematic collection and standardization of data. Establishing a

comprehensive database of indicators within the research domain, alongside the continuous monitoring of EU mobility development indicators, is crucial. To achieve this, cities must commit to monitoring systemic innovations in mobility by establishing clear standards, guidelines, and databases for sharing EU standards or proposed SUMI indicators, with initial benchmarks, protocols, and data collection methods [(11)].

1.2.4 Asian Cities:

In the absence of comprehensive frameworks and standards for measuring the state of urban transport systems in the Asian context, the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) developed the Sustainable Urban Transport Index (SUTI) with 10 key urban transport indicators (UNESCAP, 2016b). SUTI is based on ten key urban transport indicators representing the ecological, social, and economic dimensions of sustainability. Assessment results can support policymakers in cities to make evidence-based policies and measures to improve urban mobility. This research briefly presents the current state of urban transport systems and services in Asia, introduces SUTI, and showcases results from its pilot application in four Asian cities, drawing some conclusions and policy implications [(12)].

The "Clean Air Initiative for Asian Cities" (CAI-Asia) report of 2006 summarized the main findings from the "Partnership for Sustainable Urban Transport in Asia" (PSUTA). After presenting the strategic framework, a broad theory on sustainable transport indicators was developed, followed by a description of some indicators as developed by the three partner cities. They were tasked with developing indicators while noting information gaps and proposing ways to bridge these gaps in the future. Despite observing some shortcomings in each city's results, some general lessons were drawn, especially regarding the sustainability of transport in each PSUTA city. Recommendations included supporting key aspects to fill the gaps. The central theme throughout the report was that the goal of PSUTA was not extensive data collection but rather identifying the necessary data and indicators for each city's leaders[(3)].

1.2.5 African Cities:

Another study highlighted that research examining the interaction between policies and needs in Africa remains scarce. A multi-method approach was used to assess the alignment between urban transport policies and self-reported citizen needs in Port Louis (Mauritius) [(13)].

METHODOLOGY

The Authors prepared this study within the project of the Urban Observatory of Egyptian Cities in the General Authority for Urban Planning GOPP. This Urban Observatory Project for small cities was initiated by the General Organization for Physical Planning in 2018 as a pilot effort aimed at creating and designing indicators to generate valuable feedback for the planning process. The project focuses on developing suitable transport KPIs, assessing the comprehensiveness of indicator packages, and evaluating their integration and potential conflicts. Also, it aims to establish a unified national monitoring framework and system to manage the urban planning process in Egypt [(14)].

The objectives of urban observatories include integrating transport KPIs into the planning process (monitoring and evaluation stage, planning formulation stage, and current situation diagnosis stage). Additionally, the project aligns with the Sustainable Development Goals (SDGs), particularly Goal 11, which focuses on sustainable cities and communities. The urban observatory project forms a cornerstone of the small cities urban observatory initiative, linking it with the Wellbeing Cities Initiative [(11)]. The concept of the Urban Observatory includes a systematic approach to managing data: collecting, unifying, analyzing, and disseminating urban statistics. It also features an interactive mechanism that allows

comparisons of various cities' data maps globally, providing decision-makers with a tool to periodically assess the city's conditions and compare them over time and between cities [15].

The project was implemented in four cities: Samanoud, Santa, Qutur, and Basyoun in the Gharbia Governorate [16]. This research will focus on the Samanoud city.

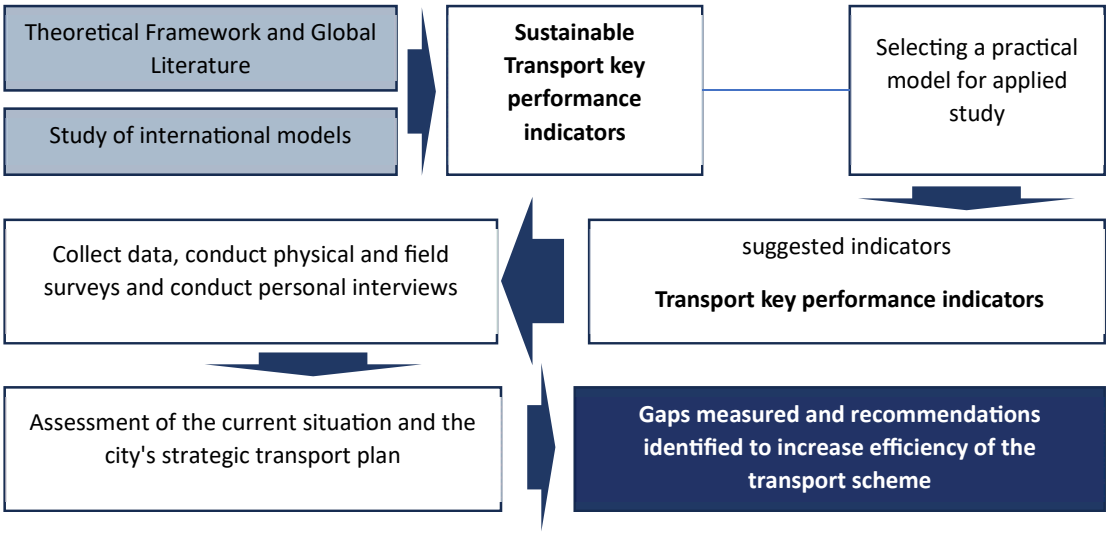

Figure (1) shows the methodology for preparing indicators and applying them to the study status and then identifying gaps and recommendations for increasing the efficiency of urban transport schemes.

Fig. (1). Research methodology. Source: Authors

1. Data cllection

Various methods were used to collect data and information from Samanoud city including:

- **Field Surveys:**

The city was divided into cells, each measuring 200m x 200m. An Excel sheet was created for the sample survey, specifying the cell number and the sample within the cell. The sample results were then integrated into the geographic database of the city. The sample size and distribution were determined to cover all city cells within the urban boundary and areas outside the approved boundary to 500m. The distribution aimed for balanced coverage, especially in new and areas of change, besides problem zones.

- **Secondary Data Collection:**

Secondary data included information such as: The city's strategic plan, Population census data from the Central Agency for Public Mobilization and Statistics, Data from the governorate's Information Center and the City Council, and Urban boundaries and unplanned urban growth within the proposed area.

- **Urban Planning Criteria for Cell Division:**

The city was divided into urban cells based on several planning criteria, and the transport KPIs were applied to the entire cell:

- Urban boundaries such as waterways, main and secondary road axes, railways, and high voltage lines.
- Large agricultural plots as boundaries between cells.
- Cemeteries, industrial uses, and warehouses as boundaries between cells.
- Regional service complexes and main city-level services as cell centers.
- Homogeneity in social, economic, and urban characteristics, as well as historical development within the city.
- The function of the residential area (residential, commercial center, residential craft).
- Proximity to the city center (core, transitional areas, outskirts).
- Area dynamics (stable areas, forming areas, residential replacement areas).
- Urban fabric pattern (organic, linear, grid, scattered).
- Adherence to the 200m x 200m cell dimensions specified in the Terms of Reference for the study.

These methods ensure comprehensive data collection to inform the planning process effectively, integrating transport KPIs into various stages of urban planning and providing a solid basis for sustainable urban development.

2. Key Performance Indicators KPIs used in the city

A set of Transport Key Performance Indicators (transport KPIs) was used to measure the efficiency of the transport systems and movement within the city. These indicators were developed as part of the project and their formulation methodology was discussed in another research paper which provided a theoretical framework for performance measurement indicators in the transport sector across different urban levels such as regional, sub-regional, and urban cities [8, 17, 18, 19, 20, 21, 22, 23] . For this study, only the urban city indicators were utilized. These indicators were categorized into main groups with specific objectives, under which the primary indicators were listed as Shown in Table 3).

Table 3. Citywide final indicators.

Categories	Goals	main dimensions	main indicator	sub- indicator	Source of Data	How to gather data on indicator		The final result of the indicator	
						Cells	٪	Show on map	Number n
network performance	Maintenance and development of road network	Road network maintenance and development rates	Periodic maintenance of the road network	Ratio of the length of road networks maintained from the total length of the existing city network	A / B / C				%5.48
				Proportion of the length of the road network for which maintenance and development have been carried out from the total length of roads in the annual development plan	B				
				Total budget implemented from the total budget submitted for the development and maintenance of the existing road network	B				6 milion
	Road Network	Efficient road network condition	Paved Internal Roads	Proportion of length of paved internal road networks	A / C				%61.6
				Proportion of land allocated to streets	A / C				
				Percentage of major roads suffering from traffic bottlenecks	C				%19.2

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Effectiveness of the road network	Effectiveness of the road network	Encourage the use of and improve transit and active transport networks	Regional mass transport positions (official/random)	Number of situations relative to the degree of development (with services for citizens and drivers)	A / B / C					%50
			Inland mass transport situations (official/random)	Total number of internal positions (official/random)	B					0
				Number of internal situations developed or created/transferred/cancelled	B / C					0
			Elements of the inland mass transport network	Multiple means (formal – informal)	B					
				Main and sub-positions (formal – informal)	A / B / C					
				Length and distribution of mass transit routes in the city	A					0
				Main and branch station locations	C					
				Service, storage and maintenance premises	B / C					
			Mass transport capacity	Total mass transport capacity	C					25
				Total number of vehicles in service at the city level	B					
		Efficient carriage of goods	Total cargo load per year per ton	Total cargo load per year per ton	B					
			Chuen Parking and Maintenance of Heavy Transport Vehicles	Chuen parking space and maintenance of heavy transport vehicles	B / C					
				Distribution of Chuen parking and maintenance of heavy transport vehicles	B / C					
			Land use related to industry and its complementarities	Distribution or concentration of industrial land uses – warehouses – charging and unloading places – markets of various degrees	B / C					
		Improved transition time	Time to move to the nearest city within the center	Average time to move from the city to the nearest city within the center	A / C					
			Time to move to the nearest city outside the center	Average time to move from the city to the nearest city outside the center	A / C					
			Time to move from the city centre to the nearest regional mass transport situation	Average time to move from the city centre to the nearest regional mass transport situation	A / C					
			Road Service Level	Total Number of Flights/Network Flight Generation Rate	A / C					
			Time to move from the city centre to the nearest entrance to the city	Average time to move from the city centre to the nearest entrance to the city	A / C					
	Efficient operation of the transportation system	Availability of complementary network elements	Availability of road components complementing the land network	Network complements reduce flight time and congestion	A / B / C					
			Availability of routing network elements (railways) – river transport)	Number and whereabouts of elements of targeted transport networks (railways) – river transport)	A / B / C					
			Availability of heavy transport service stations	Number and distribution of service and refuelling station premises	B					
					A / C					
			Availability of service stations for owners and fare	Number and distribution of service and refuelling station premises	A / B / C					
Social Inclusion & landuse	Affordability and Accessibility	Improve access to daily destinations by all modes	The energy of mass transport within the range of a longitudinal kilometre of mass transport	The energy of mass transport within the range of a longitudinal kilometre of mass transport	A / C					
			Affordability of transport		C					
			Ratio of compatibility with land use schemes	Affordability of transport	C					
			Ownership of private vehicles	Length of roads per 1,000 people (Km)	B					
			Modal split	Ownership of vehicles in the governor	B					

		Inland Road Network Connectivity	Intersection density	Percentage of modal split	A				
			Road Network Density	The city's intersection density	A				20 km/km2
			Road Network Space	Density of the city's inland road network	A				
			Average Road Offers	Percentage of space allocated to a road network	A				
				Percentage of roads from 8 m Fakil					
	Private parking spaces	Capacity for parking spaces in the city	ON street	Number of parallel parking spaces allowed on roads	A				
					A				
			Off Street (Official – Informal)	Space allocated for parking Total Number of parking Available in the City And the total space allocated for parking	A / B / C				
					C				
					A / C				
			Total capacity of parking spaces in the city		C				

Source: Author from:[8, 17, 18, 19, 20, 21, 22, 23]

By focusing on these main groups and objectives, the transport KPIs provide a comprehensive framework for evaluating and improving the performance of urban transport systems. The indicators help in identifying areas of strength and weakness, guiding policy decisions, and ensuring sustainable urban mobility

A: Approved Strategic Plan

B: Official authorities (Directorate of Roads and Transport of the governorate/City Council/Central Agency for Mobilization and Statistics)

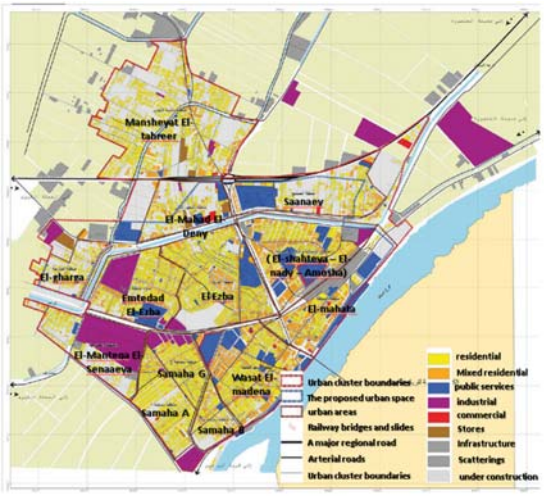
C Urban Survey

	How to collect data on the indicator	Final result of the indicator
	Cells	**Show on map**
	٪Ratio	**Number after application of the equation**
	The data was not evidenced	
	The indicator has not been applied in the study case	

RESULTS AND DISCUSSION

1. Implementation of Transport KPIs in Samannoud (small city)

a. Overview of case study & Investigation of KPIs in current situation



Samannoud is a city in the Samannoud District, one of the eight administrative districts in the Gharbia Governorate. It is located in the northeast and is bordered by the Damietta Branch of the Nile River, Aga District, Talkha District, Mahalla El-Kubra District, and Zefta

District. The district covers 144.7 km² and has a population of 285,960. Samannoud is centrally located within the district and is known for its position on the regional agricultural road connecting Tanta and Damietta as shown in Fig. (2).).

Fig. (2). Current Land Use Plan Source: - Urban Survey of Samannoud City 2018

Source: Authors from [16]

b. Monitoring performance and measuring achievement rates

Figures (3-10) illustrate the application of some indicators on the spatial maps of the Samannoud city. Additionally, the results of sample social surveys are geographically projected onto the maps, covering areas such as residents' perceptions of street service levels, household car ownership density, average travel time to work and services, public transport stops, and the classification of areas according to transportation costs.

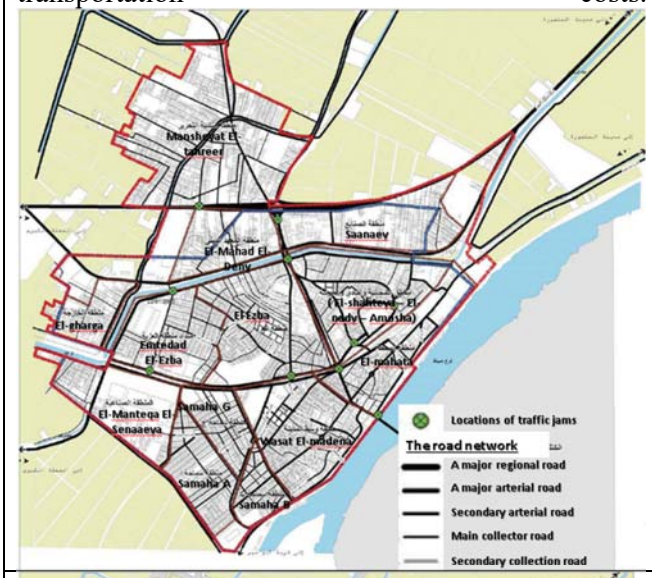


Fig. (1). Roads suffering from car traffic jams

Source: Authors from [16].

Indicator: Roads experiencing traffic congestion

Cells: Main and regional roads in the city

Notes: Areas with concentrated central, commercial, and industrial activities

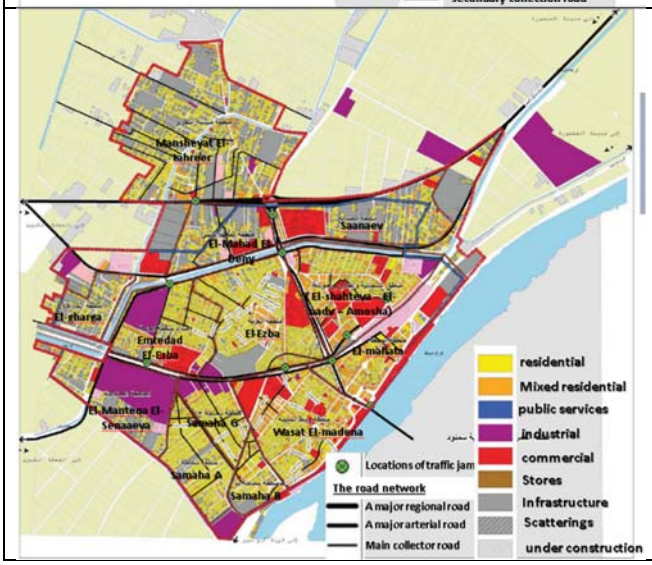


Fig. (4). The relationship between roads suffering from traffic congestion and land use

Source: Authors from [16].

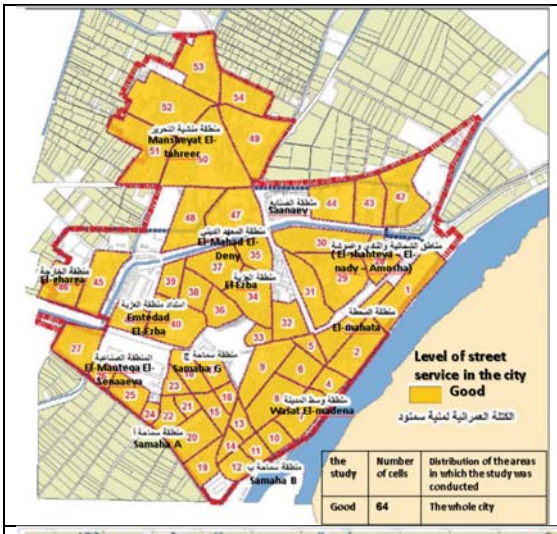


Fig. (5). Distribution of areas according to the level of street service in the city
Source: Authors from [16].

Indicator: Level of street service in the city
Cells: Areas with a good level of service covering all parts of the city according to residents' perspectives
Notes: Reflects the attention given to street cleanliness and beautification

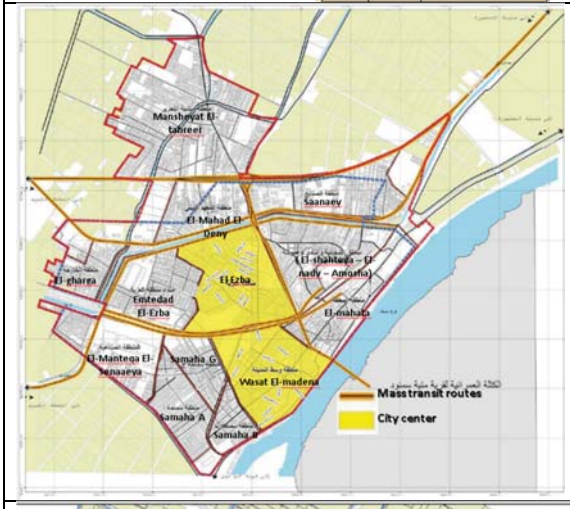


Fig. (6). Mass transit routes running through the city centre
Source: Authors from [16].

There were no mass transit paths that penetrate the city center, but there are external paths that penetrate the city center

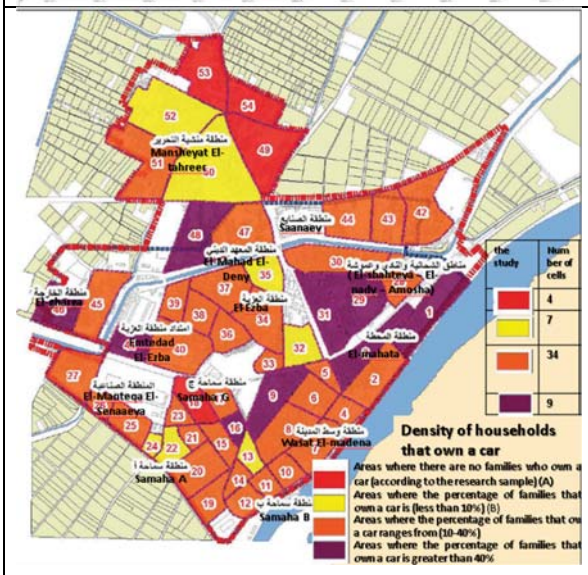


Fig. (7). Density of households that own a car
Source: Authors from [16].

Indicator: Percentage of households owning a car out of the total sample households
Cells: Cells numbered 1-3-9-16-29-31-41-46-48 represent a percentage of households owning a car of more than 40%
Notes: According to the profession and income level of the residents

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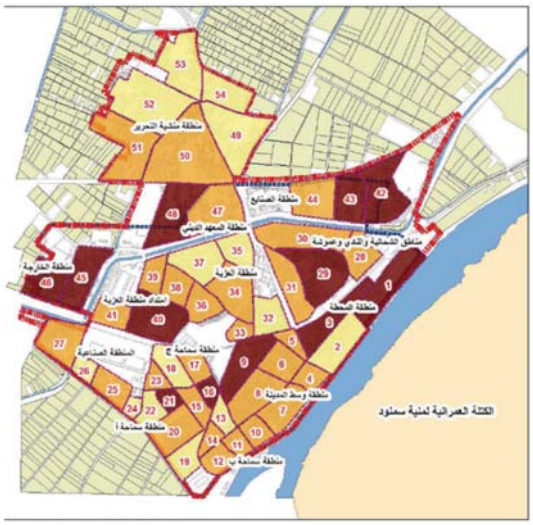

Fig. (8) Classification of regions according to transportation costs
Source: Authors from [16].
Indicator: Classification of areas according to transportation costs for different purposes for households
Cells: Transportation costs are higher in most cells located on the outskirts, which are primarily residential areas not mixed with other activities
Notes: Based on the distribution of services, work locations, and the city center
Less than 400 Pounds
400 – 800 pounds
More than 800 pounds

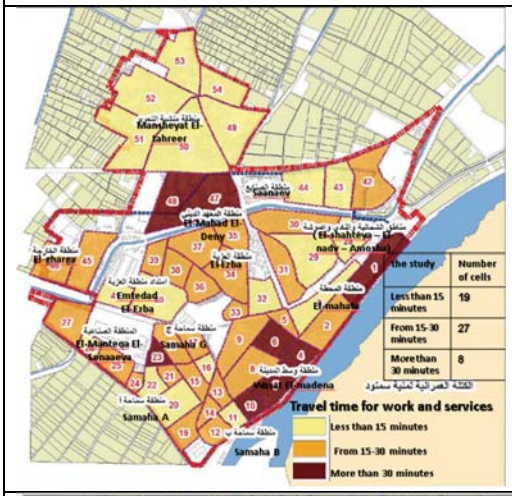

Fig. (9). Classification of regions according to average travel time to work and services
Source: Authors from [16].

Indicator: Average travel time to work and services
Cells: Travel time is less than 15 minutes in cells representing approximately 40% of the total cells (19 out of 54 cells)
Notes: Areas close to locations of concentrated services and activities

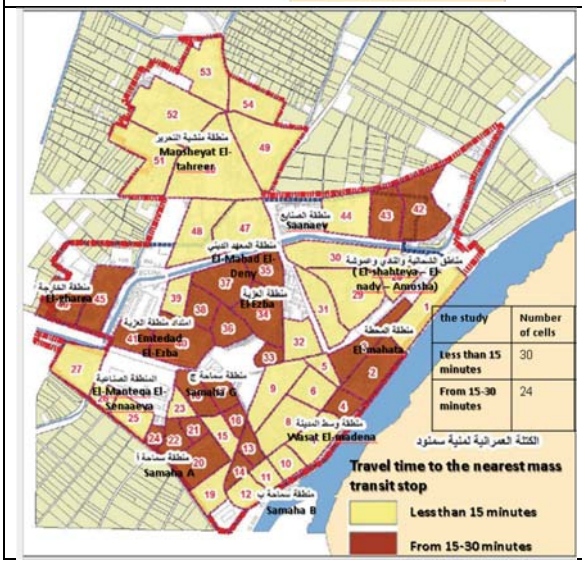

Fig. (10). Classification of areas according to the average travel time to the nearest mass transit stop
Source: Authors from [16].

Indicator: Average travel time to the nearest public transportation stop
Cells: More than half of the cells (33 out of 54 cells)
Notes: According to the distribution of public transportation locations

c. KPIs based SWOT Analysis of Samannoud city

First: Internal Environment Analysis:

Weaknesses	Strengths
− Transportation costs are high, representing more than 400 Egyptian pounds per month for most households in the city (about 85%). − The railway line divides the city's built-up area, leading to environmental pollution, weak connectivity on either side of the railway line, congestion at level crossings, and frequent traffic accidents. − Narrow residential streets in many parts of the city, such as the older areas, informal settlements, and new extension areas. − Traffic congestion at main entrances and intersections (especially at the eastern entrance leading to the village of Menia Samanoud), as well as at the roads adjacent to the city's commercial center and major services. − Weak connectivity in some residential areas. − Unpaved roads in the city account for about 20% of the total road length. − Limited contribution of the private sector and non-governmental organizations in funding road and transportation projects	− The level of street service in the city is good according to residents. − The travel time to work and services is 30 minutes or less for more than 85% of the population. − About 60% of the population has a travel time to the nearest public transportation stop of less than 15 minutes, while the remaining percentage has a travel time of 15 to 30 minutes. − The city has high connectivity with urban centers in the Delta region through regional transportation routes. − The city has several arterial roads wider than 12 meters, such as Saad Zaghloul Street and El Bahr Street. − Some streets in informal areas have been paved at a cost of around 2 million Egyptian pounds. − The city has numerous spots and squares that can be utilized as connection and distribution points within the city's transportation network.

Second: Analysis of the external environment:

Risks and threats	Opportunities
− Insufficient budget allocated to the city for the road and transportation sector. − Lack of specialized personnel in the field of roads and transportation and reduced central support. − Difficulties in enforcing urban regulations in existing areas. − Continued unplanned growth of the road network in new extension areas due to a lack of monitoring and supervision capabilities. − Environmental risks resulting from the fragmentation of the urban area by the railway line, as well as social and visual impacts. − Risks related to the local administration's inability to remove street encroachments, leading to traffic congestion	− Availability of centrally funded projects to develop the road and transportation network in the city, aimed at improving the urban environment, although these projects may not fully meet the actual needs. − The local administration's willingness to partner and cooperate with non-governmental organizations to improve the city's roads and transportation. − The government's commitment to developing informal settlements and unsafe areas, which will lead to improvements in the road network in these areas. − Opportunities to utilize the Damietta branch to revive river transport, which in turn could boost the local economy of the city. − Enhancing the role of community associations in developing and improving the city's road and transportation network

d. Strategic Plan Gaps of Samannoud city

Based on the assessment of Transport Key Performance Indicators (transport KPIs) for the city of Smannoud, several gaps in the City Strategic Plan had been identified. These gaps primarily involve the inability to measure the impacts of unplanned growth in the transportation and road sector. The key gaps were as follows:

- Insufficient Public Transport Facilities (Official and Informal): The city has four public transport facilities, one of which is a developed terminal (with services for citizens and drivers) with a total capacity of 120 vehicles. Another official terminal has a capacity of 200 vehicles, while there are two informal terminals with a combined capacity of 400 vehicles.
- Public Transport Routes Cutting Through the City Center and Vital Residential Areas: Public transport routes in the city are limited to regional connections between Smanoud and other cities, such as the (Mansoura – El Mahalla) road, and routes connecting the city with nearby villages (e.g., Abu Seir, Mahlat Ziad, and El Aziziya). There are no internal public transport routes within the city, due to the relatively limited urban area and the use of simple means of transport by residents for commuting within the city.
- Road Lengths Affected by Usage Distribution Causing Congestion: Roads experiencing traffic congestion are concentrated in the main roads and intersections between regional roads and internal city roads. Congestion is notably present in the city center and areas with mixed-use and high density. There are seven roads suffering from traffic congestion, totaling approximately 13.6 km (e.g., Mansoura-Talqha Road, Al-Thawra Street, Al-Sahel Canal Road, Railway Street, Al-Bahr Street).
- Areas with Road Widths Less Than 8 Meters and Low Road Network Density: Roads narrower than 8 meters total 34 km, with most concentrated in the heart of the city, including Central City, Al-Mahatta, Al-Azba, Al-Shahatia, Al-Nadi, and Amousha.
- High Connectivity with Continuous Roads: The city has good road connectivity and accessibility, with roads serving all classifications and gradients adequately.
- Inadequate Routine Maintenance and Budget Allocation: The percentage of road network length maintained from the total existing network length in the city from the year of the plan's preparation to the present is 2 km, which is 5.48% of the total network length. The budget allocated for the development and maintenance of the existing road network and in the annual development plan is approximately 6 million EGP.

Conclusion

The paper indicates that the strategic plans for cities have proposed a range of factors influencing the identification and localization of proposed projects for these plans. However, some factors crucial for sustainable transportation systems have been overlooked. This research suggests adding a set of additional factors and not neglecting them when making decisions about identifying and localizing projects in strategic plans, as outlined in the following table:
Proposed Transport Performance Indicators to be Added for Project Identification and Localization (according to research results):

- Focus on public transportation and non-motorized transport as a primary priority instead of relying on private cars.
- Reduce unnecessary trips by integrating land uses and intensifying services to decrease travel time and eliminate unnecessary journeys.
- Localize services and activities to reduce the distance and travel time between residences, workplaces, and essential services.

Additionally, several policies to enhance connectivity within the Samannoud city have been proposed as follow:

Categories	Goals	main dimensions	Policies to Enhance Connectivity & Accessibility :
network performance	Maintenance and development of road network	Road network maintenance and development rates	Prioritize investment in the development and improvement of regional roads and transport corridors.
	Road Network Efficiency	Efficient road network condition	Increase connectivity when traveling between residential areas and economic activity zones.
Effectiveness of the road network	Effectiveness of the road network	Encourage the use of and improve transit and active transport networks	Establish a transport planning unit to prepare urban public transport plans. Develop the institutional framework for departments responsible for managing public transport services.
		Efficient carriage of goods	
		Improved transition travel time	Plan and develop transport corridors and public transport services to revitalize the city. Enhance light rail and public transportation systems
	Efficient operation of the transportation system	Availability of complementary network elements	
Social Inclusion & landuse	Affordability and Accessibility	Improve access to daily destinations by all modes	Expand the use of pedestrian movement and bike lanes.
		Inland Road Network Connectivity	Provide sufficient and safe transport routes and services to connect neighborhoods in small cities.
Efficient Parking Services	Private parking spaces	Capacity for parking spaces in the city	

Without mentioning the application mechanisms or indicators used to apply these policies spatially. Research suggests using the indicators used for research as determinants of the application of these spatially dimensional policies in the city's development.

2. Challenges in implementing KPIs for transportation in small cities

There is limited information on the challenges of implementing Transport Key Performance Indicators (KPIs) in small cities from the available literature. However, some challenges can be inferred. One challenge is the lack of data and resources in small cities, which can make it difficult to collect and analyze data for developing KPIs.

Another challenge is the unique characteristics of small cities, such as low population density and limited transport infrastructure, which may complicate the development of relevant and effective KPIs for these cities. Additionally, the lack of standardization in KPIs across different cities and regions can make it challenging to compare and evaluate transport performance.

Finally, implementing KPIs may require significant investments in technology and infrastructure, which can be a challenge for small cities with limited resources. Overall, the challenges in implementing transport KPIs in small cities are likely related to data availability, the unique characteristics of small cities, standardization, and resource constraints.

3. Challenges specific to the study area (Samannoud city)

The following is a summary of the main reasons for not using some indicators and using others in the case study (Samanoud City):

- Difficulty in obtaining data to measure the indicator.
- Discrepancies in data from different sources.
- Insufficient time to gather information to complete the research.
- High financial cost of collecting accurate data.
- Insufficient capacity of the local administration to assist in obtaining detailed data.
- Inaccuracy of geographic information system (GIS) databases and discrepancies with field reality.
- Lack of data availability in publications, databases, and statistical guides produced by various relevant agencies.

Main Issues Faced by the Research Team:

First: Data Collection

- The lack of qualified personnel for conducting social and urban field surveys (in some cities), and the need for mandatory cooperation from city heads through official correspondence between cities and the governorate only.
- The study's timeline (3 months) is unbalanced among its core elements.
- The dimensions for defining study cells (for small cities) need to be redefined, making the sample sizes ranging from 650 to 1000 per city excessively large.
- Technical issues related to data collection and field surveys, such as discrepancies in street names, etc.

Second: Housing and Poor Areas

- The local administration does not plan for the development of poor neighborhoods.
- There are no resources available to provide incentives, transportation, and job opportunities in poor areas.
- Difficulties in planning existing areas due to narrow streets.
- Developing roads in poor areas provides opportunities for commercial projects and job creation in these areas through the local administration.

Third: General Issues in the City

- Narrow streets in many parts of the city.
- Low efficiency of services.
- No resources available to fund the development of poor neighborhoods and no partnerships between the public and private sectors to support and develop poor areas.
- Lack of public participation in policy formulation and lack of awareness of laws, regulations, and guidelines applicable to residents.
- Conflicts in the responsibilities of different local administrations and weak administrative capabilities within the local unit.
- Weak role of non-governmental organizations in addressing local issues.

4. Requirements for Improving the Performance of Smanoud City in the Road and Transport Sector:

The following Table indicated the suggested requirements to improve the Performance of Smanoud City in the Road and Transport Sector:

Type of requirements	Requirements	Priority		
		1	2	3
Planning requirements	**Re-planning of the City's Main and Secondary Entrances**		■	
	Planning of Intersections and Major Squares and Congestion Hotspots: Redesign intersections and main squares, and address congestion points.		■	
	Development of Internal Road Network and Establishing an Appropriate Hierarchical Structure: Improve and expand the internal road network with a suitable hierarchical layout.	■		
	Development of Public Transport Terminals: Upgrade and expand public transport facilities.		■	
	Establishment of Internal Public Transport Routes: Implement internal public transport routes within the city.	■		
	Construction of Connectivity Projects Along Both Sides of the Railway Line (Pedestrian Bridges): Build pedestrian bridges to reduce risks associated with vehicle and pedestrian interactions with the railway line and level crossings.		■	
Institutional /administrative requirements	Removal of Road Obstructions: Address and remove illegal road obstructions.			■
	Development and Paving of Dirt Roads, Especially Main and Collector Roads: Improve and pave dirt roads, focusing on main and collector routes.	■		
	Encouraging Local Administration to Develop the Road Network and Initiate Projects to Reduce Environmental Risks: Promote local administration efforts to enhance the road network and undertake environmental risk reduction projects.		■	
	Improvement of Traffic Management, Especially at Smanoud/Mania Smanoud Bridge (The Bridge Over the Damietta Branch): Enhance traffic flow and management around the Smanoud/Mania Smanoud bridge.	■		
	Capacity Building for Local Administration Staff in Development Management through Providing training and capacity building for local administration personnel in development management.			■
Legal requirements	Establishment of Regulatory Guidelines for Main and Collector Roads According to Strategic Plan Directions: Implement regulations for main and collector roads in line with strategic planning objectives.	■		
Funding requirements	Encouraging Non-Governmental Organizations and Private Sector Participation in Implementing of some listed items: Promote the involvement of NGOs and the private sector in the executing specified projects.		■	

5. Recommendations and suggestions to address the gaps in Samanod City strategic plan:

The strategic plan for the city of Smanoud prioritizes transportation and road projects, which include the construction of two pedestrian overpasses above the railway line at two

locations: (in front of the October 6 Schools Complex and in the city center). Below are some specific and general recommendations from the consultant regarding this project, as well as proposals to address the gaps in the city's strategic plan:

1. **Recommendations for Improving the Existing Transportation and Road Network:** (A) Enhance the hierarchical structure of the road network by classifying roads according to their function. (B) Remove obstructions that impede traffic flow, especially on main and collector streets. (C) Implement regulatory measures for some of the relatively narrow existing roads to integrate them into the city's public transportation network according to strategic planning guidelines. (D) Designate certain streets for one-way traffic, especially in older areas with relatively narrow streets. (E) Develop and pave dirt roads, focusing on main and collector roads. (F) Redesign entrances and main squares to improve their efficiency. (G) Improve and maintain roads in impoverished areas. (H) Enforce regulations governing transportation and road management. And (I) Reduce sources of noise and visual pollution on roads.

2. **Recommendations to Encourage Public Transport Services:**
   (A) Encourage the private sector and non-governmental organizations to undertake public transportation projects within and outside the city by providing various incentives and facilitation. (B) Develop public transport terminals and allocate additional sites for internal public transport facilities. (C) Raise public awareness and educate citizens about the environmental, economic, and functional benefits of using public transportation through community engagement. (D) Encourage government institutions and local factories to operate public transport lines for workers and employees. And (E) Develop and utilize local resources to support public transport services in the city.

3. **Recommendations for Improving Travel Time and Reducing Road Congestion:** (A) Encourage residents to use light transportation options such as bicycles, especially for short trips. (B) Improve and upgrade pedestrian sidewalks, particularly on main streets. (C) Redesign entrances, squares, hotspots, and intersections. (D) Expand public transport terminals to serve different areas and neighbourhoods instead of concentrating them in a single location. (E) Provide markets for street vendors. (F) Focus on general cleanliness and beautification of the city. (G) Establish wholesale markets for agricultural and food products outside the city's urban area. And (H) Dispose of waste using sanitary and effective methods.

6. Recommendations for Future Research

1. Develop transport KPIs specific to small and medium-sized cities.
2. Enhance transport indicator sets with metrics that include future developments in mobility (such as electric transport, connected automation, or mobility as a service).
3. Implement policies to enhance connectivity within cities and urban regions.

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تأثير مؤشرات قياس كفاءة أداء شبكات النقل الحضري على اعداد المخططات الاستراتيجية للطرق والنقل للمدن الصغيرة بالتطبيق على مدينة سمنود ـ محافظة الغربية

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المستخلص

يعتبر قطاعي الطرق والنقل من اهم قطاعات التنمية المكانية (الشـــاملة أو القطاعية) علي كافة المســـتويات التخطيطية، حيث أن تخطيط النقل والطرق داخل المدن من القضـايا متعددة الجوانب وهو جزأ لا يتجزأ من عملية التخطيط العمراني و التنمية الحضـــرية، وبعتر التخطيط المســـتدام لكل من الطرق والنقل الحضـــري من ناحية والتنمية العمرانية الحضـرية من ناحية اخري وجهان لعملة واحدة. حيث تواجه المدن المصـرية بشـكل عام العديد من المشـكلات بسـبب النمو العشـــوائي لقطاع النقل والحركة وذلك بســـبب عدم إمكانية قياس تأثيرات ذلك النمو العشـــوائي عند اعداد المخططات الاســـتراتيجية للطرق والنقل الجماعي وبالتالي لا تنعكس على رؤية الوضـــع الراهن وصـــياغة القرارات في المخطط الاســـتراتيجي. وتتأتي أهمية البحث في تقييم تجربة قياس كفاءة أداء شـــبكات النقل الحضـــري على احد المدن المصـــرية الصغيرة وتحديد سياسات التنمية ذات الصلة به وذلك بهدف تعظيم المرود التنموي من المخططات الاستراتيجية علي كافة القطاعات وتحقيق التنمية المســـتدامة، حيث يوجد ارتباط وثيق بين شـــبكات النقل والطرق وبين القطاعات المختلفة من اقتصاد او بنية تحتية او خدمية او عمرانية. ويتناول البحث تطبيق مؤشرات قياس كفاءة أداء شبكات النقل الحضري وتحليل التجارب الدولية ومن ثم اســـتخدام البعض منها خلال الدراســـة التطبيقية علي مدينة ســـمنود وذلك بهدف قياس كفاءة المخططات الاستراتيجية للطرق والنقل الحضري باستخدام تلك المؤشرات، ومن ثم اقتراح توصيات وآليات سد الفجوات المستنبطة في التحليل. ويخلص البحث الى نتائج تقييم تطبيق المؤشرات على صياغة المخطط الاستراتيجي، وعرض اهم معوقات التطبيق، واقتراح التوصـيات لتحسـين اسـتخدام تلك المؤشـرات على الحالات المشـابهه وأخيرا توصـيات لبعض الأبحاث المستقبلية لتحسين تطبيق تلك المؤشرات في الحالة المصرية بشكل عام.

الكلمات الدالة: مؤشرات قياس كفاءة الأداء – النقل الحضري – المدن الصغيرة – مدينة سمنود