A FRAMEWORK OF PRACTICAL ECONOMIC INDICATORS FOR TRANSIT-ORIENTED DEVELOPMENT (FPEI-TOD): IDENTIFICATION AND EXPERT VALIDATION

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Abstract

Transit-Oriented Development (TOD) can be one of the tools to achieve sustainable urban management (SUM), as promoted by SDG11 on Sustainable Cities and Communities. In the context of Malaysia, TOD is seen as a potential solution to urban challenges, i.e., traffic congestion, pollution, rising cost of living, lack of employment opportunities, and the prevalence of crime. However, in determining a balanced approach to SUM, TODS must have a framework of indicators that can be used to guide its implementation so the three sustainable development dimensions are catered for, particularly the economic dimension. A review of previous studies and literature on TOD revealed a dearth of studies on economic indicators for TOD in Malaysia. Using the sequential mixed methods approach, this research aimed to improve the current implementation of TOD for sustainable urban management by proposing a framework for practical economic indicators of TOD and endeavouring to close the gap in practical TOD assessment in Malaysia. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) were used to extract the economic indicators before deploying a questionnaire survey for experts' validation. A total of 48 economic indicators that are practical to implement for TOD were produced based on the experts' opinions. These indicators would serve as measuring tools for ensuring sustainable TODs that not only provide greater transit facilities but are also resilient in facing future urban challenges.

Keywords: Sustainable Development, Transit-Oriented Development (TOD), Urban Management and Economic Sustainability, Indicators

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INTRODUCTION

TOD is a planning strategy that focuses on creating compact, mixed-use communities around public transportation facilities, such as train or bus stations (Gomez et al., 2019). The goal of TOD is to encourage sustainable urban development by promoting efficient and convenient public transportation options, reducing reliance on private cars, and fostering a more pedestrian-friendly and environmentally-friendly urban environment (Bista, 2008). TOD is crucial for sustainable urban management as it offers a holistic approach to urban development that integrates transportation, land use, and environmental considerations, contributing to more resilient, liveable, and environmentally friendly cities (Chan et al., 2016; Khalid & Samsudin, 2023). Many recent studies on TOD tap into the influence of economic aspects on urban function, which refer to the various activities, land uses, and functions within a development to support a transit-friendly environment (Yu et al., 2022). The urban function within TOD areas typically aims to enhance accessibility, walkability, and the overall quality of life in the communities (Zhang et al., 2022). The current challenges to TOD faced worldwide are primarily land use zoning and regulation, which hinder the efficient development of mixed-use, and high-density areas around transit nodes, which are essential for successful TOD (Liu et al., 2020). Others include gentrification and affordability, which displace existing lower-income residents near transit nodes (Chava & Renne, 2022), last-mile connectivity, which ensures convenient and safe connectivity between transit hubs and final destinations (Venter, 2020), and integrating new technologies such as ridesharing, electric scooters, and autonomous vehicles into TOD planning (Butler et al., 2020; Cervero, 2020; Litman, 2021).

Examining the economic indicators for TOD is crucial as it provides valuable insights into the economic impact, viability, and sustainability of TODs (Cucuzzella et al., 2022). Economic indicators offer a comprehensive understanding of how TOD initiatives contribute to local and regional economies (Almatar, 2022; Newman et al., 2021). These indicators provide a quantitative basis for decision-making, encourage informed planning, and help stakeholders understand the broader economic implications of TOD on urban areas (Liu et al., 2020; Maheshwari et al., 2022). The lack of a structured framework for economic indicators can hinder the ability to comprehensively assess, plan, and manage TOD projects (Furlan et al., 2021), besides the risk of unintended economic consequences such as uncontrolled gentrification, insufficient job creation, or an imbalance in the mix of land uses within TOD areas (Asiz, 2020; Surya et al., 2020).

This paper is part of larger research that aims to develop a framework of practical economic indicators for TOD in Malaysia. The purpose of this paper

is to present the preliminary findings after the first round of Delphi expert validation. This paper is organised into the following sections: a literature review to establish the framework and context of this paper; research methodology that describes methods and procedures used; analysis and discussion to analyse and interpret results in the context of the paper's aim; and a conclusion to summarise and emphasise the significance of this paper and its contribution.

LITERATURE REVIEW
Concept of Transit-Oriented Development (TOD)
TOD is a recent concept focusing on efficient modes of transportation other than the automobile (Chan et al., 2016). The concept of TOD was introduced by Peter Calthorpe, who urged planning for pedestrians and transit "not to eliminate the car, but to balance it" (Ibraeva et al., 2020; Ramlan et al., 2021). TOD is one of the best alternatives for various sustainable challenges, especially preventing urban sprawl (Olaru et al., 2011). It is seen as a logical means towards compact urban development and sustainable transportation (public transit, cycling, and walking) (Thomas & Bertolini, 2017). Other benefits of TOD include strengthening local economies by improving local public transit, which reduces vehicle transportation costs and time spent commuting (IPA, 2013). TOD also creates compact communities and strong transit systems. These criteria would help to attract innovative youngsters towards the inner city, thereby creating more jobs and a vibrant environment. Generally, TOD is about creating an urban environment with mixed and diverse land use and a walkable transit stop that balances the need for sufficient density to support convenient transit services (Rahim, 2018). According to Thomas and Bertolini (2017), as well as Mu and de Jong (2012), TOD planning principles have been adopted around the world to control urban growth, reshape the quality of urban form, and provide efficient transportation systems. The possibilities of TOD to address urban problems such as traffic congestion that results from urban sprawl have also been studied by various Asian governments such as China, Hong Kong, Singapore, and Japan (Hasibuan et al., 2014; Mu & de Jong, 2012; Sung & Oh, 2011). Gomez et al. (2019) emphasised that the main concept of TOD is aimed at providing a vibrant and liveable community. In practice, there are different approaches proposing different quantitative measurement criteria for TOD.

TOD Core Principles and Components
The core of TOD is to reduce car use (Ali et al., 2021). By reducing the need for vehicle travel, mixed-use development brings shared community spaces such as plazas, parks, and sidewalks to foster interaction among community members (Zamorano & Kulpa, 2014). According to Calthorpe (1993), there are seven **core principles** associated with TOD: (i) Compact growth should be organised at

regional level and be transit-supportive; (ii) Housing, offices, and "civic uses" should be located within walking distance of transit stops; (iii) Streets should be bike and pedestrian friendly and connect to local destinations; (iv) There should be a mix of housing types, densities, and costs; (v) Ecosystem services should be preserved, as well as high-quality open space; (vi) Public space should be the central focus of buildings and neighbourhoods; and (vii) Existing neighbourhoods requiring infill should be redeveloped along transit corridors.

The University of Delaware (2013), referring to the core principles of Calthorpe (1993), further listed five (5) **key components** of TOD: (i) It contains a walkable, high-quality pedestrian environment that integrates streetscaping; (ii) The highest housing densities are located closest to the transit centre to decrease sprawl and promote compactness; (iii) The transit centre is also at the centre of a destination that has a diverse and mixed-use development; (iv) The community has quality public transit facilities and services; and (v) Parking is carefully located, designed, and managed.

Issues Faced by TODs
Despite the numerous benefits of TOD, issues in urban areas are still on the rise. The various issues include zoning and regulatory barriers that impede the efficient development of mixed-use, high density around transit nodes (Mathur & Gatdula, 2023), hindering the TOD concept, inadequate public transport structures that limit the effectiveness of TOD initiatives (Ibraeva et al., 2020), and the security and safety of commuters at transit stations, which can deter people from using public transport (Ruslan et al., 2023; Soto et al., 2022). These prevailing issues of TOD are an alarm that suggests the practical indicators for transit development are timely and crucial to ensuring the TOD-ness of transit development in Malaysia, especially in solving the economic-related problems in the urban area.

TOD Indicators
The selection of indicators should be based on the essential details of TOD (Nyunt & Wongchavalidkul, 2020), including land use characteristics, built environment, and design characteristics (Loo et al., 2010; Sung & Oh, 2011) that could potentially facilitate planning decisions, and possibly both spatial and nonspatial indicators (Sulistyaningrum & Sumabrata, 2018). The indicators are mapped out according to the Economic Pillar of Sustainable Development Dimension (SDD) and grouped according to the TOD principles. These scholars were screened and selected through the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocols and reported according to the PRISMA Statement (which is further elaborated in the methodology section).

TOD in Malaysia
TOD in Malaysia was defined by PLANMalaysia (2018) as a development concept centred around rail transit or bus stations that promotes high connectivity, is public transportation-friendly, pedestrian-friendly, and bike-friendly, along with reducing dependency on private vehicles. Now, TOD has become a key concept for developers and property players in urban planning to create a quality, prosperous, and sustainable living environment (Gomez et al., 2019).

PLANMalaysia established specific guidelines that contain comprehensive guidance for transit development (Abdullah et al., 2022; PLANMalaysia, 2018). Kuala Lumpur is currently one of the cities that is extensively promoting transit development by introducing transit zoning. Transit zoning allows for higher density and compact development around the transit area to attract investors to redevelop and compensate the high land price with other physical and monetary incentives (Kidokoro, 2020)

RESEARCH METHODOLOGY
To achieve the aim of this paper, a mixed-methods approach was used. Firstly, economic indicators of TOD were extracted from the literature. The relevant studies were identified and screened using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). The PRISMA statement table was created using the most important parts of TOD, like land use, built environment, and design, along with the set criteria for finding the right indicators for this study. The PRISMA statement table is presented in Figure 1.
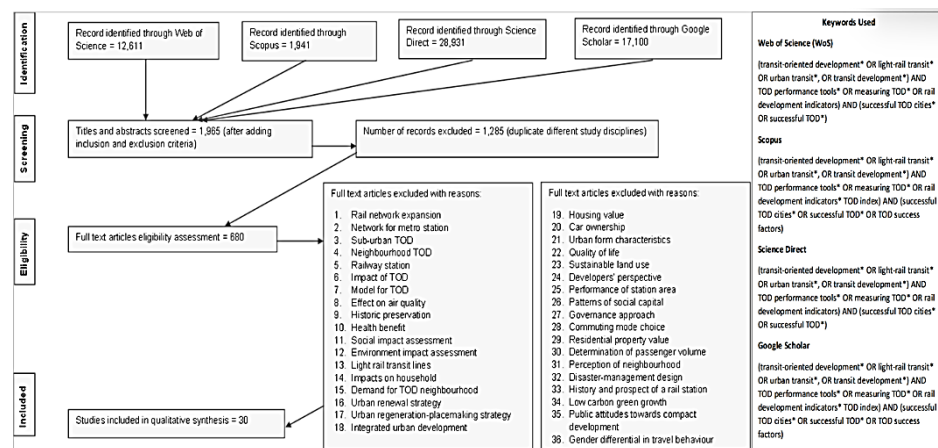

Figure 1: PRISMA Statement Table
Source: Researcher (2023)

Following the extraction of the economic indicators from the literature, the Delphi technique was used to finalise the indicators. The Delphi technique is

a structured and iterative method of communication and consensus-building among a group of experts to reach a consensus on a particular issue or topic by gathering and synthesising the opinions of a diverse group of experts (Beiderbeck et al., 2021). To serve the objectives of this research, three rounds of iterations will be carried out. A set of questionnaires was distributed to selected TOD experts to gauge the convergence of consensus among the experts. The questionnaire consists of 5-point Likert scale questions. This quantitative method was applied to validate the practical economic indicators for sustainable urban TOD assessment. A total of 16 TOD experts were selected from different planning authority levels in Malaysia (i.e., federal, state, and local government levels). These experts were top management officers who possess the related background, knowledge, and experience regarding TOD (see Table 1). To achieve the objective of this paper, Delphi Round 1 was carried out to gather the experts' opinions on the practical economic indicators for TOD to be implemented in Malaysia. The analysis and results from the Round 1 Delphi are presented in the following section.

To analyse the questionnaire, descriptive analysis of the central mean was used to eliminate impractical indicators derived from the survey. The results from Delphi Round 1 were then used to modify the questionnaire for Delphi Round 2. The results from the descriptive analysis were then verified using Principal Component Analysis (PCA) to validate the reliability and validity of the first iteration.

Table 1: List of experts in TOD

Organisation's Level	Organisation	Experts' Designation	Number of Officers	Number of TOD Projects
Federal	PLANMalaysia HQ	Deputy Director (R&D Unit)	1	5
		Head of Division (Sustainable Development Unit)	1	3
		Head of Division (Heritage and Urban Design Unit)	1	3
		Senior Town Planner	1	4
		Senior Town Planner	1	4
State	PLANMalaysia Selangor	Senior Deputy Director	1	6
		Head of Unit (Development Control)	1	4
		Senior Town Planner	1	3
Local Authority	Subang Jaya City Council	Director	1	7
		Deputy Director	1	4
		Senior Deputy Director	1	5
		Senior Town Planner	1	5
		Senior Town Planner	1	4
		Senior Town Planner	1	4
		Senior Town Planner	1	4
		Senior Town Planner	1	3
Total	**3**	**16**	**16**	**73**

Source: Researcher (2023)

ANALYSIS AND DISCUSSION

Table 3 demonstrates the result of the descriptive analysis from Delphi Round 1. The elimination process was undertaken by referring to the mean score range (Chyung et al., 2017; Garland, 1991) (refer to Table 2). A mean score above 3.50 was accepted and selected for Round 2 of the Delphi Survey (Chyung et al., 2017).

Table 2: Mean Score Range

Scale	Likert Type	Mean Score Range
1	Strongly Disagree	1.00 – 1.80
2	Disagree	1.90 – 2.60
3	Neutral	2.70 – 3.40
4	Agree	3.50 – 4.20
5	Strongly Agree	4.30 – 5.00

Source: Chyung et al. (2017)

The central mean analysis confirmed a total of **48 indicators** from the initial **77 economic indicators** to be retained for Delphi Round 2. This recorded a **38%** reduction from the result of Delphi Round 1. The retained indicators, in the view of the experts, are practical and suitable to be established in the transit development in Malaysia.

Table 3: Descriptive Analysis Results

Variable	Initial Item	Round 1 Results
Land use	11	7
Density	8	6
Population	5	0
Transit facilities	13	8
Property development	6	0
Value recapture	7	6
Economic attributes	27	21
Total	**77**	**48**

The result from the Delphi Round 1 survey was also verified by using the factor reduction method of Principal Component Analysis (PCA) to achieve credibility for the results, as well as enhance the validity of the survey. The factor reduction was performed using **varimax rotation,** with the **factor loading** criteria set at **0.60**. Components that loaded below the criteria set were eliminated for the round of the Delphi survey. The result of the PCA is presented in the following table.

Table 4: Factor Loading of Component Matrix

SD Dimension	Variable Components	Factor		
		1	2	3
Economic	**Land Use**			
	Quantity of mixed-used development		.775	
	Comprehensive development		.897	
	Efficient land use patterns	.860		
	Location efficiency	.786		
	Diversity of housing types	.834		
	Access and accessibility	.708		
	Urban development		.807	
	Density			
	Density of development	.914		
	Population density	.820		
	Business density	.702		
	Ground floor retail density		.931	
	Retail density		.924	
	Land use density	.901		
	Transit Facilities			
	Information display system	.948		
	Frequency transit service		.686	
	Safety of commuters at transit stops	.907		
	BRT facilities	.748		
	Points of interest (POI)		.748	
	Stations in CBD		.892	
	Number of public facilities	.846		
	Average distance from public facilities to commercial area		.698	
	Value Recapture			
	Increase in property value	.903		
	Tax earnings of the municipality	.934		
	Value recapture	.912		
	Financial return	.934		
	Land prices	.752		
	Private investment	.828		
	Economic Attributes			
	Subset 1			
	Number of business establishment		.827	
	Economic development	.875		
	Average car ownership			.924
	Degree of multifunctionality	.868		
	Household income		.887	
	Real per capita income	.647		
	Industrial accident rate			.810
	Transport and communication	.811		
	Utility efficiency		.735	
	Sustainable urbanisation rate	.900		
	Strengthening national and regional development planning	.727		

Subset 2		
Liveability	.708	
Percentage of professional jobs/service jobs/other jobs		.876
Number of workers in economic cluster		.682
Poverty rate	.894	
Unemployment rate	.834	
Average rental to household income	.698	
Delivery system	.894	
Institutional strengthening	.905	
Enforcement and monitoring	.832	
Serviceability	.875	
Total	**48**	

Source: Researcher (2023)

The component matrix showcases the strength and direction of the relationships between the observed variables and the underlying factors for practical TOD indicators. The components for each variable resulting from the experts' opinion were lateral to non-spatial indicators as listed by Sulistyaningrum and Sumabrata (2018), such as safety of commuters in transit, frequency of service, number of public facilities, and average distance from public facilities to commercial areas. The component matrix displayed the significant factor loadings, offering a nuanced understanding of how the economic TOD indicators contribute to and align with the underlying factors that affect sustainability. This affirmed that these components represent a significant contribution to facilitating planning decisions for efficient urban management, as mentioned by Sulistyaningrum and Sumabrata (2018).

The finding was consistent with Nyunt and Wongchavalidkul (2020), who suggested that the selection of indicators should be based on the essential characteristics of TOD. The essential details of TOD may possibly be both spatial and nonspatial indicators, as explained by Loo et al. (2010) and Sung and Oh (2011). The confirmed main economic variables entailed the spatial indicators, which include land-use diversity, density, and transit facilities that align with the suggested spatial indicators by Sulistyaningrum and Sumabrata (2018).

The confirmed 48 economic indicators, as per the experts' opinions, are essential in evaluating the success and sustainability of TOD. They offer valuable insights into the contribution of the economic vitality of the TOD and its alignment with economic objectives within a TOD framework (Liu et al., 2020). Thus, these indicators play a crucial role in determining the economic feasibility and impact of TOD projects (Cucuzzella et al., 2022). From the 77 extracted economic indicators, some, in the opinion of the experts, were irrelevant to the Malaysian context. These indicators were extracted from developed countries, while Malaysia is still a developing country. They differed in several ways due to variations in economic structure, levels of development, and the influence of global economic dynamics (Huang et al., 2022; Lin, 2011). The eliminated

indicators may have unique features based on their special circumstances, policies, and development goals (Huan et al., 2021), which may not be suitable for TOD in Malaysia, in the opinion of the experts.

CONCLUSION
In order to integrate sustainability elements into urban management, there is an essential requirement for diligent monitoring of transit development's impact on economic sustainability through appropriate indicators. Reviews from the works of literature established the need for specific indicators to evidence the effectiveness of TOD engagement in solving economic-related problems in urban areas. Therefore, this study contributed to addressing this identified gap and meeting the main aims of this research.

The outcomes of this study have successfully achieved the objective of this paper, which was to determine the economic indicators for sustainable urban TOD assessment. Round 1 of the Delphi survey also concluded with **48** general economic TOD indicators. The most significant indicators were mainly Density, Transit Facilities, Value Recapture, and Economic Attributes Components, with significant factor loadings, which confirmed that these are the fundamental components in proposing the practical economic indicators framework for TOD. Experts validated the economic indicators to make it easier for decision-makers to evaluate the transit development's performance in terms of economic sustainability within the Malaysian context.

This paper was proposed to determine the economic indicators for sustainable urban TOD assessment and help establish the framework of practical economic indicators for urban transit development. This framework offers valuable insight into the performance and sustainability of TODs, particularly in urban areas. These indicators are anticipated to assist stakeholders, decision-makers, and industry players in making decisions, attract investment, and optimise the economic benefits while considering the broader goals of SDG 11 to create sustainable cities and communities.

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