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An Empirical Analysis of Transportation Infrastructure Feasibility Study Considerations

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1 Introduction

Transportation infrastructure impacts on the growth of an economy through employment creation and therefore enhances economic development and provision of social services (Chen and Cruz 2012). Achieving

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successful and sustainable operations throughout the life span of transport infrastructure should therefore be the focus in transport project planning and development (Glaister et al. 2010). However, transportation infrastructure is fraught with uncertainties, which if not taken cognizance of at the time of planning, may threaten the sustainability of the projects. According to Merrow (2011) and Mišić and Radujković (2015), the proportion of mega infrastructure project failure, globally, is as high as 66%, with cost overruns of over 50%, and a significant proportion of these projects fail to meet the objectives for which they were constructed in the first instance. This suggests that the factors considered at the initiation and conception of projects influences its performance during the operational stage. Therefore, if huge discrepancies between expected and actual outcomes occur, the magnitude of inherent risks and uncertainties which materialise at the operational stage is unplanned for, and the result can be a project failure. The quality of feasibility studies therefore appears to be a critical factor to the sustainability of transportation infrastructure projects.

However, although studies had been conducted on the factors which should be considered in feasibility studies to ensure good quality outcomes (Hyari and Kandil 2009; Nicolaisen et al. 2012; Flyvbjerg 2014), the relative importance of these factors have not been determined. It is therefore not clear which factors are most critical to the outcome of feasibility studies. Understanding the critical factors will assist in developing a comprehensive feasibility study. The objective of the current study was therefore to establish critical factors that should be considered in feasibility studies.

2 Transportation Infrastructure Feasibility Study Considerations

Feasibility studies include all elements that may impact on a project's performance. These include finance availability and procurement strategies (Glaister et al. 2010), local environment (Rudžianskaitė-Kvaraciejienė et al. 2015), institutional support (Quium 2014) and users' needs (Erlich

2015; Mišić and Radujković 2015). Therefore, good feasibility studies should consider a wide variety of project performance-influencers.

In addition, the people involved may affect feasibility studies and the procedures followed during the feasibility studies. Nicolaisen et al. (2012) and Flyvbjerg (2014) indicated that inadequate or incorrect feasibility assessments are the result of delusions (psychological biases) or honest mistakes and deceptions or strategic manipulations of information by the people involved. On their part, Hyari and Kandil (2009) contend that a lack of understanding of the basic underlying processes involved in feasibility studies results in unreliable outcomes. The procedures followed, which require designating time and effort into conducting feasibility studies, are important because errors could be introduced and some critical aspects may be omitted (Rosenthal et al. 2015).

Based on the above discourse, the factors identified were categorised into data used, procedures followed and criteria factors considered. These were used to collect empirical data for further analysis.

3 Methods

A quantitative approach was adopted to conduct the study. A pilot-tested field questionnaire survey was used to collect data regarding factors considered in feasibility studies, on a five-point Likert scale, with responses ranging from 1=strongly disagree to 5=strongly agree. Prior to data collection, ethical clearance was granted by the university authorities. Consent was also obtained from some of the participants' superiors as and where required. The questionnaire was distributed by hand, as well as online via email and google forms. Out of over 400 questionnaires distributed, a total of 132 questionnaires were returned and used for analysis. The respondents were selected through purposive and snowball sampling techniques. They comprised built environment professionals in the nine provinces of South Africa, who had been involved in transportation infrastructure projects, either at the feasibility stage or during operations or both. Responses were obtained on various types of projects, as projects were the units of analysis.

Table 8.1 Internal consistency reliability results

Constructs		Cronbach's alpha	Mean inter-item correlations	Number of items
Transportation infrastructure feasibility study (TIFS)	Data used	0.72	0.25	8
	Criteria factors considered	0.93	0.39	21
	Methods used	0.89	0.51	9

Source: Made by the authors

Data were analysed to output descriptive scores based on mean, standard deviation, median and interquartile range analyses. Preliminary analysis included assessment of missing data, normality and outliers. The results of the analysis are presented in the succeeding section. Cronbach alpha test was also undertaken to check the internal consistency reliability of the scale. The alpha values ranging from 0.72 to 0.93 indicated good internal consistency reliability (Pallant 2013). Mean inter-item correlations were also reported to further demonstrate internal consistency reliability, with values exceeding 0.20 as recommended by Pallant (2013). The internal consistency reliability results are presented in Table 8.1.

4 Findings

Descriptive analysis was used to establish the predominant transportation infrastructure feasibility study elements. The findings included the data used, criteria factors considered and methods adopted for the feasibility studies. The results displayed were the mean (M), standard deviation (SD), median (MD), 25% and 75% quartiles (Q1 and Q3), and interquartile range (IQR) values from the responses on each of the variables.

4.1 Data Used

Respondents were asked to indicate the extent to which they agreed or disagreed with statements regarding the data used during the feasibility study of the projects they were involved in. Table 8.2 showed that

Table 8.2 Findings on planning data used

Factor	Measures	Mean	SD	Median	Q1	Q3	IQR
Planning data	Traffic data	4.13	0.826	4.00	4.00	5.00	1.00
	Infrastructure development master plans	4.04	0.801	4.00	4.00	5.00	1.00
	Existing design and structural reports, for upgrade projects	3.98	0.818	4.00	4.00	5.00	1.00
	Audit observations and performance reports, for upgrade projects	3.82	0.840	4.00	3.00	4.00	1.00
	Existing financial and tender records	3.68	0.863	4.00	3.00	4.00	1.00
	Public records and manufacturers	3.67	0.905	4.00	3.00	4.00	1.00
	International projects as examples	3.34	1.197	3.00	2.00	4.00	2.00
	Household income survey data	2.82	1.195	3.00	2.00	4.00	2.00

Source: Made by the authors

participants indicated most agreement (including strong agreements) with *traffic data*, which recorded the highest mean (M = 4.13), with SD = 0.826; MD = 4.00 (4.00–5.00). The median value (4.00) indicated that 50% of the respondents were in agreement regarding the statement. The SD values were less than 1, indicating that the responses were closer to the mean. The interquartile range values of between 4.00 and 5.00 (IQR of 1) also supported that responses were not far from the median. These values seemed to suggest that the respondents had similar opinions regarding the statement that traffic data were used in the feasibility studies for the projects.

Infrastructure development master plans followed with M = 4.04; SD = 0.801; and MD = 4.00 (4.00–5.00). Similarly, the SD values less than 1 indicated unified opinions from respondents. The IQR of 1 indicated that the respondents were in agreement regarding the statement as the answers were mostly concentrated around the median.

On the other hand, *international projects as examples* (M = 3.34; SD = 1.197; MD = 3.00 (2.00–4.00) and *household income survey data* (M = 2.82; SD = 1.195; MD = 3.00 (2.00–4.00) ranked the least among the statements, suggesting that participants indicated most disagreements with these statements. Both the SD and MD values also indicated that the respondents tended to disagree on a wider range, with an IQR of 2 respectively.

4.2 Feasibility Criteria Factors

Respondents were asked to indicate the extent to which they agreed or disagreed with statements regarding factors on which assessments were based (criteria) during the feasibility studies. Table 8.3 indicated that respondents were in agreement with statements regarding *user safety, local conditions, condition of infrastructure, speed and travel time, stakeholders' interests and needs, land use integration, structural capacity of existing infrastructure, for upgrade projects, convenience to users* and *management capacity*. These statements had mean scores of 4.00 and above, indicating that responses were mostly on the "agree" category. Further, all the median values for the above statements were also 4.0 indicating that 50% of the respondents agreed with the statements. Al the IQR values for these nine statements also indicated that the respondents had similar opinions as the answers were within the range of agree (Q1 = 4.00) to strongly agree (Q3 = 5.00).

4.3 Investment Appraisal Methods Used

Table 8.4 presents findings with regard to the methods used in feasibility studies. Respondents were asked to indicate the extent to which they agreed or disagreed with the statements. The table evinced that methods used mostly entailed design and scope requirements (M = 4.21; SD = 0.691; MD = 4 (4–5), environmental impact assessments (M = 4.15; SD = 0.842; MD = 4 (4–5), as well as cost and benefits analysis (M = 4.13; SD = 0.795; MD = 4 (4–5). The least used methods or approaches appeared to be *financing alternatives relative to costs (financial)* (M = 3.61; SD = 1.068; MD = 4 (3–4) and *rate of return on investment* (M = 3.42; SD = 1.185; MD = 3 (3–4). The median value of 3 for the *rate of return*

Table 8.3 Findings on feasibility criteria factors

Factor	Measures	Mean	SD	Median	Q1	Q3	IQR
Feasibility criteria factors	User safety	4.24	0.926	4	4	5	1
	Local conditions	4.15	0.805	4	4	5	1
	Condition of existing infrastructure, for upgrade projects	4.09	0.890	4	4	5	1
	Speed and travel time	4.08	0.913	4	4	5	1
	Stakeholders' interests and needs	4.08	0.768	4	4	5	1
	Land use integration	4.03	0.941	4	4	5	1
	Structural capacity of existing infrastructure, for upgrade projects	4.02	0.877	4	3	5	2
	Convenience to users	4.01	0.878	4	4	5	1
	Management capacity	4.00	0.865	4	4	5	1
	Central Government's support of the project from start to finish	3.98	0.935	4	4	5	1
	Life cycle cost of the system	3.97	0.980	4	3	5	2
	Accessibility to all, including the disabled	3.95	0.864	4	3	5	2
	User comfort during travel	3.92	0.978	4	3	5	2
	Sources of project finance	3.88	0.996	4	3	5	2
	Preservation of cultural heritage	3.85	0.912	4	3	4.75	1.75
	Proximity to user daily needs	3.82	0.998	4	3	4	1
	Travel costs for commuters	3.77	1.138	4	3	5	2
	Existing businesses/vendors	3.77	1.081	4	3	5	2
	Competing transportation modes within the locality	3.54	1.125	4	3	4	1
	Financial self-sustenance of the system	3.48	1.176	4	3	4	1
	Financial input from private investors	3.15	1.308	3	2	4	2

Source: Made by the authors

on investment statement indicated that responses were mostly concentrated on the "neutral" category, and the IQR value of 1 suggested common views among the respondents.

Table 8.4 Findings on investment appraisal methods used

Factor	Measures	Mean	SD	Median	Q1	Q3	IQR
Investment appraisal methods	Design and scope requirements	4.21	0.691	4	4	5	1
	An environmental impact assessment	4.15	0.842	4	4	5	1
	Costs and benefits analysis	4.13	0.795	4	4	5	1
	Site/location characteristics	4.11	0.774	4	4	5	1
	Best scenario outcome	4.02	0.804	4	4	5	1
	Traffic growth analysis	4.01	0.887	4	4	5	1
	Multi-criteria analysis	3.84	0.907	4	3	5	2
	Financing alternatives relative to costs (financial)	3.61	1.068	4	3	4	1
	Rate of return on investment	3.42	1.185	3	3	4	1

Source: Made by the authors

5 Discussion

Findings from the descriptive analysis revealed that available planning data used in the feasibility studies of the sampled projects were mostly traffic counts, infrastructure master plans and international projects for benchmarking. Traffic data obtained from counts and surveys reflect the frequency and distribution, which are the bases of forecasts and determination of infrastructure size (Beria 2007; Serero et al. 2015). Further, reference to infrastructure master plans was considered important for a comprehensive feasibility study. This is because integration of proposed networks with existing ones will be possible as was the case with the Addis Ababa light rail transit in Ethiopia (Nallet 2018). However, household income survey data was not considered important. This was not consistent with an extant view that feasibility studies should reflect income earning opportunities and ability to pay the set travel charges (World Bank 2005; Maunganidze and Del Mistro 2012; Nallet 2018).

With regard to feasibility study criteria factors considered on the sampled projects, the descriptive analyses indicated that safety, local conditions, existing infrastructure condition (for upgrade projects), as well as speed and travel time were considered the most prevalent factors. Due to the wide array of impacts that may materialise from transportation infrastructure projects, feasibility studies should unambiguously account for and accurately incorporate local conditions and environment, stakeholder interests as well as related factors including traffic fatality rates, value of personal time and safety benefits to users, which manifest either as infrastructure and user costs (Schutte and Brits 2012). On the other hand, financial aspects were deemed to be the least important aspects. This finding was surprising since sufficient financial leverage is needed to implement investments with higher returns and benefits (Crescenzi et al. 2016).

Further, the descriptive analyses revealed that the methods considered in a comprehensive feasibility study entail design and scope requirements, environmental impact assessment and cost-benefit analysis as well as site and locational characteristics (Beria 2007; Cervero 2011; Jones et al. 2014). Conversely, the *rate of return on investment* and *the financial alternatives relative to costs* were not considered important appraisal methods among the respondents. These findings may have resulted because some projects (public and government funded) are provided for the benefit of the community. However, these appraisal approaches are needed to evaluate projects and make decisions on more acceptable and beneficial investments for financial and economic status as was the case with the feasibility study of Metro Rail projects in Madurai in India (Subash et al. 2013).

6 Conclusion

Empirical data were analysed using SPSS to output descriptive scores based on mean, standard deviation, median and interquartile range. The study found that traffic data and infrastructure development master plans were the most sources of data referred to. The criteria factors considered include user safety, local conditions and physical condition of infrastructure. Further, design and scope requirements, environmental impact assessment and cost-benefit analysis were the most appraisal methods employed in feasibility studies.

Further studies are recommended with more robust analytical techniques to validate or refute these findings. Nevertheless, by identifying the factors that are critical in feasibility studies, more comprehensive feasibility studies will be undertaken and delivered in order to make more reliable decisions of proposed transportation infrastructure projects.

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