Development of Road Selection Model for Transportation Improvement with Minimum Compensation Costs in Upgrading Informal Settlements: The Case of Dar es Salaam City, Tanzania

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Abstract
Selection of roads for improvement of transport network with minimum demolition of houses required in roads widening has been a challenge for many years in upgrading informal settlements. The problem is compounded by lack of a methodological tool required to assist decision makers on selecting roads that can be widened and improved for improvement of transport network with minimum demolition of houses and compensation costs. This paper is therefore reporting upon a study that has developed a Road Selection Model (RSM) within a framework of Multiple Criteria Decision Making (MCDM) models for selecting roads for improvement of transport network with minimum demolition of houses and compensation costs. The model is formulated based on the roads Functional Performance Criteria (FPC) and Space Syntax Criteria (SSC). It can be used to support decision making pertaining to the selection of roads for widening when upgrading informal settlements.

Keywords: *Informal settlements, Road selection model,* Multiple criteria, Road functional performance, Space syntax criteria, *Property compensation costs*

1. Introduction

Existence and upgrading of informal settlements is a global issue that affects mostly Latin America, Southeast Europe, Asia, South America and Africa. Similarities with these settlements, from one country to another, stands on irregularity in land use development and lack of basic service infrastructures such as paved roads. However, the difference stands mainly on the cause for establishment of the settlements and the approaches used to upgrade them.

In Latin America, informal settlements that mostly accommodates low income people occurs on environmentally vulnerable land or illegal development on public, communal or private land with insecurity of land tenure although property rights of ownership base on customary practices (Aguilar & Santos, 2011), (Fernandes, 2011). Furthermore, Benitez, et al.,(2012) and Fernandes (2011) explains that informal settlements in Latin America are also associated with irregular development patterns without any formal town planning and they lack essential service infrastructures such as paved roads. Upgrading of informal settlements therefore, involves either improvement of security of tenure through titling as practiced mostly in Peru and Mexico (Aguilar & Santos, 2011), (Fernandes, 2011); or improvement of public services such as roads; or both as practiced mostly in Brazil (Fernandes, 2011). It is further explained by Fernandes (2011) that the ongoing legal reforms, especially in Brazil aim to include payment of compensation to residents in cases of relocation in upgrading informal settlements.

In Southeast Europe, informal settlements that mostly accommodates economic migrants, refugees, and internally displaced people occurs with illegal development on public or private land. Others occur on high quality public land and environmental reserves. They lack security of tenure and basic service infrastructures. Houses in informal settlements that accommodate vulnerable people such as refugees are extremely poor with shacks built of recycled materials, plastic sheets, and leftover construction materials. In areas where houses are good, such as Bar in Montenegro, they do not have building permit and illegal land subdivisions does not meet planning standards for right-of-way of different types of roads. Upgrading of informal settlements therefore, involves improvement of security of tenure through obtaining formal land titles and by providing service infrastructures such as roads, water, electricity and sewer (Tsenkova, 2012).

In Lebanon, informal settlements occurred during the civil war on the squatted land on the southern suburbs of Beirut that were stronghold of the Shi'i parties, Amal and Hezbollah. The settlements had insecurity of land tenure and lack of basic service infrastructures. Squatting was on parcels of land that were either subject to ownership disputes, owned by public institutions, or which experienced difficulties in implementing town planning regulations and plans. Upgrading of informal settlements were carried-out after the civil war with negotiation of different parties, from the government, to include the Prime Minister, the municipal councils, and government institutions with input to upgrade the settlements; Shi'i parties, Amal and Hezbollah; professionals such as consultants, engineers, town planners, architects and economists; judges and lawyers; political representatives; owners and residents; real estate developers and financial investors with projects in the area; and observers such as journalists, teachers and researchers. The upgrading components, after negotiations, involved provision of service infrastructures, especially roads and public facilities, and development of real-estate and tourist resorts along the beach. Compensation was paid to those whose properties were affected with provision of service infrastructures (Clerk, 2012).

In India, informal settlements are poorly built with semi-permanent and non-permanent building materials. These are areas with congested tenants and unhygienic environment usually with inadequate service infrastructures that are occupied mostly by urban poor (Kit, et al., 2011) (Patel, et al., 2012).

As India is intended to eliminate all informal settlements, the upgrading is carried-out through an organized network of urban poor communities called Shack/Slam Dwellers International (SDI). By enumeration, they survey and map themselves houses and land they occupy and represent themselves on their needs to the government through this collective voice (Patel, et al., 2012).

In China, informal settlements absorbs a large influx of migrants and they are characterized by poor housing and living conditions. They are categorized by local governments as urban villages that are dirty, chaotic and dangerous places that are unsalvageable and should be demolished. Unlike informal settlements in other developing countries, informal settlements in China were originally villages that were encircled by rapid urban expansion. In large cities such as Beijing, Shangai, Guangzhou and Shenzhen have demolished a number of urban villages. Studies and data on residential satisfaction are gathered to assist better understanding of these urban villages and to develop an alternative view to the official discourse to explain informal settlements in negative ways (Li & Wu, 2013).

In Kenya, informal settlements that mostly accommodates low income people occurs through encroachment of private land and government land such as road reserves, railway reserves/tracks, and riparian reserves of river valleys. Most of the rooms in the settlements are rented to tenants who migrates from rural to urban areas but maintain linkage with the rural areas. They lack security of tenure and service infrastructures. Upgrading of informal settlements involves provision of service infrastructures and development of new houses of which the affected families are relocated to the nearby sites. In the upgraded settlements, numbers are allocated to the houses and those living in the houses are provided with residential addresses. Streets are developed with names for provision of service infrastructures such as roads and water (Karanja, 2010;Mberu, et al., 2013).

In Tanzania, informal settlements that accommodates more than 80% of the urban population occurs through informal urban land development process and procedures, from land occupation to housing development, and they lack basic service infrastructures such as paved roads (Kombe & Kreibich, 2000; URT, 2007a; URT, 2007b, URT, 2012). It is explained by Tibaijuka (2010) that people who build in informal settlements have 'perceived' security of tenure because of at least three reasons. The first is historically that the Government since the early 1970s has been sympathetic and tolerant to the development of these settlements. Secondly is the fundamental principles of the National Land Policy (1995) that requires compensation to any person whose right of occupancy or recognized long-standing occupation or customary use of land is revoked or otherwise interfered. Thirdly is the government adopted in 2000 a progressive human settlements development policy which, among other things, states that slum upgrading shall be done by their inhabitants and the government playing a facilitating role. Upgrading of informal settlements is carried-out by improvement of basic service infrastructures such as roads (Tibaijuka, 2010) with community participation (Magigi, 2013).

2. The Issue of Road Selection and High Compensation Costs in Roads Widening

Ferguson (1996) explained the issue of high public cost incurred in provision of service infrastructures in informal settlements such as roads that twist in between the buildings and wind through the settlement. Improvement starts by selection of one road that connects to the nearest arterial road to provide better access to the community with relocation of houses that are in the way (Ferguson, 1996). However, the methodology for which road should be selected first and what next for improvement of transport network were not covered.

Hassan (2006) explained internal infrastructure improvement within informal settlements that are linked with external development of trunk infrastructure such as roads and sewerage. By using a demonstration of sewerage improvement, he explained that the communities in informal settlements can finance, manage and build infrastructures provided that they are organized and provided with technical support and managerial guidance (Hassan, 2006). However, the methodology for which infrastructure should be selected first and what next was not covered.

Navarro and Almaden (2014) explained the issue of compensation for improvement of service infrastructures in informal settlements. They recommended the use of Fair Market Value (FMV) compensation for loss of assets and Replacement Cost (RC) for people affected with improvement of service infrastructures. However, the compensation cost becomes very high in case of many properties being affected in improvement of service infrastructures. The methodological issue is how to minimize compensation costs in roads widening.

3. Approach and Methodology for Development of Road Selection Model

The study used case study method (De Vaus, 1996) for collection of primary data used to develop the Roads Selection Model. The selected case study settlements were Mnyamani and Mnazi Mmoja informal settlements in Dar es Salaam City. Furthermore, primary and secondary data were collected from different institutions that were involved in roads improvement in upgrading of informal settlements in Dar es Salaam City through Community Infrastructure Upgrading Program (CIUP, 2003; 2004; 2009).

Secondary data were collected from different literature on Multiple Criteria Decision Making (MCDM) models and roads widening space standards. Primary and secondary data were combined in development of Road Selection Model.

Methods that were used for collection of primary data were physical survey and valuation survey. Physical survey was used for assessment of the extent of demolition of all properties affected by roads widening. Valuation survey was used for assessment of compensation value for all properties affected by roads widening. The method that was used for collection of secondary data was literature review. Data collected through literature review were such as roads widening space standards, the approaches used to select roads for improvement, and the use of multiple criteria analysis.

4. The Relevance of MCDM Models

Selection methodology is governed by several models that guide a decision maker to make decision on a choice among a set of several alternatives. These models are such as Multiple Criteria Decision Making (MCDM). It is a well known branch of decision making that deals with decision problems under the presence of a number of alternatives with decision criteria (James,*et al*., 1992; Triantaphyllou, *et-al*., 1998; Xu and Yang, 2001).

MCDM models have been widely developed and applied in different professions in the World. They are such as conflict resolution (Zeleny, 1990); environmental management (Steele, et al., 2008); construction industry (Ballestero, *et-al.*, 2003; Kaysi, *et-al.*, 2010; Malhènè, *et-al.*, 2010); earthquake management (Opricovic & Tzeng, 2002); mining industry (Motavi, 2010); and building design (Balcomb & Curtner, 2000).

This study focuses on development and application of MCDM model in transport planning, especially roads selection for improvement. There are several types of models that are available for MCDM while others are being refined. The common types of MCDM models, as explained by Triantaphyllou *et al.* (1998) and Xu and

Yang (2001), are the Weighted Sum Model, the Weighted Product Model, and the Analytic Hierarchy Process.

4.1 The Weighted Sum Model

The Weighted Sum Model (WSM) is believed to be the most common model of MCDM (Triantaphyllou*et al.*, 1998; Xu & Yang, 2001). Given the number of alternatives and the number of decision criteria, the best alternative that is selected is the one of maximum satisfaction (highest WSM score). Fishburn (1967) quoted by Triantaphyllou *et al.* (1998) established the WSM that is used to calculate WSM scores for the purpose of determining the best alternative.

$$A^{*}_{WSM} = \max_{i} \sum_{j=1}^{N} q_{ij} w_{j} \quad \text{for } i = 1, 2, 3, 4, \ldots, M \qquad (1)$$

Whereby: 'A^{*}_{WSM}' is the WSM score for the best alternative, 'N' is the number of decision criteria, 'q_{ij}' is the actual value of the i-th alternative in terms of the j-th criterion, 'w_j' is the weight of importance of the j-th criterion, and 'M' is the number of alternatives.

4.2 The Weighted Product Model

The Weighted Product Model (WPM) is the modification of the WSM. Instead of addition in the model, it considers multiplication. In this case, each alternative is compared with the other by multiplying a number of ratios, one for each criterion to the power equivalent to the relative weight of the corresponding criterion. Bridgman (1922) and Miller and Starr (1969) quoted by Triantaphyllou*et al.* (1998) established the WPM that is used to calculate WPM scores for the purpose of determining the best alternative.

$$R(A_K/A_L) = \prod_{j=1}^{N} (a_{Kj} / a_{Lj})^{W_j} \qquad (2)$$

Whereby: '$R(A_K/A_L)$' is the ration of alternative A_K and alternative A_L, 'N' is the number of criteria; 'a_{Kj}' is the actual value of alternative 'K' in terms of the j-th criterion; 'a_{Lj}' is the actual value of alternative 'L' in terms of the j-th criterion; and 'W_j' is the weight of importance of the j-th criterion.

If '$R(A_K/A_L)$' is greater than one, then alternative A_K is more desirable than alternative A_L in the maximisation case. One advantage of the WPM model is that instead of the actual values it use relative values.

4.3 The Analytic Hierarchy Process

There is similarity between the Weighted Sum Model (WSM) and Analytic Hierarchy Process (AHP) in assessment of the best alternatives that each value of the alternative in assessment is multiplied by the weight of importance of the respective criterion. However, the difference is that WSM uses actual values while AHP uses relative values. Furthermore, the latter uses a series of pair-wise comparisons. Saaty (1980, 1983, 1990 and 1994) quoted by Triantaphyllou*et al.* (1998) established the AHP model that is used to calculate AHP scores for the purpose of determining the best alternative.

$$A^{*}_{AHP} = \max_{i} \sum_{j=1}^{N} q_{ij} w_{j} \quad \text{for } i = 1, 2, 3, 4, \ldots, M \qquad (3)$$

Whereby: 'A^{*}_{AHP}' is the AHP score for the best alternative, 'N' is the number of decision criteria, 'q_{ij}' is the relative value of the i-th alternative in terms of the j-th criterion, 'w_j' is the weight of importance of the j-th criterion, and 'M' is the number of alternatives.

However, the WSM, WPM and AHP cannot be manipulated to suit roads selection in informal settlements within a framework of informal settlement upgrading approaches. This is because the upgrading requires roads widening that involves analysis of extent of housing demolition in terms of partial demolition, total demolition and chopping off parts of undeveloped plots. Furthermore, the upgrading requires compensation for all properties that are affected in roads widening that cannot be accommodated within the framework of WSM, WPM and AHP. These deficiencies require development of MCDM model for roads selection.

5. Development of Road Selection Model

Road Selection Model (RSM) has been developed within a framework of MCDM Models. It take into account summation of score points from Functional Performance Criteria (FPC) that takes into consideration the required function of the road; and Space Syntax Criteria (SSC) that takes into consideration space required for road widening and compensation. Model 4 presents the basic formulation of the RSM for selection of i-th road, which is a road with minimum score points within a range of j-th roads of the same class.

$$RSM_{SCORE} = \min_i \sum_{i=1}^{j} FPC_i + SSC_i \quad \text{for } i = 1, 2, 3,..,j \tag{4}$$

Whereby: 'RSM_{SCORE}' stands for total score of the Road Selection Model for i-th road within a range of j-th roads, which is a road with minimum score points. 'FPC_i'stands for total score of the Functional Performance Criteria for i-th road. 'SSC_i'stands for total score of the Space Syntax Criteria for the i-th road. 'j' stands for the number of alternatives of road of the same type assessed in RSM model.

5.1 Functional Performance Criteria Score

Functional Performance Criteria (FPC) score was established through summation of the function of priority weight of each road. Priority weights for each road were established according to the proportion weight of priority ranks. Model 5 explains FPC model that is used to establish FPC score points of the RSM.

$$FPC_{SCORE} = \min_i \sum_{i=1}^{j} r_{ij} w_i \quad \text{for i = 1, 2, 3,…..,j} \tag{5}$$

Whereby: 'FPC_{SCORE}' stands for total score of the Functional Performance Criteria for i-th road within a range of j-th roads. 'r_{ij}' stands for rank of priority of i-th road. 'w_i' stands for weight of priority of i-th road. 'j' stands for the last alternative of roads of the same class assessed in FPC model.

Priority Ranks

Priority Ranks (PR) were established from functional performances of roads of the same class that are arranged in ranks of priorities from the first to the last according to the functional performances of each of them. Three classes of roads in urban residential areas have been considered in the assessment of functional performances, for illustration purpose, which are local distributor roads, access roads, and pedestrian footpaths.

The functional performance of local distributor roads is to provide access to the housing clusters; abutting properties; and public facilities. It also provides access to the economic activities along the road, such as shops, small business and workshops; provide link between access roads and district distributor roads; and permits on-street parking (De Chiara & Koppelman, 1984; De Langen & Tembele, 2001; Kildebogaard, 1985). Furthermore, De Langen & Tembele (2001) explain that local distributor roads may serve as bus routes for public transport in case where the distance to the nearest district distributor road is more than 2 kilometres. Local distributor roads are therefore, ranked from the first to the last according to the assessment of functional performances that each of them provides.

The functional performance of access roads, as explained by De Chiara and Koppelman (1984), is to provide access to buildings and plots within housing clusters and link local distributor roads to the residential housing clusters. According to this functional use, Kildebogaard (1985) suggests that free length of access roads should be limited to prohibit through traffic by the use of culs-de-sac and loops. Access roads are therefore, ranked from the first to the last according to the assessment of functional performances that each of them provides.

The functional performance of pedestrian footpaths as explained by Kildebogaard (1985) and Transport Research Laboratory TRL (2005) is to provide direct access to buildings and plots within housing clusters and link the residential housing clusters to community facilities. They also form shopping streets with commercial activities on both sides of the paths. TRL (2005) clarify that pedestrian footpaths can include roadside footways, footpaths or special pathways designated for use by pedestrians and cyclists. Pedestrian footpaths are therefore, ranked from the first to the last according to the assessment of functional performances that each of them provides.

Priority Weights

Priority weights for each road were henceforth established according to the proportion weight of the added ranks of priorities. The total weights add-up to one. Table 1 therefore explains establishment of priority weights.

Table 1: Establishment of Weight of Priority

Number of Roads to be Ranked	Ranks of Priority	Weight of Priority of Each Road
When there is one road to be ranked	1	1.00
	Summation of Ranks = 1	**1.00**
When there are two roads to be ranked	1	0.33
	2	0.67
	Summation of Ranks = 3	**1.00**
When there are three roads to be ranked	1	0.17
	2	0.33
	3	0.50
	Summation of Ranks = 6	**1.00**
When there are four roads to be ranked	1	0.10
	2	0.20
	3	0.30
	4	0.40
	Summation of Ranks = 10	**1.00**

The overall process to establish priority weight of each road is summarized by the use of the following model:

$$f(w_i) = \sum_{i=1}^{j} \frac{r_i}{r_{ij}} \qquad \text{for } i = 1, 2, 3, 4, 5, \ldots\ldots\ldots, j \qquad (6)$$

Whereby: '$f(w_i)$' stands for priority weight of the i-th road. 'i' stands for the first rank of priority. 'j' stands for the last rank of priority. 'r_i' stands for the priority rank of the i-th road. 'r_{ij}' stands for the relative value of ranks of priorities.

For instance, when there are five roads to be ranked, the weight of priority of the fifth road is 0.33 as established below:

$$f(w_5) = \frac{5}{15} = 0.33$$

5.2 Space Syntax Criteria Score

Space Syntax Criteria (SSC) was developed to take into account compensation issue for all properties that are affected in widening of roads. The compensation element is captured in terms of the extent of housing demolition through partial demolition, total demolition and plots affected by chopping off parts of undeveloped plots. Therefore, SSC score is established through summation of the value of threes three components. Model 7 explains SSC model that is used to establish SSC score points of the RSM.

$$SSC_{SCORE} = \min_{i} \sum_{i=1}^{j} PD_i + TD_i + PA_i \qquad \text{for } i = 1, 2, 3, \ldots\ldots, j$$

Whereby: 'SSC_{SCORE}' stands for total score of Space Syntax Criteria for i-th road within a range of j-th roads. 'PD_i' stands for sum of partial demolition of houses along i-th road. 'TD_i' stands for sum of total demolition of houses along i-th road. 'PA_i' stands for sum of plots affected along i-th road. 'j' stands for the last alternative of roads of the same class assessed in SSC model.

In establishment of the value of partial demolition, total demolition and plots affected, weights of analysis are used in each of them so as to explain the compensation implications of these components in roads widening. Compensation value for each of these components has been done in terms of their variables. Weights of analysis have therefore been established as the ratio of compensation value of each variable in relation to the total value of all variables. The total weights add-up to one. Table 2 shows the development of weights of analysis for each variable of partial demolition, total demolition and plots affected components.

Table 2: Establishment of SSC weights of analysis used in RSM model

SSC Component	Variables of SSC Components	Average Compensation Value[1] (T.Shs '000)	Weight of Analysis (W)
Partial Demolition	Front part of the house (PH)	8,300	0.0182
	Room extended from the main house (PE)	4,000	0.0087
	Front veranda (PV)	1,200	0.0026
	Fence (PF)	1,200	0.0026
Total Demolition	One story building (TD^{BH1})	85,000	0.1859
	Two story building (TD^{BH2})	140,000	0.3062
	Three story and above, if any (TD^{BH3})	200,000	0.4374
	Relocation of household (HH)	17,000	0.0372
Plot Affected	Relocation of cemeteries (RC)	400	0.0009
	Un-built plot (UP)	100	0.0002
Grand Total		**457,200**	**1.0000**

[1]The compensation value of the variables are flexible and thus subject to change from time to time.

The underlying assumptions used to establish compensation value for each variable of partial demolition, total demolition and plots affected components are:

a) Partial demolition:
   - Front part of the house and room extended from the main house are in good condition in terms of maintenance status and are built of permanent materials.
   - The valuation rate used to establish compensation value for partial demolition of front part of the house and room extended from the main house has considered the use of a property by taking the average value of residential and commercial uses.
   - Front veranda is in good condition in terms of maintenance status and it is built of concrete canopy.
   - Fence is in good condition in terms of maintenance status and it is built of solid wall.

b) Total demolition:
   - The building (in terms of its number of story) is in good condition in terms of maintenance status and is built of permanent materials.
   - The valuation rate used to establish property value for total demolition of a building has considered the use of a property by taking the average value of residential and commercial uses.
   - The unit of relocation caused by total demolition of a house is one household.

c) Plot affected:
   - The unit size of graveyards assessed when affected with road widening is 4m x 10m (40 m^2) that accommodates 5 cemeteries.
   - The unit size of un-built plot assessed when affected with road widening is 6m x 12m (72 m^2) of which 12m is a common size of width of plots in highly developed informal settlements in Dar es Salaam.

These weights of analysis are therefore used in establishment of the score value of partial demolition, total demolition, and plots affected components of the SSC model of the RSM.

Partial Demolition

Development of Partial Demolition (PD) score value takes into account summation of four variables, which are partial demolition of front part of the house, partial demolition of room extended from the main house, partial demolition of front veranda, and partial demolition of a fence. Model 8 explains PD model that is used to establish PD score points of the SSC.

$$PD_{SCORE} = \sum_{i=1}^{j} (PH_i\, W_{PH}) + (PE_i\, W_{PE}) + (PV_i\, W_{PV}) + (PF_i\, W_{PF}) \quad \text{for } i = 1, 2, 3, \ldots, j$$

Whereby: 'PD_{SCORE}' stands for total score of partial demolition of houses along i-th road within a range of j-th roads. 'PH_i' stands for the number of houses with partial demolition of front part of the main house along i-th road. 'PE_i' stands for the number of houses with partial demolition of rooms extended from the main houses along i-th road. 'PV_i' stands for the number of houses with partial demolition of front veranda of the house along i-th road. 'PF_i' stands for the number of houses with partial demolition of fence along i-th road. 'W' stands for weight of analysis of partial demolition variables. 'j' stands for the last alternative of roads of the same class assessed in SSC model.

Total Demolition

Development of Total Demolition (TD) score value takes into account summation of two variables, which are building height and relocation of households. The considered building height takes the maximum of 3 story though it is not common to find them within the developed residential areas. Model 9 explains TD model that is used to establish TD score points of the SSC.

$$TD_{SCORE} = \sum_{i=1}^{j} (TD_i^{BH1} W_{BH1}) + (TD_i^{BH2} W_{BH2}) + (TD_i^{BH3} W_{BH3}) + (HH_i W_{HH}) \quad \text{for } i = 1, 2, \ldots, j$$

Whereby: 'TD_{SCORE}' stands for total score of total demolition of houses along i-th road within a range of j-th roads. 'TD_i^{BH1}' stands for the number of total demolition of one story buildings along i-th road. 'TD_i^{BH2}' stands for the number of total demolition of two story buildings along i-th road. 'TD_i^{BH3}' stands for the number of total demolition of three story buildings along i-th road. 'HH_i' stands for the number of households affected with total demolition of houses along i-th road. 'W' stands for weight of analysis of total demolition variables. 'j' stands for the last alternative of roads of the same class assessed in SSC model.

Plots Affected

Development of Plots Affected (PA) score value takes into account summation of two variables, which are relocation of cemeteries and chopping-off part of un-built plot. Model 10 explains PA model that is used to establish PA score points of the SSC.

$$PA_{SCORE} = \sum_{i=1}^{j} (RC_i\, W_{RC}) + (UP_i\, W_{UP}) \qquad \text{for } i = 1, 2, 3, \ldots, j$$

Whereby: 'PA_{SCORE}' stands for the total score of plots affected along i-th road within a range of j-th roads. 'RC_i' stands for the number of cemeteries relocated along i-th road whereby the unit size is 5 cemeteries that are accommodated in an area of 4m x 10m ($40\,m^2$). 'UP_i' stands for the number of part of un-built plot that is affected along i-th road whereby the unit size is 6m x 12m ($72\,m^2$). 'W' stands for weight of analysis of plots affected variables. 'j' stands for the last alternative of roads of the same class assessed in SSC model.

Conclusion

Road Selection Model has been developed within a framework of MCDM model to assist and support decision makers when selecting roads of the same and/or of different class for improvement as in most cases it is not possible to improve all roads due to lack of funds. This model is necessary for improvement of transport network in terms of traffic mobility and accessibility as it takes into account FPC and SSC analysis that are essential in selection of the best alternatives for road network within a set of several alternatives.

FPC use rank different roads of the same class and arrange them in priority from the first to the last in priority according to their functional performances. SSC use extent of demolition required to widen each road according to space standards and road design requirements so as to achieve their functional performances and minimize compensation costs. Therefore, RSM is used to select the best alternative of a road by combining FPC and SSC in a sense that the best alternative achieves the greatest functional performances and the lowest extent of demolition of houses required to widen the road.

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