



Re-emergence of Indigeneity in transformed Layouts in Urban Public Housing in Nigeria

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ABSTRACT

In contrast to the one whole homogenous configuration provided by developers that has often proved ineffective overtime, transformed public housing units are widespread in developing cities. Though transformation is a natural phenomenon of inhabitation, its various levels and degree can have implicit values. In recent times in Nigeria, heterogeneous spatial patterns of transformed houses in public housing estates has given empirical evidence of essentially inevitable reflection of culture sensitivity as hypothesized by previous studies. That hints that the mainstream sustainable values were probably ignored during design process. This study attempted to connect that possible missing link. To achieve that aim, it developed two objectives. First, is to identify core values behind space layouts in the mainstream. Then, to examine how they exist in the transformed layout as reflected at communal origins. It investigated on 42 transformed units in selected urban Public housings neighborhoods via a stratified conditional sampling conducted in five states of Nigeria. Qualitative methods were adopted for data analysis. After identifying the core ethnic groups in the region, their social indicators with regards to space use were determined through ethnographic principles. These indicators were then operationally defined, and used as a tool to examine users' motivations in the transformation process in urban context. Spatial pattern analysis, by using gamma delineation, revealed the social content in the transformations after comparing initial design and the transformed spatial configurations. The outcome signified the mainstream cultural values in the transformation process hence in Public housing design. The convergence of mainstream values into urban transformed layouts suggested that they cannot be ignored during design process. The outcome of this research might be useful in designing sustainable public housings in culture sensitive environments, better still a guide to Architects and developers in this regard.

1. Introduction

Public housing transformation in developing countries is described by Tipple (2000) as a housing supply mechanism with beneficial features, yet negatively perceived by development authorities. At the moment, the authorities choose to ignore the inspiring indicators of housing transformation, and the benefits that could have afforded optimization of users' performance, raise housing values, minimize cost to owners, and overall enhancement in users' satisfaction.

The knowledge about these contexts- i.e. establishing indicators that inspire Public housing transformation and linking them with cultural background remain unharnessed. Furthermore focusing on culture specific context creates the bedrock for culture inclusiveness which is critical in housing design (Rappoport, 2000). This study hence attempted to further extend knowledge on transformed public housing,

focusing on culture sensitive issues which the communities carry over from their previous experiences in the mainstream country life. This has become crucial as user's experience is perceived to enrich design considerations thus, providing design paradigms with potentials towards bridging the gap between root and urban space uses.

Against this backdrop, the study focused on Public housing units, which were probably executed with the assumption that potential users are of equivalent status, income level, household composition, and similar housing consumption requirements, while ignoring their socio-cultural background. Therefore these designs seem disconnected with the socio-cultural life of potential inhabitants. Consequently, the houses examined in this study targeted typical mass public housing in Northern Nigeria. In the process transformed public housing units where investigated towards establishing the phenomenon as well as culture related space uses that bond inhabitants with their root.

2. Background

In the first part of the background study, transformation as user responsiveness to desired housing deficiencies was related towards improving housing consumption by impacting cultural requirements. At this stage improved livability of households was related with housing transformation process. Next, it described the reflection of culture in the operational activities that bound social settings with building structures particularly in public housing units where it is often excluded in initial homogeneous design. Thirdly, it pointed to the inconsistency in provisions and user requirements calling for a review of initial design through accommodating both etic and emic housing design perspectives. Overall, this section relates the research gap and defines the objectives of the study.

2.1 *Improving household livability by means of housing transformation*

Existing prototype housing pattern has failed to offer solutions to Nigerian housing problems (Olotuah and Bobadaye, 2011). Housing designers have opined that at the initial design stage, potential users' needs cannot be considered as they are usually unknown. Yet scholars have argued in support of the inevitability of housing transformation in housing consumption process, which provides a platform in rethinking design solutions. Households constantly search for answers to housing stability due to disequilibrium occasionally witnessed during the consumption process thus transform to survive (Khan, 2014b). They search continuously for available options in line with the disequilibrium model on residential mobility (Clark and Ledwith, 2005). The process aligns with the dynamism in household structure and their needs which makes housing provision a continuous process even after occupation as a growing structure. The situation is often aggravated by the flexibility in the socio economic status of inhabitants. Thus, the need to envisage future changes at conception in order to improve household livability becomes essential. As internal household behavior of survival, freedom and emotional fulfilment is expressed in tune with choice theory as outlined by Glasser (Glasser, 1998). Therefore, ignoring the benefits inherent in the transformation process and considering it illegal undermines the value of the property. This act leaves these houses serving as mere transient shelter for households in desperate need of accommodation to stay for a while and plan for a more permanent shelter where their desires can be achieved. In addition qualitative and orderly housing transformation is usually hindered by the availability of fund (Isah et. al., 2014). Despite which inhabitant insist in fulfilling their long life agitations. However, housing transformation benefits improves users' efficacy and housing consumption (Seek, 1983). More so, housing transformation is significant to housing sustainability (Tipple et. al., 2004). Recent research on transformation has been focused on the practice with the search for design themes and layout patterns in the cultural and physical spheres used to implicitly define the cultural character of the inhabitants' desire for housing consumption (Khan, 2014a). Therefore, user's responsiveness to dwelling territorial control where standards are flexible allowing for users' participation irrespective of their affluence, culture and level of education are significant housing activities universally recognized (Khan, 2014b).

2.2 *Optimizing performance of Building operation through cultural bond*

Building structure and the social setting as well as the operational activities surrounding its performance remains bounded with the success in their union used to access the satisfaction derived by users.

Generations of scholars have emphasized the need for cultural reflection in buildings towards its sustainability. For instance, Rapoport (2000) advocates for culture specificity in determining the design of buildings in particular environments, in order not to undermine the history, cultural traditions and forms of design (Rapoport, 1983) linked to the background of the beneficiaries. Similarly, Davis (2000) ascribed building culture to compose of specific configurations of knowledge, establishments engaged in the building activities, the laws guiding the provision and operation as well as the building products themselves specific to time and particular to a place. The challenge however has been in the quest for attainment of higher levels of housing civilization where authorities in developing societies with long time housing cultural history tend to imbibe new building culture that is alien to its inhabitants, while ignoring the existing housing cultural practices. For instance, the long-time Africa's history of space recognition and interaction (Prussin, 1974) reflects symbolism, coherency linking principles and underlying meaning that describes their space use which cannot be undermined. Blindly adopting other cultures' design does not proffer solutions to culture sensitive communities housing problems (Khan et al., 2015). In fact, the intangibles of building that provides its meaning and symbolizes it are usually significantly focused on cultured communities, than the tangible materials of blocks, bricks, windows, concrete and walls therefore, genuine uniqueness are derived from the immaterial constituents (Rusalic, 2009). In this regard promoting indigenusness in dwellings is crucial as the building provision in achieving user satisfaction.

However, researchers have questioned the applicability of vernacular concepts in urban housing design, yet a category of urban dwellers demand for the right to live their local life in the cities and should be accommodated. In this regard Khan (2014b) stated that not all traditional values might be applicable in the urban setting where standardization is required. Therefore, there is the need to determine the threshold from users' spatial experience and perspective. To this effect Isah and Khan (2015) outlined adaptive considerations of sustainable design elements to include relating outdoor and indoor space use lifestyles and social cohesion of household in space organization. They further stated as significant streamlining value system with space use as well as screening household chores from external vision.

2.3 *Growing investment in Public Housing and rethinking the design concept*

On the overall, investment by government and private sector in the provision of public housing to bridge the existing gap in housing shortage witnessed in Nigeria has been on the rise. Consequently the delivery of large scale proto-type core housing and apartments in state capitals and satellite towns. Several existing government policies and practices have supported the public housing approach in housing delivery system. However, the failure of previous housing policies (Ikejiofor, 1999), more so that it is attributed to culture exclusion (Ibem et al., 2011; Jiboye, 2004) necessitates the new approach of research into user transformed layouts in searching for solutions to deteriorating housing problems. In this regard this study examined users' experience in public housing space transformation relating it to the root so as to establish the space use in attribution to cultural backgrounds. This is to further reveal the inseparable cultural values inherent in inhabitants' association with their dwellings. This is significant in rethinking the design concept as it would direct layout conception.

2.4 Design Implication and the need for cultural character integration

Stuck at a crossroad with inconsistency of provisions and requirements, Public housing designs require a cultural paradigm that will ensure its sustainability. Thus recent public housing studies are focused on the importance of cultural character in buildings (Chiu, 2004; Maina, 2013). Therefore, the comprehension of cultural character in space use and evaluation of standards to accommodate it becomes unavoidable. Design as solutions to problems associated with housing needs, should comprehend details of these needs in order to proffer solutions that accommodate user's efficacy. The consequence is the critical review of design options adopted for public housing estates. Interestingly, cultural perspective in housing design relates the need to comprehend contextual human behavior in space usage (Berry et. al., 1992). Doing, this will assure the consideration of indigenous situations in sustainability stance in the development of housing as emphasized by Isah and Khan (Isah and Khan, 2015). According to Isah et. al., (2015b), designs that results from the transformation process are influenced by the lifestyle of the households particularly with regards to family structure and social activities. This approach assures user participation which is regarded as significant in sustainable housing development (Isah, 2012).

2.5 Spatial Paradigm: Between Homogeneity and Heterogeneity

The existing principles adopted in public housing design at the study settings produces homogenous products presumed to be completed before occupation. However, the design being inconsistent with time as the needs and desires of potential inhabitants rapidly changes due to inflicted user initiated transformation, therefore undermining the continuous initial presumption of completeness in the formation of the units. Moreover, inhabitants' desire grows and changes overtime which also requires changes to be made to spatial configurations of the home as well. This Tipple et al. (2004), refers to as "varieties out of uniformity", where uniform designs translates into a heterogeneous forms due to growing changes in the house, households size, occupants, tenure, use, house value and housing cost.

Accordingly, overtime the configurations depict users' desires, reflecting the required housing consumption based on family norms and culture. Inevitably, households utilises the resources at their disposal to create living spaces that satisfies their needs, irrespective of the formation which in most cases does not retain the initial homogeneous design. Consequently, the heterogeneous compositions attained reflect several factors that also distinguish the households from one another. Invariably, the phenomenon evokes the changing urban spatial paradigm in developing and culturally sensitive communities that can no longer be ignored. In attaining this usually, the link with the root combined with their long time engagement with urban environment and peer group's influence directs the layout configuration in a technologically driven era (Isah et. al., 2015a).

2.6 Etic and Emic Paradigm, the search for design solutions

In a growing momentum, social scientists have criticized the spatial ordering of spaces by professional designers who emphasis on formal and visual aspects that are devoid of concentration on the relationship between spatial devices and the lives of inhabitants (Lym, 1980). As a result, the wisdom and benefits of indigenouness are seldom discouraged with associated negative perception resulting in the lack of understanding of the content and its acceptance (Asomani-Boateng,

2011). In effect the act poses the greatest challenge to the development of indigenous forms. Fundamentally, socio-cultural factors governing social settlements that has shaped vernacular physical and spatial environments have conflicted with contemporary housing styles (King, 1983) in urban settings as cities evolves and inhabitants retaining strong link with their roots (Mberu, 2005). Accordingly, recent housing research has witnessed a persistent demand for indigenous culture consideration in urban housing design. Invariably, initial housing composition and later transformations are characterized as reproduction of cultural relations in a progressive housing civilization (Franklin, 2006).

So, people search and observe their environment in obtaining useful information about their surroundings (Kaplan and Kaplan, 1982) that reshapes their spatial character. Although both in the etic and emic concepts of housing space use adopted by designers, they intuitively focus on developing an enduring space experience of potential building inhabitants; the indigenous laymen designers realize spatial orders by embarking on lifelong journeying, concentrating on spatializing inhabitants' livability while the professional designers emphasize on the formal and visual aspects of building architecture (Lym, 1980). Therein lies' the conflict that led to the emergence of culture responsive spatial paradigm to meets users' housing consumption and a void that requires professional perfection, which this study advocates and attempts to fill by examining users experience in transforming public housing designs to include their cultural desires. Thus, it necessitates the need for harmonizing cultural demands and urban ideals in the search for solutions to housing problems. A paradigm presumed to provide sustainability to dwellings in culture sensitive communities.

2.7 Knowledge gap and research direction

Arguably, the above literature analysis has demonstrated that mainstream values of communities need to be integrated in public housing to maintain sustainability. Inversely, inhabitants make temporary or dismountable adjustment in estates built for leasing, while upon occupation and possession rapid adjustments are embarked upon by owners who occupy bought estates leading to heterogeneous formations. Yet authorities often ignore the benefits users derive in housing transformation process, therefore undermining the values therein. The review has also shown that expert designers seem to promote formal and visual preference in design. Similarly, authorities emphasize adherence to standards while ignoring users' responsiveness to cultural livability. Although they emphasize standards, their passiveness in enforcement allows for uncontrolled transformation leading to chaotic formations. The persistence of the situation is worrisome and considered a path to harness by this research.

Therefore this study adopts the evaluative approach by directing harmonious synthesis of cultured spatial character and urban design standards in housing forms. This approach follows Tipple's acknowledgement of concentrating on both general processes and city specific issues related to transformation so as to account for convergences and divergences in the diversities of cities and its people. Thus the following assertions are deduced from the forgone discussion. Housing consumption in homogenous settings is devoid of households' norms and culture.

Reflecting indigenouness in design has been demanded by both researchers and community dwellers. Lay designers and professionals conceive the concept of livability differently, hence a need for

harmonious synthesis of cultured spatial character and urban design standards in housing forms.

In light of the above, the study attempt to uncover core space use values from mainstream that address the situation in order to improve design and optimize inhabitants operation, housing values and performance. The above literature analysis has shown that long time history and values such as witnessed in Africa, continuously connect urban inhabitants with their origin. Therein lay the desired meaning and symbol of culture with trio dimension to housing concept. First, it enables the understanding of the conflict between vernacular and contemporary housing styles. Second, it identifies the gap between provision and desire for spaces whose solution does not exist in other cultures. Third, housing transformation has provided improvement in the efficacy of households' livability.

This study belongs to the third dimension and subsequently the research strand is essentially considered to achieve two objectives. First, to identify core values behind space layouts in the mainstream root. Then, to examine how they exist in the transformed layout as reflected at communal origins. Hence, to search for design themes and layout patterns can be the possible applications afterwards.

3. Methodology

Using a purposive approach, this study examined forty two (42) houses in selected public housings across 5 states reflecting the six major ethnic groups in northern Nigeria namely, Hausa, Fulani, Kanuri, Nupe, Gbagyi, and Tiv (Mustapha, 2006). The research process involved two stages corresponding to the two objectives; first stage included identifying core space use attributes at the dwellings in the mainstream at countryside through micro-ethnography. The second stage adopted qualitative techniques through comparative analysis followed by development of themes in order to search for spatial patterns of transformed units that is rooted in the mainstream.

3.1 Stages

3.1.1 First Stage: Micro-ethnography

Identifying core indicators of space use in dwellings common to the major ethnic groups: This stage comprised of micro-ethnography intended to identify the core cultural indicators of space use in dwellings in the countryside, and the associated space use attributes common to the major ethnic groups in the study area. This was achieved through researchers' engagement with the setting as participant observer.

3.1.2 Second stage: Qualitative analysis

Examining how cultural indicators exist in the transformed layouts: In order to further evaluate the impact of cultural indicators as well search for design themes and patterns in the transformed layout, the second stage of the research assessed the transformed layouts in the urban setting in relation to the communal space use identified at the first stage.

3.2 Basic Elements for Comparison

Space uses patterns in typical compounds inhabited at the root as well as in transformed layouts were observed focusing on domestic chores as households relate with their dwelling spaces. The essence was to enable

Table 1 Basic elements for comparison

Dimensions	Description of measures	Comparable Spaces in	
		Dwellings at Root	Transformed layouts
Core Spaces	Central areas that are the nucleus of houses usually public spaces that socially integrate households	Reception, Outdoor relaxation space	Porch
Linkages	Connections between core spaces and ancillary spaces	Courtyards (Outer, Inner)	Lobbies/Corridors, Inner Courtyard
Ancillary Spaces	Usually (but not limited to) private spaces that provide habitation tendencies to households	Bedrooms, Kitchen, and Toilets	

research process to qualitatively observe and compare the spatial relationships in the configurations. The observation was illustrated using the principles of gamma diagram to qualitatively delineate space uses. Three dimensions were thus adopted as measures and thus presented below as well as in Table 1.

Gamma Diagram that measures relationships between social life and built environment using spatial configurations approach was adopted to explore relationship between social behavior and space. The principle of Gamma Diagram introduced by Hillier and Hanson (1984) nullifies the effect of size and shape of the spaces, and focuses on the connection between them in order to look for hierarchy, connectedness, and depth of the spaces. Focus was on network of activities as it reflects level of space integration related to access, movement and function. Typical layout configuration, two each from the ethnic root and from the urban transformed layouts were presented as below.

4. Examples of dwellings from Root and from Urban transformed layouts

4.1 Examples of Layouts of dwellings at the root

Analytically, the root's spatial layout was characterized with a pattern that included unordered outdoor area bounded by the entrance at one end and an arbitrary line with the street at the other end (Figure 1). Then a symbolic entrance hall that opens to a forecourt as the first habitation and an inner court as the next habitable area. Families' spaces comprise of rooms for sleeping, cooking, storage all opening to a courtyard where domestic activities are carried out (Figure 2). Gamma diagram (Figure 3) shows the connectedness and depth of the spaces. There seems to be a reflection of the three dimensions with the configuration reflecting the social lifestyle of its inhabitants.

Similar example from another group, i.e Tiv, is illustrated in the following figures. Figure 4 shows the layout, Figure 5 shows the inner spaces, and Figure 6 shows the Gamma diagram of the spaces.

4.2 Examples of typical transformed layout of urban public housing

Undoubtedly, transformation practice in these public housing initiated by governments was observed as salient issue that was being ignored. Inhabitants found out that initial units could not conform to the domestic chores of inhabitants, hence they embarked on transformation. Across the housing neighborhoods studied

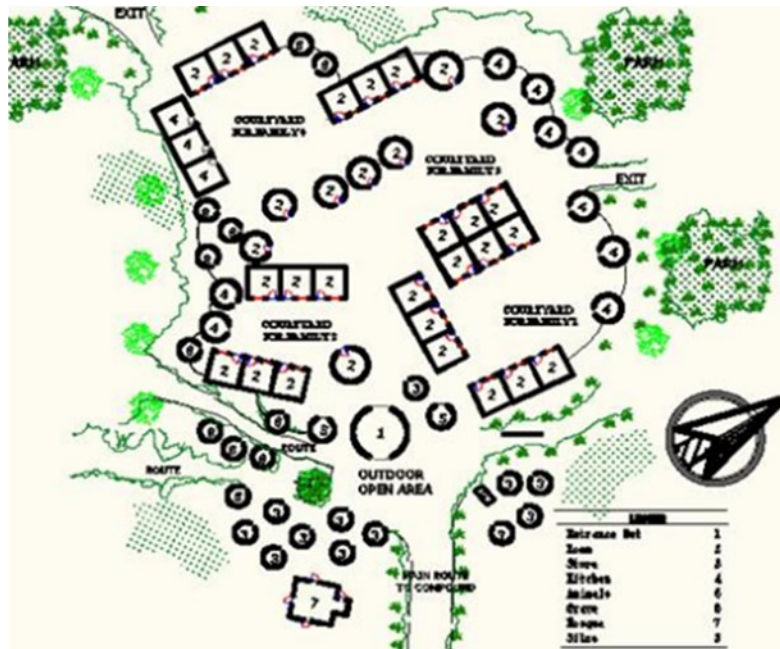
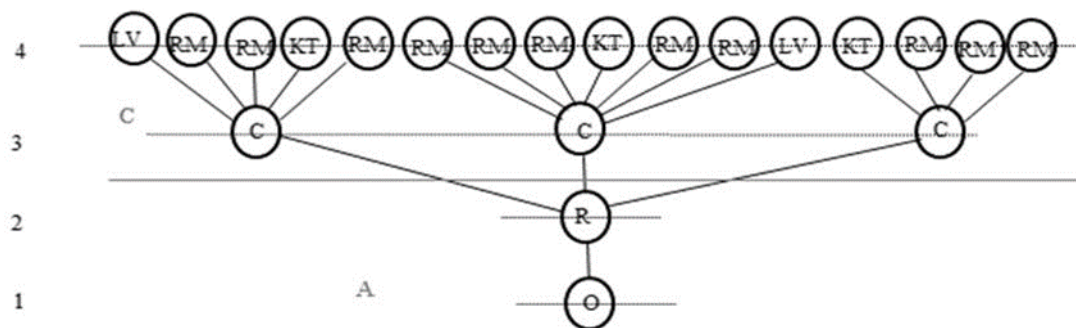


Figure 1: Layout of a Gbagyi house.



Figure 2: A Gbagyi indigenous house in Kpamuko-Maitumbi Minna, Nigeria. (a) Outer courtyard, (b) Formal Entrance, (c) Inner courtyard



Legend: A: Core space, C: Ancillary Space, RM: Room, SH: Shower, LV: Lavatory, C: Courtyard, O: Outdoor, KT: Kitchen, R: Reception

Figure 3: Gamma diagram of a typical Gbagyi house

concentration was on activities and the space use pattern as initial designs were compared with transformed layouts. Two examples out of the 42 transformed houses studied were illustrated in order to show the space linkages in the transformed layouts. The two instances (Figure 7) significantly show enclosed functional spaces around a courtyard, which were carved out during transformation. In particular, the adjustment shown in second case in Figure 10b include fencing the compound which enabled the creation of fore courtyard, inner courtyard and a side entrance describing movement and flow pattern within the compound. These provisions in the transformed layout can be related to the

situation at the root. Therefore, the outcome relates the significance of social lifestyle in space use pattern.

5. Findings

Consequently, Outdoor relaxation, Sleeping rooms, Cooking activity, Domestic chores were the elements seen to have been given high significance by the transformers as these attributes of social lifestyle of inhabitants commonly found at the root were compromised in the initial provisions. Spatial pattern analysis revealed through gamma

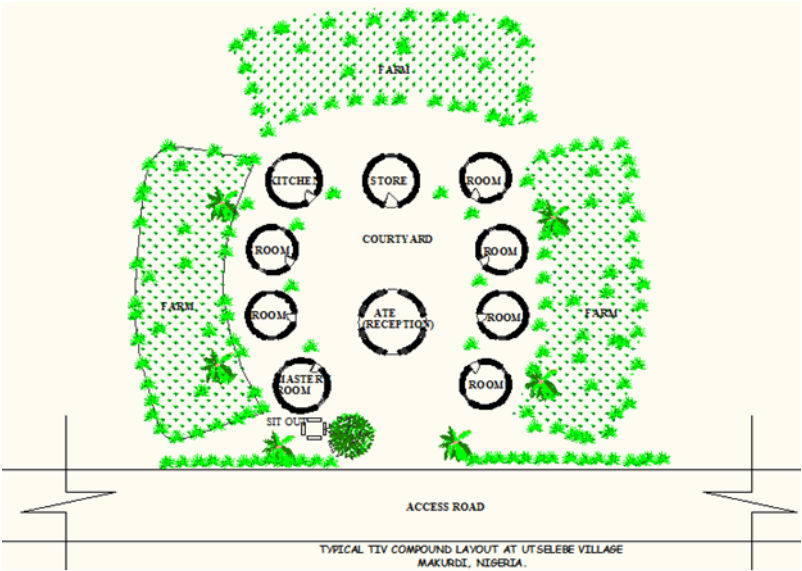
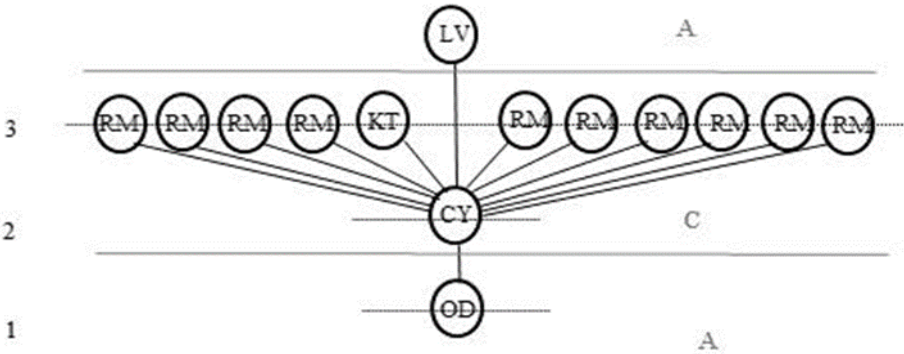


Figure 4: Layout of a Tiv house



Figure 5: A Tiv compound in Makurdi, Nigeria: (a) Formal Entrance (b) Courtyard (c) Sit out area



Legend: A: Core space, C: Ancillary Space, RM: Room, SH: Shower, LV: Lavatory, C: Courtyard, O: Outdoor, KT: Kitchen, R: Reception

Figure 6: Gamma diagram of a typical Tiv house

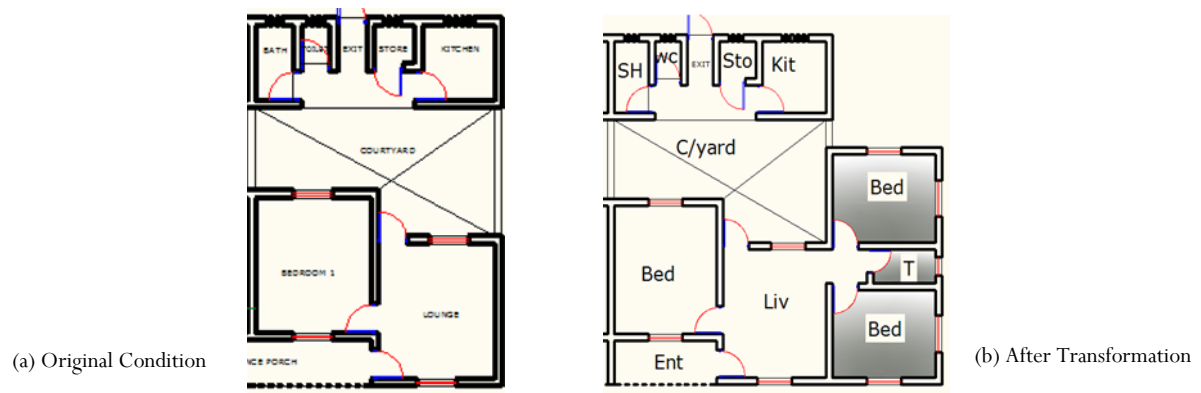


Figure 7: Layout of a typical one-bedroom public housing unit



Figure 8: View of the unit

diagrams showed that the distinguishable public and private spaces, as well as the linkages appeared after transformation. These features with common conceptual outlook exhibited consistency across the samples studied, hence tangible for generalization. Consequently, these illuminated two major outcomes for the study in terms of specificity of space usage, and certain philosophical concepts that signified the particular patterns of transformations. In effect functional space use pattern at the root re-surfaced portraying the significance of the transformation process. We can look back at those components again.

5.1 Major Re-emergences

a. Courtyard(s)

The transformed layout had courtyards introduced as part of the transformation process. Courtyards are the most significant part at the residential unit. In the root, it is still the single most important space. This is the space where family members traditionally intermingle, as well as perform different household activities. However the study found that the initial public housing design layouts did not provide courtyard, and as a result, the users has to improvise the layout by themselves as shown in (Fig 7b). Even some of them managed to get two courtyards in one unit (Fig 10b), with the outer one mainly dedicated for males, and the internal courtyard are mainly for female and children, reminiscent to the root culture. That affirms the spatial link of urban dwellers with their house that was however been ignored in the initial design layout of urban public housings. The re-emergence of courtyards in urban public housing layout signified the importance of spaces which activities related as a practiced at the root.

b. Reception

The reception areas in the root are mainly for public usage, where usually the males interact socially. The outdoor relaxation spaces are also located over there for males to gather around (Fig 2c, 5c). The urban public housing units initially did not provide any such space, but the users seem to recreate and re-modified the space by using boundary walls (Fig 7b, 10b) and integrating it with the fore courtyard. It seems that the resident did try their best to enforce this option because the value of males gathering means a lot in their social life. In fact it shows the gender preference in spaces usage which is inherent in the social lifestyle of the inhabitants. In this regard, the space provided for male visitors' reception, gathering during social occasions and male inhabitants' outdoor relaxation. Usually this is traditionally linked with the living room which provides spaces for the indoor performances of these functions.

5.2 Significance of Transformation practices

It is not only in one or two occasions, but significantly in most examples the re-emergences occurred. The transformed layouts showed consistency in the patterns that re-introduced forecourt, entrance reception area, side exit, inner court, service enclosures such as kitchen detached from main building and opening to the inner court, separation of older boys apartment, additional family living rooms, and attachment of private toilets to rooms are modified and harmonized space uses that characterize evolving indigenous urban housing architecture. Though it was not easy to provide all of them in every occasion due to the limitations of the site, but the re-emergence of courtyard and receptions seemed inevitable.

The value underlying the cultural reflection of urban housing lies in the unbroken linkage of urban residents with their roots (Mberu, 2005), a common model practiced in culturally centered settlements is therefore discovered. In this regard transformed housings appear with unintentional layout patterns that depict a common direction as seen at the root. Therefore, this outcome is indicative of the significance in the cultural character of dwellings to its inhabitants.

The study uncovered the significance of socio-cultural attributes in influencing transformation decision. Hence, a formal practice that streamlines housing delivery mechanism with the mainstream values of inhabitants. Inhabitants' values are critical features in sustainable housing delivery that should therefore be promoted. This is vital as initial design configuration greatly hindered the successful practice of transformation thereby relegating the quality of the transformed product. Perhaps accounting for the reason why the benefits are not comprehended despite the persistence shown by the inhabitants. Essentially, the inevitability of transformation and the useful benefits inherent can no longer be ignored in attaining sustainable public housing design.

6. Conclusion

Apparently, cultural space uses in Public housings were astonishingly observed to be modified by inhabitants in order to reflect the root space concepts. The findings of the research have applicable usability to various purposes. First, it identified peculiarities in the evolving structure appearing as attributes reflecting culture responsive dwelling features. Second, urban architectural spatial layout forms that advances indigenous housing features emerges, and would encourage policies and aid developers to create innovative culture responsive public housing designs as a mechanism in housing delivery scheme.

The quest for culture responsive design has been acknowledged, but the perfection and sustainability remains undiscovered. The model in the transformed product of public housing adjustment if improved with professional outlook and supported by policies, will resolve urban housing quality and improve housing consumption while easing the delivery mechanism. The contextual cultural character that evolves would reflect in the housing units redirecting transformation practices towards positive outcomes rather than pronounced negativity. Such is the indigenous urban house promoted by the outcome of this study. Further research could therefore focus on the standardization of transformation attributes and products in advancing the perfection of the process.

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Documenting its Applications in Quantity Surveying Research: A Review

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ABSTRACT

Literature review is an indispensable segment in scholarly undertaking. Although important, it appears that little has been documented about its process especially from the perspective of research in quantity surveying. This despite such effort could possibly benefit novices attempting to explore the vast territory of quantity surveying intellectual domain. Hence, drawing from the author's recent research in identifying the issues that have impeded the use of the bills of quantities (BQ), this paper aims to document the steps involved in the process of reviewing literatures concerning the research. Accordingly, a nuts-and-bolts approach to literature review has been put forward in the background and it strives to describe the steps following the review processes carried out in the research underpinning this paper. This paper reflects that the process for reviewing the literature could be viewed as iterative-cyclical. In this regard, searching; mapping; analysing and synthesising have been recognised as the important steps in the process. The paper also demonstrates that the use of NVivo assisted greatly in the process and adds significant value through its pragmatic features and useful displays. The paper discussed these processes in relation to research in quantity surveying which is significant to the domain or a part thereof.

1. Introduction

Review of the literature is necessary to demonstrate the researcher's awareness on the current progress and the state of a specific area of knowledge (Hart, 1998). It is an essential process, which inform the researcher on the limitations of previous research before adequate relationships can be drawn to justify how current research may fit in the context of previous findings. Thorough literature review helps to identify the focus for the research (Creswell, 2003) and enable the researcher to clearly see the progress of a subject in the same area of research (Sekaran and Bougie, 2010). This, according to Fellows and Liu (2008), will help any researcher from re-inventing the wheel or wrongly contemplating a gap of otherwise an important research into a subject.

Being important, there seems to be various approaches to literature review across different domain of knowledge. These were specific and normally carried out to achieve particular goals in the research. The variability of approaches to literature review indicates the specific purpose for which it was undertaken. In this regard, it appears that little has been spent in documenting the process of this vital research component, saved the outcomes shaping out from it. It becomes clear that any effort to deconstruct and document the process would be advantageous. This will benefit future researcher, especially novices pursuing interest in any research such that of quantity surveying.

Thus, this paper aims to document the steps involved in a review process by drawing direct illustration from the author's recent effort on identifying issues concerning the application of the BQ to the contracting organisations (Shamsulhadi, 2015; Shamsulhadi *et al.*, 2014). These are the researches that underpinned this paper which have been focused on restructuring relevant issues found in the literature. The extensive application of review techniques learned and applied from textbooks have strengthened the understanding of the process, hence making it a sound basis to objectively support the work presented in this paper.

The methodological nature of this paper requires background knowledge on the relevant steps involved in literature review. These are gathered by sourcing from various published materials which includes Hart (1998); Ridley (2008) and Booth, *et al.* (2012). This ensures that the documented steps are in accordance to the published materials. Flowchart summarising the technical aspects is also developed from the references to ensure important steps are not missed throughout the process. In this respect, the flowchart developed helps to explain general process to literature review and form the main reference from which the appropriate steps in the process have come to light.

Apart from the flowchart, this paper has also considered the application

of dedicated analysis software – NVivo to support the process. The software facilitates in synthesising evidences collected from the review thus helps to minimise errors which prone to occur with the manual analysis. Besides, the graphical representation features of the software have characterised much of the steps discussed in this paper and significant in espousing focal nodes relevant to the outcome of the review. The following section provides definition to literature review. It also presents brief technicality of the process.

2. The ‘Literature Review’

Definition of literature review was found in materials sourced for this paper. In this respect, a collection of definition was given in Ridley (2008, p. 3) and consist of various emphasise on its role and purpose. Amongst this, the definition by Hart (1998, p. 13) was mostly cited across sources. This is obvious as the definition unpicked what a review process entails, which was found to focus on documents as the essential components in the process. Hart (1998, p. 13) states:

[LR is] the selection of available documents (both published and unpublished) on the topic, which contain information, ideas, data and evidence written from a particular standpoint to fulfil certain aims or express certain views on the nature of the topic and how it is to be investigated, and the effective evaluation of these documents in relation to the research being proposed (Hart, 1998, p. 13).

Thorough literature review helps to develop various parts of the study (Welman *et al.*, 2005). It shows a researcher’s familiarity with the topic (Hart, 1998) and helps prevent wastage of valuable resources caused by reinventing the wheel (Sekaran and Bougie, 2010). A researcher needs to evaluate the research that has already been undertaken, to show and subsequently explain the relationship among the findings (Saunders, *et al.*, 2007). Saunders, *et al.* (2007) maintain that literature review will almost always seek to draw out the key points and trends in the published findings, hence allowing readers to see the current research against the backdrop of relevant researches in the area.

Though significant, Hart (1998) stated that researchers especially novices are constantly baffled with the technicality involves in literature review. This comes as the data for analysis is information and not the common data collected via pre-construct research instrument (Hart, 1998). The emphasis is that the analysis requires critical understanding and interpretations towards arguments that others have proposed, by systematically extracting ideas and concepts from the literature (Hart, 1998). Hence, literature review should weave all relevant information in a cogent and logical manner, rather than a chronological bits and pieces of inept information (Sekaran and Bougie, 2010).

There seems to be significant emphasis from the references on the process commanding to the literature review outcome. This includes the need to be critical and systematic. According to Saunders, *et al.* (2007) being critical means having the appropriate skills to appraise or evaluate the relevant piece of literature. It is the judgement a researcher exercise in deriving the review (Saunders, *et al.*, 2007). While critical was associated with thinking, being systematic is about the flow of process involved in the review. According to Booth, *et al.* (2012) this consists two principal aspects which are methods and presentation. Booth, *et al.* (2012) continued to highlight that methods are the conduct of search, appraisal, synthesis and analysis whereas presentation involves the act of

reporting these steps. These were the important concepts in literature review in allowing the process to be performed to concede to the right amount of quality (Booth, *et al.*, 2012; Tranfield *et al.*, 2003).

The concepts suggested that thinking and process are the important aspects in literature review (Booth, *et al.*, 2012). Hart (1998) stated that this concept is rather generic hence is relevant across disciplines and applicable to any domain. This somehow explains the variability of approaches to literature review. In this respect, the generic application of the concepts has allowed researcher to suit and adjust the processes to his or her review requirements (Sekaran and Bougie, 2010). This is often characterised by the subject and purpose the review is conducted. Irrespective, documentation of the processes is considered important. This stimulates how the thinking and process intertwine in a specific domain.

As the paper is focused on the literature review process, the following section will first outlined the generic approach and processes to literature review. This is to enable prior understanding to the literature review technicality, with a view to produce a review with an acceptable breadth and clarity. Effort will subsequently be expanded to explain the processes carried out in relation to the research underpinning this paper. This adds to the knowledge base and bolstering current understanding in this respective domain.

3. The Literature Review Process

The literature review process was illustrated by Saunders, *et al.* (2007, p. 56) as an upward spiralling process. It started by clear research questions and objectives, and proceeded by generating and refining relevant keywords. The process continued by searching and obtaining relevant literatures before these are then subjected to evaluation. This cycle is repeated with added focus and draft revision before finally culminating to the critical review of the literature.

There has been emphasis that literature review should be carried out systematically. This implies that review process should contain a proper methodological structure and strives to eliminate the potential for developing any kinds of bias (Booth, *et al.*, 2012; Denyer and Neely, 2004; Tranfield, *et al.*, 2003). Rousseau in Booth, *et al.* (2012, p. 25) states:

*[Being] systematic means comprehensive accumulation, transparent analysis, and reflective interpretation of all empirical studies pertinent to a specific question. Reliance upon any sampling or subset [of the literature] risks misrepresenting its diversity in findings, outcome methods, and frames of reference (Rousseau, *et al.* (2008) in Booth, *et al.* (2012, p. 25).*

The idea of systematic review was outlined in the paper by Tranfield, *et al.* (2003). This was further refined by Denyer and Neely (2004) and presented by Saunders, *et al.* (2007, p. 72) as: (1) Develop clear and precise aims and objectives for the LR; (2) Pre-planned search methods; (3) Comprehensive search of all potentially relevant articles; (4) The use of clear assessment criteria in the selection of articles for review; (5) Assessment of: quality of research and the strength of the findings; (6) Synthesising using a clear framework, and; (7) Presenting the result in a balanced, impartial and comprehensive manner.

Drawing from the above suggestions, an approach suggested by Booth,

et al. (2012) was to cover iteratively, by exhaustively citing all relevant literatures and capturing new evidence as it emerges continuously from related researches. This is simplified by Booth, *et al.* (2012) in the author's **SALSA** framework (acronym of Search, Appraisal, Synthesis and Analysis).

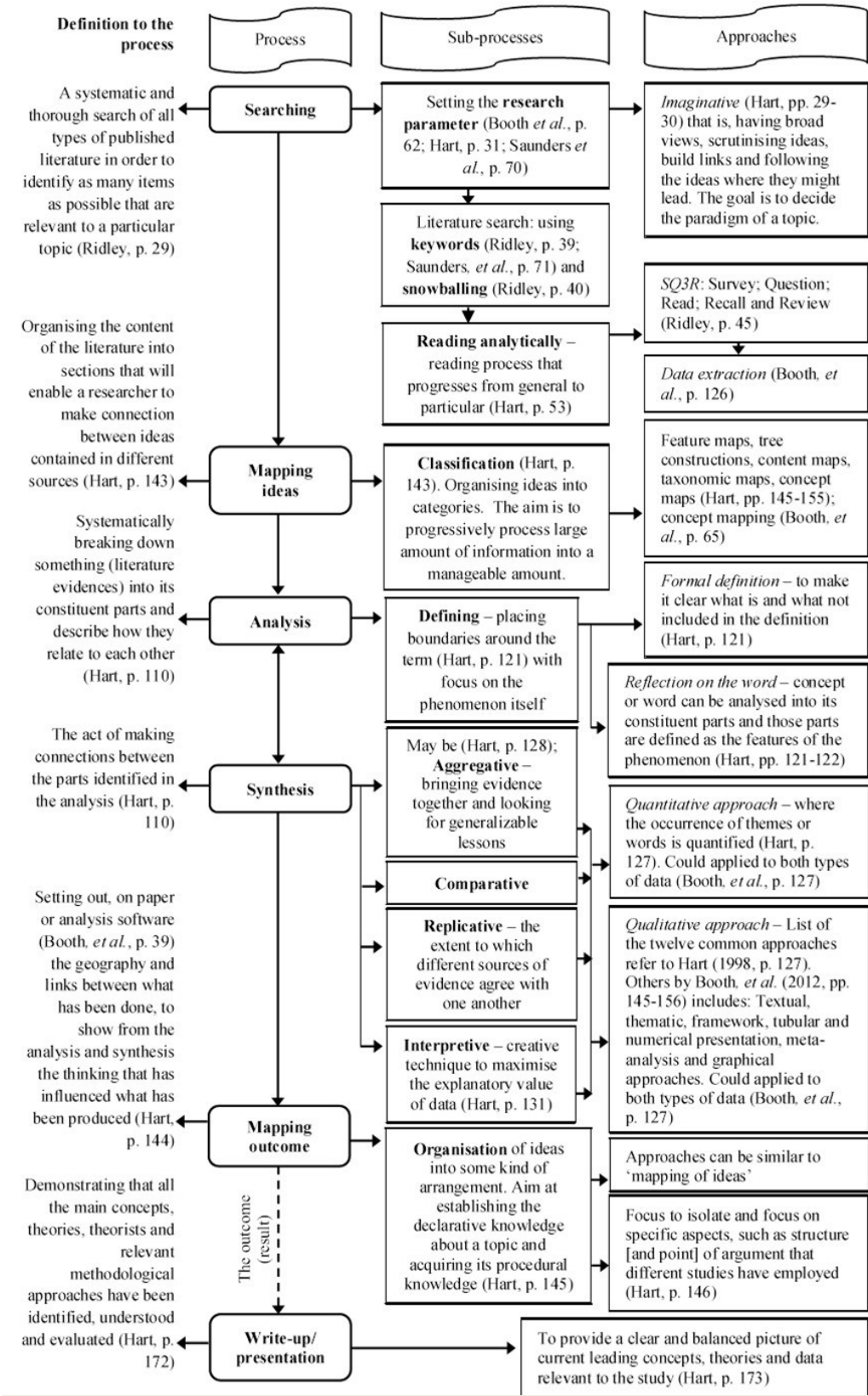


Figure 1: The processes involved in literature review
 (Developed based on Hart (1998); Saunders, *et al.* (2007); Ridley (2008) and Booth, *et al.* (2012))

The above implies that literature review is not a linear process despite having a clear start and expected deliverable. Rather, it is a back and forth effort to iteratively frame new literature evidence and one that is simply cyclical (Grix, 2004, p. 45; Ridley, 2008, p. 80). Ridley (2008) maintained that there is no clear cut-off point when one activity ends and the other begins while Hart (1998) opined that the process will never be definitive.

Although it is important to continuously incorporate relevant studies in a review, there is always intimidation that a review will never be finished (Fellows and Liu, 2008, p. 62). It is rather impossible to review every single piece of literature concerning a subject (Saunders, *et al.*, 2007, p. 57). In countering this, Fellows and Liu (2008) suggested for the establishment of a realistic 'dead-line' to close entries to the review. Hence, the purpose of literature review is not to summarise everything that has been written, but to review the most relevant and significant research on the topic (Saunders, *et al.*, 2007, p. 57).

The knowledge gained from the study on literature review results a useful understanding on the process and technicalities involved. This is presented in Figure 1 as a series of a process flow and aim to bring together every sub-processes and approaches relevant to the main process. Reference to the relevant materials is given with further explanation taking place in the following sections of this paper.

Figure 1 shows a summary of process to literature review developed from the references. It lists the common processes identified and detailed out how the processes should ideally be carried out. The processes essentially involved five main steps. These start with searching, mapping of ideas, analysis, synthesis and finally mapping of outcome. The steps as Ridley (2008) opined is iteratively-cyclical. The aim being the critical review of the literature (Saunders, *et al.*, 2007). The following sections present the documented processes from the researches underpinning this paper. Efforts have been made to explain how the literature review was carried out in relation to the processes shown in Figure 1.

4. Searching

The researches underpinning this paper were aimed at recapitulating relevant issues concerning the use of the BQ by the contracting organisations. Two objectives were outlined: (1) to explore the issues impeding the use of the BQ; and (2) to restructure the issues following the outcome of the review. The aim and objectives outlined help to set the research parameter. Keywords were drawn from the objectives and the snowballing technique was used to locate relevant literatures. It commenced by searching in leading monographs before further references are identified through backward and forward approaches (Webster and Watson, 2002). All references were then subjected to analytical evaluation.

5. Mapping of Ideas and Analysis

Mapping involves putting together different strands that make up the topic to enable analysis and synthesis to be undertaken (Hart, 1998). It aims to progressively reduce the large data extracted from the analytical evaluation and identifies the main abstractions in the argument (Hart, 1998). In relation to the research underpinning this paper, this step helps by reducing data accumulated from the review and organising the content into sections that contain meaningful connections.

The extracted data was then organised into a featured map (Hart, 1998). This involved developing a table which contain predefined criteria following the object of the review. According to Booth, *et al.* (2012), criteria for mapping a review can be developed following the specific purpose of the review. It is a form of classification and should focus in identifying concerns highlighted in previous researches (Booth, *et al.*, 2012). In relation to the research underpinning this paper, the developed criteria were devised for the purpose of framing issues concerning the use of the BQ. This requires predefined criteria of issues, authors and leading concepts to be inculcated in the mapping process. The developed criteria helped the review to remain objective in its stride and subsequently discloses the leading concepts from the materials reviewed. Further, this aid in exploring the thoughts behind the leading concepts and help to combine sources with similar argument. The outcome from this step is shown in Table 1. This follows the second process shown in Figure 1.

Table 1 shows that the analysis of the identified issues took place by reflecting the words (or terms) used from the extracted data. These were portrayed as the features of the phenomena (Hart, 1998) and were defined in the overall context of the issues. The approach allows leading concepts to be noted and recognised. It discloses the gist of the issues and provides an appreciation on the category of issues embodied in the literature (Bryman, 2008). This acts as the basic structure of the issues and exposes the headings in preparation for the next process in literature review – synthesis.

5. Synthesis

Synthesis is the act of making connections between the parts identified in the analysis (Hart, 1998, p. 110). Hart (1998, pp. 128-131) stated that this may be aggregative, comparative, replicative or interpretive. Synthesis is subjected to either quantitative or qualitative approach. It could apply to both quantitative and qualitative data (Booth, *et al.*, 2012, p. 127).

Synthesis was carried out in the research underpinning this paper by way of aggregative. This follows from the reflection of the words (or terms) used in identifying the issues. Some levels of interpretations were also exercised to group the evidences from the analysis. It reflects that quantitative approach has been adopted in the synthesis.

The quantitative approach applied in the synthesis followed the method outlined by Bryman (2008). This involved counting the frequency of certain concepts. The objective was to reveal the predilection that exaggerates certain number of concepts prompted from the analysis. Further, it helps by espousing the weightage that the concepts have and provide first evidence on the concept's structure. For this purpose, the qualitative analysis software – NVivo was used. The process was performed by invoking the 'Word Frequency Query' command available in the software. This command generates a model that represents the frequency of the leading concepts shown in Figure 2.

The 'Word Frequency Query' command helped in transiting the featured map (Table 1) to the generated model. It also helped to minimise error which prone to occur with manual analysis and assisted in suggesting the connections among parts identified in the analysis. This showed that clarity was incorporated by using the software, hence increasing the credibility of the structure developed from the literature review.

The model developed from the software shows that 'information',

‘format’ and ‘methods’ are the three most occurring concepts identified from the analysis. This implies that these are the main concepts underlying the identified issues in its broadest continuum. The emphasis of the model has also been on the weightage of the concepts. It is clear that ‘information’ contain the most number of issues followed by ‘format’ and ‘methods’ respectively. This implies

that issues related to BQ can be structured into three main categories. Hence, this helped to suggest discerning pattern from the data gathered from the review.

As synthesis is about making connections, it seems imperative to incorporate the issues presented in Table 1 back in the categories

Table 1: The mapping of ideas and analysis of issues identified from the literature review

No.	Issues identified from the literature review process	Authors
1.	BQ <i>does not provide</i> (*information) on the (time) and quantity schedule for the on-site delivery of materials required for the works.	Hamimah <i>et al.</i> (2011); Smith and Hoong (1985)
2.	BQ (*information) provide <i>no assistance</i> to anyone drawing up a pre tender programme (*time).	Contributed (1964)
3.	BQ (*information) only represent cost breakdown structure with <i>no link</i> to actual project schedule (*time).	Mohd Hisham and Azman (2008)
4.	SMM based BQ (*information) <i>unable to provide</i> a useful basis for contractor's work programme (*time).	Jaggar <i>et al.</i> (2001); Smith and Hoong (1985)
5.	<i>Preliminaries bill</i> and <i>specification</i> (*information) documents <i>contain many unnecessary</i> (*insufficient/ inadequate) items as a result of direct copy and 'standardised' document.	Hamimah, <i>et al.</i> (2011)
6.	BQ <i>quantities and descriptions</i> (*information) <i>do not accurately</i> provide information on work sequence and <i>contractor's methods</i> of operation (*working methods and planning).	Hamimah, <i>et al.</i> (2011); Leon (1966)
7.	The specialist trades contractors consider that the <i>tasks of planning</i> (*time) <i>could not be achieved</i> by using the bills (*information).	Morledge and Kings (2006)
8.	BQ (*information) is <i>unnecessary</i> for <i>compiling</i> (*format) sub-contractor's quotations and is <i>inadequate</i> for reviewing materials quotations from potential supplier as <i>quality of materials</i> (*specification) are <i>not clearly stated</i> .	Hamimah, <i>et al.</i> (2011); Kinlay (1984b)
9.	(*Information) in BQ are <i>uncoordinated, aggregation on similar materials</i> rather than <i>operation</i> (*format and working methods).	Kodikara <i>et al.</i> (1993)
10.	BQ (*format) is <i>not in final forms</i> for direct use by site personnel.	Kodikara and McCaffer (1993); Kodikara, <i>et al.</i> (1993)
11.	BQ (*information) <i>requires sub-processes</i> as the information are <i>not presented</i> in a standardised (*format).	Cornick and Osbon (1994)
12.	BQ <i>fail to become a mechanism</i> to determine <i>construction processes</i> (*working methods). It does <i>not consider input</i> (*information) to the construction process (*working methods) but only identifies the end result or product of construction.	Holes (1990); Jaggar, <i>et al.</i> (2001)
13.	BQ <i>only present</i> (*information) <i>that have been processed and in final form</i> (*format). Detail (*information) such as supporting details on <i>quantities measured, work location and types of operations</i> (*working methods) the contractors have to employ are of use by estimators should access is given.	Hamimah, <i>et al.</i> (2011); Turner (1983); Wood and Kenley (2004)
14.	BQ (*information) had <i>inadequacies for utilisation</i> by contractors. (*Quantities) <i>Location of quantified information</i> was <i>not adequate</i> for its purpose.	Baccarini and Davis (2002); Wood and Kenley (2004)
15.	BQ do <i>not indicate</i> (*information) as <i>where the quantity is located</i> (*location) and therefore <i>difficult to get a feel</i> for the projects from the bill.	Slattery (1994)
16.	BQ <i>disregard potential</i> further value of reanalysing the (*information) into activities, operations or elements (*format).	Kinlay (1984a)
17.	BQ (*format) is <i>not adequate</i> as it <i>hinder effective use of</i> (*information) contained.	Rosli <i>et al.</i> (2006); Smith and Hoong (1985)
18.	BQ <i>fails to convey</i> details (*information) of <i>materials</i> (*specification), <i>plants and temporary works</i> required for <i>proper work execution</i> (*working methods and planning) and to enable those resources to be identified, quantified and valued by contractor's estimator.	Ahenkorah (1993); Hamimah, <i>et al.</i> (2011); Holes (1990)
19.	BQ only useful for tendering and financial control but <i>not used extensively</i> for <i>contractor's site operation</i> (*working methods and planning).	Smith and Hoong (1985)
20.	BQ <i>do not support</i> contractor's management function. BQ (*information) <i>disregard</i> resource requirements and <i>only measures</i> (*quantity and units) <i>fixed in place measurement</i> .	Baccarini and Davis (2002)
21.	<i>Nett quantities and inaccurate quantities</i> (*information) are <i>major dissatisfaction</i> among contractors in the way (*quantities) are provided in BQ.	Hamimah, <i>et al.</i> (2011)
22.	BQ (*format) other than trade <i>fails to facilitate</i> contractor's pricing (*unsuitable format).	The BOQ Working Group (1995)
23.	BQ (*format) <i>do not indicate</i> project's buildability, work sequence and control of work (*inflexible format).	Skoyles (1968)
24.	BQ (*format) <i>do not adequately reflect the interaction</i> (*inflexible format) between the design of a building and the production process (*working methods and planning).	Skoyles (1964)
25.	BQ (*format) is <i>not adequate</i> to fulfil its maximum functions (*unsuitable format).	Hughes (1978)
26.	BQ (*format) and <i>data presentation</i> (*unsuitable format) are the <i>major cause for inefficient</i> flow of estimating data.	Kodikara and McCaffer (1993)
27.	BQ data (*information) <i>fail to provide</i> contractors with information they need for <i>proper planning, organising and managing</i> of their work (*working methods and planning).	Contributed (1964); Holes (1990); Leon (1966); Waterworth and Weddle (1978)
28.	BQ (*information) <i>requires sub-processes</i> by site QS as the information <i>are not presented</i> in a standardised format (*unsuitable format).	Cornick and Osbon (1994)
29.	BQ (*information) produced is <i>inaccurate</i> in terms of its <i>quantities and descriptions</i> . Inaccuracy is caused from an omission of important cost items, disparity between drawing details and quantity list and over and under measurement of cost items.	Abdul Rashid and Normah (2004); Rosli <i>et al.</i> (2008)

Note: (***bold**) refers to the reflection of the word (or concept) being the outcome from the analysis. The reflected objects (as words or terms) come before (***bold**) with details of the framed issues highlighted in **bold-italic**. **Source:** Shamsulhadi (2015); Shamsulhadi, *et al.* (2014).

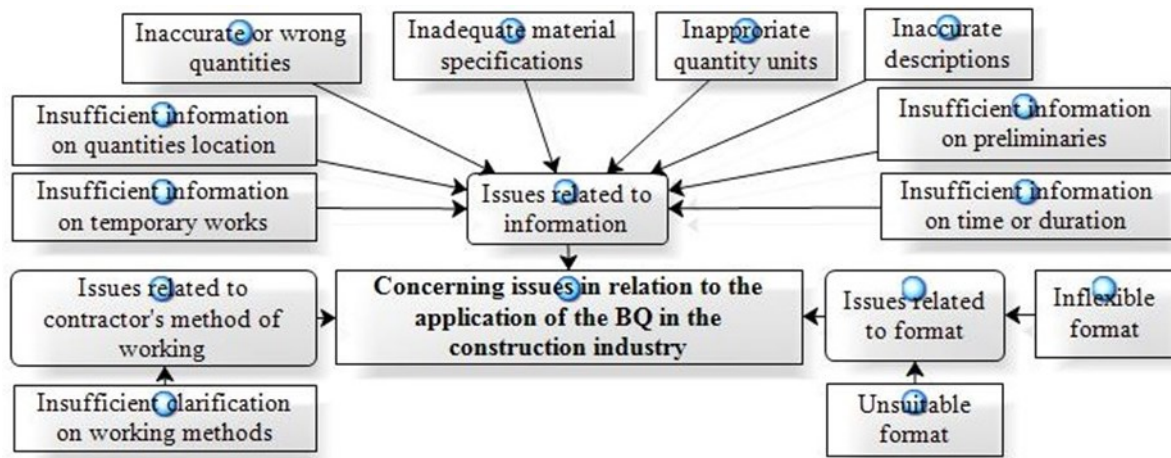


Figure 3: The generated model for mapping the literature review outcome
 Source: Shamsulhadi (2015) and Shamsulhadi, et al. (2014) based on NVivo Software .

6. Mapping the Outcomes

Mapping of outcome is about establishing the geography of thinking and presenting the outcome from the literature review (Hart, 1998). The process seeks to organise the ideas into some kind of arrangements, aim to establish what Hart (1998) refers as declarative and procedural knowledge. It focuses at isolating the structure and point of arguments, hence creating the focal nodes for further elaboration to take place. The research underpinning this paper has taken on this by a model generated from NVivo. This is presented in Figure 3. The model presents the main findings from the review and a geographical map linking the outcome gained from the process.

7. Significant Insights

The documented processes provide insights on how literature review was carried out in the research underpinning this paper. Essentially, this paper has outlined five relevant processes in literature review. It starts by searching the literature followed by mapping of ideas, analysis, synthesis and mapping out the literature review outcome. These are the important processes to be comprehended before a proper review is written on any subject.

Though the details to the processes are quite extensive, it was shown that there is freedom to opt for the most appropriate approaches in the processes. This basically applies in mapping and synthesis. In this respect, researchers are encouraged to choose judiciously following the nature of the evidence, objectives and research questions that need to be answered (Hart, 1998; Saunders, et al., 2007). This was explained in the respective sections based from the research underpinning this paper.

In relation to the research underpinning this paper, the documented processes have allowed issues concerning the use of the BQ to be recapitulated and subsequently structured. The processes learnt and applied have enabled this to be performed effectively. It also indicates that the outcome contain the right amount of quality. Quality in this instance means that an 'appropriate breadth and depth, rigor and consistency, clarity and brevity, and effective analysis and synthesis' was considered (Hart, 1998). Hence, this indicates that the available methodological foundation was adhered to and followed in the whole process of reviewing the literature.

Overall, this paper showed that literature review was a structured process. It has a clear methodological foundation and this applies to the research which supports this paper. It showed that literature review was about understanding the arguments presented in the earlier studies and reflecting how these arguments can be connected. Literature review is not always about finding the similarities among the previous studies. Rather, it is a stride to provide a clear and balanced picture of leading concepts and use it to justify a gap or node in an inquiry. This is an important concept in every review, hence differentiates it from a mere summary of literature.

8. Conclusion

The aim of this paper was to document the process in reviewing the literature. This was accomplished by documenting the process carried out in research on identifying issues concerning the application of the BQ. Through the documentation process, information on important steps to literature review was gathered. This improves understanding and substantially adds to the material concerning the subject.

The research which supports this paper aimed at restructuring issues concerning the application of the BQ. It essentially sought to identify the issues from past studies thus requiring background knowledge on the applicable method for review. For this reason, important method and steps were gathered from various sources. Extracts from the references have been thoroughly reviewed and presented as the background for this paper.

Succinct understanding on the process enabled the steps to be applied and documented in this paper. To add, the application of NVivo has facilitated in the synthesis through models generated by the software. The application of NVivo had further reduced the chance for error. This was important for increasing the credibility towards the review.

Lessons gained from the explanation given in this paper have contributed by framing literature review from the perspective of quantity surveying research. It is a set of process that must be thoroughly understood before the theoretical validity or pattern characterising a research subject is formulated. Hence, it asserts that literature review could function more than a gateway but a dedicated knowledge base should proper process is followed.

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Impact of Street's Physical Elements on Walkability: a Case of Mawlawi Street in Sulaymaniyah, Iraq

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ABSTRACT

A pleasant walking environment is a precondition for living in a sustainable city. Appropriate street design can increase quality and quantity of walking. However, the adequacy and quality of physical elements as the most significant components of street can seriously affect walkability in the streets. The objective of this study was to critically assess the walkability level in terms of physical elements of Mawlawi Street, a famous commercial street located in the city center of Sulaymaniyah, Iraq. The qualitative research based on interview with locals, direct observation and quantitative research via questionnaire with pedestrians were conducted in this study. First, site observation was carried out through PEDS (Pedestrian Environment Data Scan) audit tool and the taking of photographs in order to observe the streetscape features. In this regard, four criteria as environment, pedestrian facility, road attributes, walking environment, and subjective assessment were considered as well serving the purpose of providing a broad direction about streetscape features. Then, a 5 point Likert scale questionnaire with pedestrians was conducted to triangulate the findings from observation. Later on, the findings were validated through an interview with locals regarding their subjective ideas about those criteria. The study showed that inadequate and poor quality of street's physical elements changed the street to an unsafe and uncomfortable environment for walking with weak and low level of street connectivity and accessibility for pedestrians.

1. Introduction

Walking is a part of most people's everyday routine. It is the simplest mode of transportation, and free, convenient, requires no equipment, and is encouraged as part of a healthy lifestyle (Forsyth, Hearst, Oakes, & Schmitz, 2008). It is an attractive mode of transport for experiencing an adjacent environment and interacting with society, which is not possible by transport modes (Wey & Chiu, 2013). Walking is also combined with other forms of transportation. Going from your car to your destination involves walking; accessing the nearest bus stop or train station involves walking (Lo, 2009). The way in which the environment is able to support and encourage walking is called walkability.

Walkability has effect on health, environmental, and economic benefits. According to Wey and Chiu (2013), traffic congestion and environmental pollution is emerging problems in many areas. Therefore, it was found that walking as a means of transport has positive implications towards solving those problems. However, the walking environment has continued to be ignored and until recently, relatively not enough research has been done on walking behavior in relation to the walking environment. Suitable street design can considerably enhance the quality and quantity of the walking environment. It is not only limited to the urban design qualities that may promote walking, but also the psychological aspect, such as the pleasure and enjoyment while walking. Physical elements are known as the principal components of

street whose quality can have a significant influence on walking status in the streets. This paper takes Mawlawi Street, located in the city center of Sulaymaniyah within Iraq as a case study to assess in detail the walkability level in terms of physical elements in this famous commercial street.

2. Background of the study

2.1. Defining the Walkability

Walkability is emerging as a concept of new urbanism in planning as many communities are becoming less walkable due to increasing dependence on other transport modes except walking (Azmi & Karim, 2012). Walkability should be considered as it converges the different elements of urban design, namely, the structure, context, time, distance for users to make sense of the city. It is an evaluation of having knowledge about the reliability of an area for walking. Thus, Walkability is often described as a measure of how friendly an area is for pedestrians and typically accounts for the overall quality of walking conditions (Litman, 2003). Research done on walkability in the past have mainly focused on macro-scale variables such as population density and mixed land use and socioeconomic conditions of an area; nevertheless, an increasing body of research suggests that the built environment as well has a remarkable effect on walkability and the quality of the pedestrian environment (Saelens & Handy, 2008). The

walkability level can be influenced by the qualities associated with walkable environment; these include accessibility, environmental and social safety, aesthetically pleasing man-made and natural features, pedestrian amenities for comfort, and land use diversity (Brown, Werner, Amburgey, & Szalay, 2007). In addition, quality of footpaths, sidewalks or other pedestrian right-of-ways, and traffic and road conditions are significant factors in assessing the walkability level (Gehl, 2010). Finally, a walkable environment should be legible in order to provide a sense of orientation and visual comfort (Southworth, 2005).

2.2 *Street as a walkable environment*

Buildings, open spaces, streets and paths are significant urban elements in an urban district. The legibility and connectivity of these elements support ease of movement and accessibility of the pedestrians (Wall & Waterman, 2010). In addition to simply accommodating pedestrian movement, sidewalks and streets are recognized as the most prominent public spaces found in a city (J. Jacobs, 1961, p. 29, p.29). The word "street", based on Kostof (1992) description, constituted a road way, a pedestrian way, and flanking building. Street as an institution is an equally critical subject beyond its architectural identity, because every street has an economic function and social significance (Rykwert, 1986). Streets not only facilitate automobile movement, but also provide an environment for pedestrians that is inviting, safe, aesthetically pleasing, and accessible, as well as equipped with sufficient pedestrian amenities (Litman, 2003). The elements of a street along with the overall image of the streetscape contribute to the quality of the walking environment. In order to rebalance the functionality of street networks, individual streets need to be planned and designed with all users in mind. The complete streets movement takes a holistic approach to street design in an effort to produce streets that are safe, convenient, and inviting for drivers, bicyclists, public transit users, and pedestrians of all ages and abilities (LaPlante & McCann, 2008). Meanwhile, sidewalks and walkways are considered key components of pedestrian-friendly streets and should allow pedestrians to experience safety, accessibility, comfort, and efficient mobility when walking along them. Sidewalks are meant to be for pedestrian use. However, pedestrians must share this space with a long list of obstacles and street hardware, much of which is required for traffic control matters (Fruin, 1971).

2.3 *Principles regarding walkable street*

Past reviews and newer studies often identify that several built environment characteristics have significant relationships with walking activity. These criteria are called the design criteria or characteristics of the built environment in walkable communities. They can be grouped as:

Connectivity: A connected street is a physical and physiological network that offers multiple routing options for a diverse range of activities, resources, services and places, encouraging physical activity (Jackson, 2009). Connectivity comprehensively refers to straight paths and also shorter distances in order to reach the desired destinations (Saelens & Handy, 2008). In addition, connectivity includes continuity that occurs by adjacency and connection with other types of transportation. The city can be connected very well by continuous sidewalks without gaps and short blocks. Also the street can connect to the surrounding public transportation network (Jackson, 2009). Thus, a contracted street is more pedestrian-friendly (Southworth & Ben-Joseph, 2003).

Safety: is considered important within the pedestrian network for people of different ages from dangers of the crime and traffic. Pedestrian safety can be considered as the most advanced and implicit feature of

walkability (Southworth, 2005). Walking trips are enhanced by safer places. People who can identify the convenient and safe places have a high tendency for walking, about 41.5% more than individuals who are not informed about those places (Powell, Martin, & Chowdhury, 2003).

Accessibility: An accessible place is capable of being used by people of all ages and mobility levels. Universal access should be addressed in the design of all transportation modes, public spaces and connections (A. B. Jacobs, 1993). Pedestrians in such environment consider getting to their destinations or transit nodes easier and quicker and people place demands on better quality walkways as well. The walking characteristics include compact land use, wider paths, rub-cut ramps, tactile strips, and on-slip tiles. Proximity to potential destination related issues are a major discourse in most studies done on accessibility. Five reviews show adequate evidence to deduce that more walking can be achieved with accessibility based on distance to destinations (Handy, Boarnet, Ewing, & Killingsworth, 2002).

Comfort: Walking should not be a burden. In deriving the best walking experience, factors such as comfort, aesthetics of the environment and others have a role to play. In developed countries, active pursuit is given to characteristics such as streetscape beautification, landscaping, etc. (Leow, 2008). A comfortable place is an environment where the form and the capacity of streets and public spaces match the pattern of human behaviors, providing a sense of ease and enabling a feeling of personal safety (A. B. Jacobs, 1993).

Convenient: A convenient place is a location with clear image and legibility. The area is easy to understand, providing a sense of being near-at-hand with visual cues and physical directness to a pedestrian's most essential need. Way finding is known as circulation of certain pedestrian as well as vehicle movement in a complicated environment by serving landmarks, maps, and signs. An appropriate way finding system can easily support users to meet an environment positively and also encourage visitors to choose the proper way (Giles-Corti, Kelty, Zubrick, & Villanueva, 2009).

Engaging: An engaging place is a visually rich aesthetic setting with interrelated parts, providing a sense of contentment and enabling both formal and informal forms of social exchange. Several contributing factors lead to the positive experiences along a street from the treatment of building facades, spacing of trees, lighting, quality of benches and cafe space on wide sidewalks. Even trash bins add to the experience along the street (Giles-Corti et al., 2009).

Vibrant: A vibrant place is an area pulsating with life, vigor and activity. Many of these attractions are referenced in the implementation framework along with recommendations on how to support and enhance the holistic pedestrian experience along the routes to each destination (Giles-Corti et al., 2009). Therefore, principles related to walkable street can be classified in many ways with all attempts used in describing the same characteristics. To promote walking, more factors are needed to be considered. This study focused on comfort, safety, accessibility, and connectivity as the major factors.

2.4 *Physical elements that influence quality of pedestrian environment*

The qualities of the built environment thought to have an effect on walkability include the physical features (road width, sidewalk width, street furniture, urban amenities) and the intangible characteristics (human scale, degree of enclosure, level of cleanliness, transparency) (Saelens & Handy, 2008). For the rest of the paper, physical elements

of built environment were considered. These elements work to provide an environment conducive to pedestrian travel at both street and site level. Such well-structured designs, based on the elements, make it easy for pedestrians to opt for walking based on their built environment perception (Frank, Engelke, & Schmid, 2003). The primary stage in defining walkability is to resolve what physical properties to test and calculate. Design elements that ensure safety from traffic, at the level of the street, are paramount to a walkable environment (Brown et al., 2007; A. B. Jacobs, 1993). In the list are marked pedestrian crossings, curb extensions (chokers), curb cuts or curb ramps, pedestrian refuge islands, medians, and raised crosswalks, traffic signals, speed bumps all of which provide a protective measure for the pedestrians to calm traffic and improve visibility to drivers (Daisa, 2010; Giles-Corti et al., 2009). Bicycle lanes and on-street parking can also serve as a demarcation between automobile traffic and pedestrians (Daisa, 2010; A. B. Jacobs, 1993). Way finding signs, pedestrian signals, flashing warning lights, overpasses/underpasses, and pedestrian crossing warning lights are intended to ease pedestrian movement, some actually end up benefiting vehicles (Whyte, 2012). Sufficient lighting should be made available for the safety of both pedestrian facilities and vehicle traffic. Continuous pedestrian network (crosswalk) are located at the intersections for greater safety for pedestrians (Daisa, 2010). The pavement of the road should slope up with a gradual inclination to meet the sidewalk's elevation so as to prompt vehicular traffic to slow down. A wider sidewalk creates a comfortable and inviting walking environment and can accommodate more pedestrians of varying speeds without their colliding with each other, and café seating or other suitable building-related functions give more life to the pedestrian environment (McNally, 2010). Landscaping and street trees can serve as barriers between fast moving traffic and pedestrians, and can also stimulate visual enjoyment and protective measures, thereby making walking a pleasing experience (Giles-Corti et al., 2009; A. B. Jacobs, 1993). Elements like kiosks, benches, public garbage and signs, which are pedestrian scale, can give the pedestrians some orientation and provide an attractive, leisurely, enjoyable walking experience (A. B. Jacobs, 1993). The pedestrian facility material must not accommodate any form of obstruction and physical interruption. Smaller building width and transparent facade helps to create more variety of uses as well as activities. The monotony of a long block can be broken up by a variety of building types and materials, and helps give visual interest for the pedestrian (Daisa, 2010). Public transportation and bus stops and shelter have great impact on the pedestrian environment (Nakazawa, 2011). Finally, a pedestrian space that provides a variety of above-mentioned amenities located appropriately in an effort to encourage long stay of people is considered successful (Moughtin, 2003).

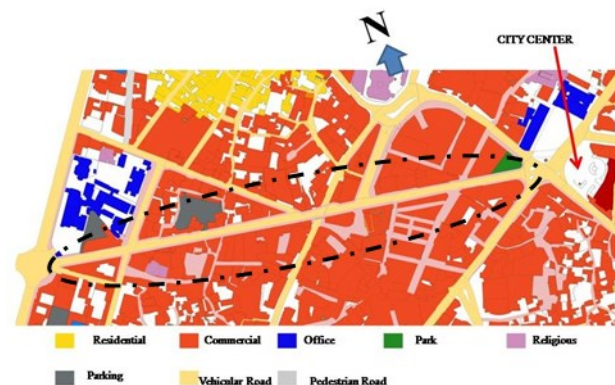


Figure 1 (a) Location of Mawlawi Street



Figure 1 (b) Mawlawi street as the busiest commercial area

who have now demolished the houses and converted them to commercial buildings. Thus, lack of residential function around the street reduced security, especially at night time. More importantly, the unpleasant quality of the built environment in such historical street has made the street inactive at all times of day excluding the evening (Figure 1b). Despite being the main and busiest commercial path, the street is now uncomfortable for walking affecting pedestrians and visitors no longer use the street for walking, fun and pleasure during their free time. Therefore, it is essential to improve the walkability level of such commercial street by focusing mainly on the design and provision of streetscape elements.

2.5 Mawlawi Street

The rapid economic growth of Iraq after the war in 2003 made the citizens more dependent on private cars resulting in difficulties and an unsafe environment for walking. Mawlawi Street is one of the busiest and famous commercial streets located in the city center of Sulaymaniyah in Iraq. It can be considered as the main link that connects the city center and historical area to the public park and Salm Street (Figure 1a). The width of this historic street is 15m and it is almost 1 km long. It is the entrance to the city center and historical district in Sulaymaniyah (Taha, 2007). There are different types of activities on both sides of the street, including hotels, green groceries, retail shops, restaurants, book shops as well as informal activities such as vendors and hawkers. However, lack of efficient public transportation has made people more dependent on private cars. In addition, after 2003 most of the residential houses around Mawlawi Street were bought by traders

3. Method

In order to promote walkability, it is significant to determine those basic physical factors that influence the walkability in the streets. This study employed the mixed-method approach including quantitative and qualitative data. Qualitative survey consisted of direct observation and interview, whereas quantitative data were collected via questionnaire. First, direct observation was applied in collecting the streetscapes information, namely the PEDS audit tool and taking photographs in order to observe the streetscape features that were available on the street segment for appraising the pedestrian environment quality. Four criteria were considered in PEDS audit tools: environment, pedestrian facility, road attributes, walking environment, and subjective assessment as a separate part. These criteria gave the researcher a broad direction in terms of the observation to be made by being specific about the

streetscape features and facilities to consider. Meanwhile, photographs were taken throughout the observation to provide a visual depiction and to contextualize the observed streetscape features. For triangulation of data, a 5 point Likert scale questionnaire survey was conducted on pedestrians who come to Mawlawi Street for their needs. In order to know their subjective ideas about the quality of physical elements four basic features were found: safety, comfort, accessibility, and connectivity. Later, the interview was conducted with local people who work in Mawlawi Street to validate the previous findings. They were asked questions about the strength, weakness, opportunity, and threat of the street in terms of walking. Finally the potential proposal was drawn in order to reinforce the physical elements of the street to enhance walkability. Figure 2 depicts the methodological framework of this study.

4. Result and Discussion

4.1 Observation

With the rising interest in active living and a bigger concern for the quality of public space, many audit instruments have been introduced by researchers which focus on the streetscape environment and measure the physical components or features related to walkability (Clifton, Livi Smith, & Rodriguez, 2007). Audit tools are a systematic observational method which demands that personal data be collected by an observer within a targeted environment. There is also considerable variation in the level of details measured by each audit tool; some focus only on a couple of features while others are more in depth and include dozens of features that address many different environmental characteristics (Brownson, Hoehner, Day, Forsyth, & Sallis, 2009). This study makes use of PEDS audit tool. The PEDS audit tool is made to be a systematic assessment of the physical environment that appraises streetscape features, presence, and qualities. It is hypothesized to influence walkability consisting of both sides of one street block (Clifton et al., 2007). With the use of on-site assessments, auditors observe the environment against definite criteria. This audit tool included 36 criteria that focused on different components of a pedestrian environment which are grouped into four major sections as “Environment, Pedestrian Facility, Road Attributes, Walking Environment” and subjective assessment. Within each section, there are predominantly close-ended questions (Likert scales and check boxes) with a few open-ended questions to incorporate researcher’s comments. Each criterion is based upon extensive research and literature to reflect environmental features that are considered to be a key attribute of pedestrian environments that affect walkability (Clifton et al., 2007). Section A as “Environment” dealt with streetscape features that were less tangible but still important to consider when evaluating the quality of the pedestrian environment. Section B was focused on “Pedestrian Facility”, the type of pedestrian facility depending on the surrounding environment and the activities that would occur along it. Section C included “Road Attributes” as the condition, features, and size of a roadway which could have a remarkable efficacy on the quality of the pedestrian environment. Section D consisted of “Walking Environment” and showed that the elements of a street along with the overall image of the streetscape contribute to the quality of the walking environment. Finally, the subjective ideas of the researcher were wanted in the last segment (Figure 4). As shown in the results of this audit tool and photographs which were taken from the site, Mawlawi Street was not attractive and safe for walking (Figure 3).

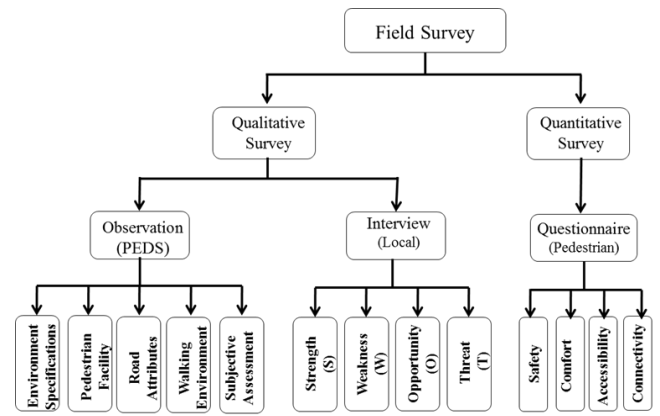


Figure 2: Methodological Framework

4.2 Triangulation by pedestrians via questionnaire

Previous works have indicated several main criteria determining the walkability of urban public spaces. For the purpose of this paper, only those criteria relating to safety, comfort, accessibility, and connectivity were discussed in the questionnaire. The questions in this survey were divided into five parts. Figure 5 shows the dependent and independent variables in the survey. According to this conceptual framework, five independent variables of demographics, comfort, safety, accessibility,



Figure 3: (a)
Pedestrian-vehicle conflict



Figure 3: (b)
Unsuitable place of informal activities



Figure 3: (c)
Lack of street furniture

and connectivity features (by Likert scale) were developed with each consisting of several item variables. Table 1 shows the descriptive analysis of the collected data. The questionnaire survey was distributed among pedestrians who come to the street for their own purposes. According to Ferguson and Cox (1993), 100 respondents are considered as a minimum number of respondents for taking part in a questionnaire. Thus, one hundred participants were considered

for this study. Moreover, SPSS software has been used to analyze the data in this study.

4.2.1 Analysis of questionnaire

For investigating the determinants of street walkability, a series of statistical methods can be applied. First of all, reliability analysis via

0. Segment type Low volume road ☐ 1 High volume road ☒ 2 Bike or Ped path - skip section C ☐ 3		If no sidewalk, skip now to section C.		24. Bicycle facilities (all that apply) Bicycle route signs ☐ 1 Striped bicycle lane designation ☐ 2 Visible bicycle parking facilities ☐ 3 Bicycle crossing warning ☐ 4 No bicycle facilities ☒ 5							
A. Environment 1. Uses in Segment (all that apply) Housing - Single Family Detached ☐ 1 Housing - Multi-Family ☐ 2 Housing - Mobile Homes ☐ 3 Office/Institutional ☐ 4 Restaurant/Café/Commercial ☒ 5 Industrial ☐ 6 Vacant/Undeveloped ☐ 7 Recreation ☐ 8		11. Curb cuts None ☐ 1 1 to 4 ☐ 2 > 4 ☐ 3									
2. Slope Flat ☐ 1 Slight hill ☐ 2 Steep hill ☐ 3		12. Sidewalk completeness/continuity Sidewalk is complete ☐ 1 Sidewalk is incomplete ☒ 2									
3. Segment Intersections Segment has 3 way intersection ☐ 1 Segment has 4 way intersection ☒ 2 Segment has other intersection ☐ 3 Segment deadends but path continues ☐ 4 Segment deadends ☐ 5 Segment has no intersections ☐ 6		13. Sidewalk connectivity to other sidewalks/crosswalks number of connections <u>3</u> 1									
B. Pedestrian Facility (skip if none present) 4. Type(s) of pedestrian facility (all that apply) Footpath (worn dirt path) ☐ 1 Paved Trail ☐ 2 Sidewalk ☒ 3 Pedestrian Street (closed to cars) ☐ 4		C. Road Attributes (skip if path only) 14. Condition of road Poor (many bumps/cracks/holes) ☐ 1 Fair (some bumps/cracks/holes) ☐ 2 Good (very few bumps/cracks/holes) ☐ 3 Under Repair ☐ 4		D. Walking/Cycling Environment 25. Roadway/path lighting Road-oriented lighting ☐ 1 Pedestrian-scale lighting ☐ 2 Other lighting ☐ 3 No lighting ☐ 4							
The rest of the questions in section B refer to the best pedestrian facility selected above. 5. Path material (all that apply) Asphalt ☐ 1 Concrete ☒ 2 Paving Bricks or Flat Stone ☐ 3 Gravel ☐ 4 Dirt or Sand ☐ 5		15. Number of lanes Minimum # of lanes to cross <u>1</u> 1 Maximum # of lanes to cross <u>2</u> 1		26. Amenities (all that apply) Public garbage cans ☐ 1 Benches ☐ 2 Water fountain ☐ 3 Street vendors/vending machines ☐ 4 No amenities ☐ 5							
6. Path condition/maintenance Poor (many bumps/cracks/holes) ☐ 1 Fair (some bumps/cracks/holes) ☐ 2 Good (very few bumps/cracks/holes) ☐ 3 Under Repair ☐ 4		16. Posted speed limit None posted ☐ 1 (mph): <u>1</u> 1		27. Are there wayfinding aids? No ☐ 1 Yes ☐ 2							
7. Path obstructions (all that apply) Poles or Signs ☐ 1 Parked Cars ☐ 2 Greenery ☐ 3 Garbage Cans ☐ 4 Other ☐ 5 None ☐ 6		17. On-Street parking (if pavement is unmarked, check only if cars parked) Parallel or Diagonal ☐ 1 None ☒ 2		28. Number of trees shading walking area None or Very Few ☐ 1 Some ☐ 2 Many/Dense ☐ 3							
8. Buffers between road and path (all that apply) Fence ☐ 1 Tress ☐ 2 Hedges ☐ 3 Landscape ☐ 4 Grass ☐ 5 None ☒ 6		18. Off-street parking lot spaces <table border="1"> <tr> <td>0-5</td> <td>6-25</td> <td>26+</td> </tr> <tr> <td>☐ 1</td> <td>☐ 2</td> <td>☐ 3</td> </tr> </table>		0-5	6-25	26+	☐ 1	☐ 2	☐ 3	29. Degree of enclosure Little or no enclosure ☐ 1 Some enclosure ☐ 2 Highly enclosed ☐ 3	
0-5	6-25	26+									
☐ 1	☐ 2	☐ 3									
9. Path Distance from Curb At edge ☐ 1 < 5 feet ☐ 2 > 5 feet ☐ 3		19. Must you walk through a parking lot to get to most buildings? Yes ☐ 1 No ☐ 2		30. Powerlines along segment? Low Voltage/Distribution Line ☐ 1 High Voltage/Transmission Line ☐ 2 None ☒ 3							
10. Sidewalk Width < 4 feet ☐ 1 Between 4 and 8 feet ☐ 2 > 8 feet ☐ 3		20. Presence of med-hi volume driveways < 2 ☐ 1 2 to 4 ☐ 2 > 4 ☐ 3		31. Overall cleanliness and building maintenance Poor (much litter/graffiti/broken facilities) ☐ 1 Fair (some litter/graffiti/broken facilities) ☐ 2 Good (no litter/graffiti/broken facilities) ☐ 3							
		21. Traffic control devices (all that apply) Traffic light ☐ 1 Stop sign ☐ 2 Traffic circle ☐ 3 Speed bumps ☐ 4 Chicanes or chokers ☐ 5 None ☒ 6		32. Articulation in building designs Little or no articulation ☐ 1 Some articulation ☐ 2 Highly articulated ☐ 3							
		22. Crosswalks None ☐ 1 1 to 2 ☐ 2 3 to 4 ☐ 3 > 4 ☐ 4		33. Building setbacks from sidewalk At edge of sidewalk ☐ 1 Within 20 feet of sidewalk ☐ 2 More than 20 feet from sidewalk ☐ 3							
		23. Crossing Aids (all that apply) Yield to Ped Paddles ☐ 1 Pedestrian Signal ☐ 2 Median/Traffic Island ☐ 3 Curb Extension ☐ 4 Overpass/Underpass ☐ 5 Pedestrian Crossing Warning Sign ☐ 6 Flashing Warning Light ☐ 7 Share the Road Warning Sign ☐ 8 None ☒ 9		34. Building height Short ☐ 1 Medium ☒ 2 Tall ☐ 3							
				35. Bus stops Bus stop with shelter ☐ 1 Bus stop with bench ☐ 2 Bus stop with signage only ☐ 3 No bus stop ☒ 4							
				Subjective Assessment: Segment... Enter 1, 2, 3, or 4 for 1=Strongly Agree 2= Agree, 3=Disagree, 4=Strongly Disagreeis attractive for walking. <u>3</u> 1is attractive for cycling. <u>4</u> 1feels safe for walking. <u>3</u> 1feels safe for cycling. <u>4</u> 1							

Figure 4: PEDS audit tool for Mawlawi Street

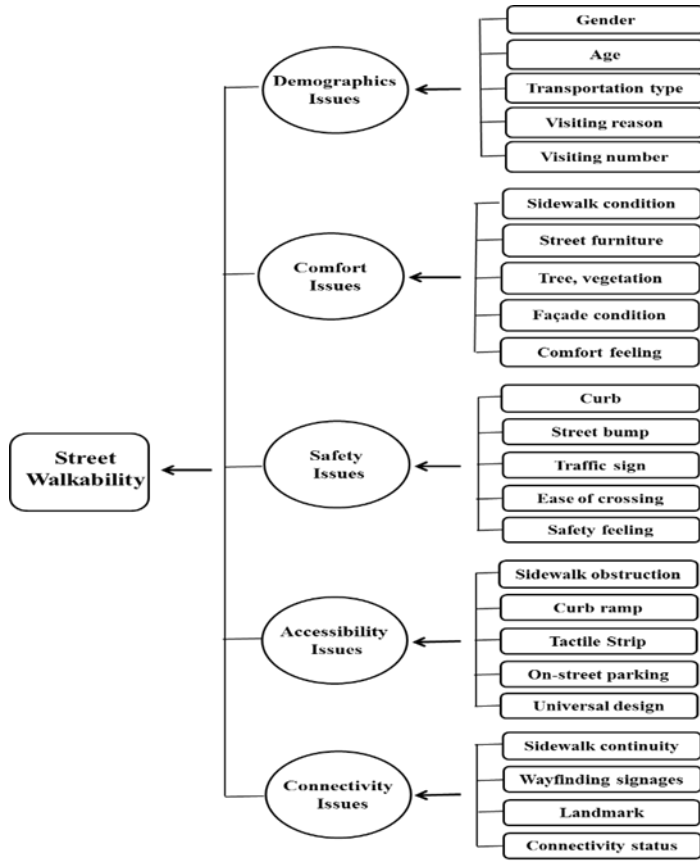


Figure 5: Conceptual Framework

Cronbach's alpha, which is the most common reliability measurement technique, may be conducted in the research. The Cronbach's alpha of this variable was 0.941, and as it was more than 0.9, the acceptability of the result was considered excellent. Afterwards, the KMO (Kaiser-

Table 2: Exploratory factor analysis

Items	Component	
	1	2
Sidewalk Condition	0.823	
Street Furniture	0.796	
Tree, Vegetation	0.791	
Facade Condition	0.806	
Comfort Feeling	0.804	
Curb	0.853	
Street Bump	0.889	
Traffic Sign	0.784	
Ease of Crossing	0.817	
Safety Feeling	0.818	
Sidewalk Obstruction		0.662
Curb Ramp		0.749
Tactile Strip		0.783
On-Street Parking		0.679
Universal Design		0.782
Sidewalk Continuity		0.780
Wayfinding Signs		0.877
Landmark		0.857
Connectivity Status		0.871

Meyer-Olkin) measure and Bartlett's test was performed to specify the sample adequacy. Since the KMO value was 0.935 which is more than 0.5, it has an acceptable value to go forward to the factor analysis (Seyed Mohammad Mousavi, Khan, & Javidi, 2013). Lastly, exploratory factor analysis and correlation analysis were served to detect different relationships.

Table 1: Summary of the demographics, comfort, safety, accessibility and connectivity variables

Variables	Descriptive Values/Measures/Scales	Mean
Gender	1 male; 2 female	1.40
Age	10<'1'<19; 20<'2'<29; 30<'3'<39; 40<'4'<49; 50<'5'<59; '6'≥60	2.79
Transportation Type	1 bus; 2 private car; 3 taxi; 4 on foot; 5 bicycle; 6 others	2.17
Visiting Reason	1 working; 2 shopping; 3 meeting; 4 walking; 5 eating; 6 others	2.50
Visiting Number	1 every day; 2 once in a week; 3 twice in a week; 4 more than twice; 5 only weekends	3.42
Sidewalk Condition	1 very poor; 2 poor; 3 average; 4 good; 5 very good	2.68
Street Furniture	1 very poor; 2 poor; 3 average; 4 good; 5 very good	2.12
Tree, Vegetation	1 very poor; 2 poor; 3 average; 4 good; 5 very good	1.98
Facade Condition	1 very poor; 2 poor; 3 average; 4 good; 5 very good	2.80
Comfort Feeling	1 very poor; 2 poor; 3 average; 4 good; 5 very good	2.09
Curb	1 very poor; 2 poor; 3 average; 4 good; 5 very good	2.40
Street Bump	1 very poor; 2 poor; 3 average; 4 good; 5 very good	2.20
Traffic Sign	1 very poor; 2 poor; 3 average; 4 good; 5 very good	2.45
Ease of Crossing	1 very poor; 2 poor; 3 average; 4 good; 5 very good	2.33
Safety Feeling	1 very poor; 2 poor; 3 average; 4 good; 5 very good	2.42
Sidewalk Obstruction	1 very poor; 2 poor; 3 average; 4 good; 5 very good	2.57
Curb Ramp	1 very poor; 2 poor; 3 average; 4 good; 5 very good	2.13
Tactile Strip	1 very poor; 2 poor; 3 average; 4 good; 5 very good	2.14
On-Street Parking	1 very poor; 2 poor; 3 average; 4 good; 5 very good	2.28
Universal Design	1 very poor; 2 poor; 3 average; 4 good; 5 very good	2.34
Sidewalk Continuity	1 very poor; 2 poor; 3 average; 4 good; 5 very good	2.52
Wayfinding Signs	1 very poor; 2 poor; 3 average; 4 good; 5 very good	2.63
Landmark	1 very poor; 2 poor; 3 average; 4 good; 5 very good	2.34
Connectivity Status	1 very poor; 2 poor; 3 average; 4 good; 5 very good	2.89

4.2.2 Exploratory factor analysis

First, basic item analysis with Varimax rotation was conducted to test whether variables regarding street walkability could be categorized into a smaller number of factors. In this case, item variables with factor loading less than 0.40 were removed from the groups (S.M Mousavi & Khan, 2013). 19 questionnaire items were categorized into 2 components. Component 1 had ten items regarding comfort and safety issues, while component 2 had nine items regarding accessibility and connectivity issues. All reliability loadings were more than 0.6 representing adequate reliability (Table 2).

4.2.3. Correlation analysis of affordability price & knowledge

Correlation analysis was carried out to test the intensity of relation among four main features of walkability (comfort, safety, accessibility, and connectivity). Table 3 illustrates the correlation matrix of those items. It revealed that all walkability-related items were positively and significantly correlated to each other at the significance level of 0.01. However, comfort and safety were more correlated to each other in comparison to the rest, meanwhile accessibility and connectivity items were mostly correlated to each other compared with the others.

4.2.3. Demographic and walkability features

The number of males was more than females; most respondents were between 20 and 40 years old. The study showed that age was not a basic variable of street walkability. Most of the respondents came to the site with their private cars or taxi (60%) while the minority of them came on foot. This may be a strong reason that street cannot persuade people to come there on foot. In addition, the street was not inviting for walking. Most people (70%) visited the site for shopping, with a small percentage showing a tendency for walking in such a main street of Sulaymaniyah. According to descriptive statistics, although all the figures of items related to street walkability were between 'Poor' and 'average', participants were mostly partial to choose poor status rather than neutral choice. Among them, comfort issue had the lowest mean score (2.09) than the other three features of walkability, while the mean scores for safety and accessibility were 2.42 and 2.34, respectively. Although connectivity obtained the highest mean score (2.89) compared to others, "average" was the most common choice of participants. Finally, it can be concluded that participants declared the poor status of physical elements of street in terms of walkability.

4.3 Validations by local people

An interview including open-ended questions was conducted with seven local people who work and live on Mawlawi Street. They were asked questions about the strength, opportunity, weakness and threat of this

Table 3: Correlations

	Comfort	Safety	Accessibility	Connectivity
Comfort	1	0.820**	0.721**	0.584**
Safety	0.820**	1	0.734**	0.638**
Accessibility	0.721**	0.734**	1	0.785**
Connectivity	0.584**	0.638**	0.785**	1

** .Correlation is significant at the 0.01 level (2-tailed).

Table 4: Issues related to 'Environment'

Strength	- Existence of various activities - The main road is flat.
Weakness	- Street vendors make barriers resulting in traffic for both pedestrians and vehicles - Different levels between front side and back side of the road - Poor condition of building.
Opportunity	The street located in the city center.
Threats	Some activities like chicken sellers made the area dirty.

street on the basis of those four items based on audit tools. Table 4, 5, 6 present the summary of these interviews. Table 4 shows those four items related to the environment. Moreover, most of interviewees only declared some weaknesses regarding 'pedestrian facilities' including unpleasant sidewalk materials, poor condition of the sidewalk in some places, narrow sidewalk, existence of path obstruction such as bollards in sidewalk, lack of buffer between pedestrians and vehicles, and lack of ramps and curb cuts on the corner of sidewalks especially for disabled pedestrians.

Table 5: Issues related to 'Road attributes'

Strength	The maximum allowed speeds is 30 km/hour.
Weakness	- Poor condition of roads in some spots - Lack of on-street parking - Invisible crosswalks - Lack of traffic control at the intersection and crosswalks - High traffic volume - Conflict between pedestrian and vehicles - Lack of maintenance
Opportunity	Named as the main road of city center.
Threats	NA

Table 6: Issues related to 'Walking environment'

Strength	Combination of historical buildings and modern buildings.
Weakness	- Lack of proper lighting - Lack of maintenance of lighting - Lack of sufficient urban amenities such as public toilets, beaches, and litter bins - Lack of sufficient and mature trees - Lack of landscape maintenance - Lack of Wayfinding signs and Directional Maps - Lack of shelters and benches in the bus stop - Lack of cover linkages - Lack of Building Setbacks from Sidewalk - Unattractive appearance like electricity wire, chicken shops
Opportunity	Historical location
Threats	Wet market

5. Potential proposal for redevelopment

At this stage the proposals to enhance walkability can be directly based on those four factors. As the walkability level in Mawlawi Street was low, the following recommendations can improve walkability through proper design of physical elements.

Enhancement of the pedestrian environment by widening sidewalks for multiple site furnishing configurations and narrowing the road width. Benches should be located under the trees to take benefit of shading and also to be out of the way of the pedestrian passageway. Benches, bollards and planting more trees along the sidewalks can also create buffer between the sidewalks and road.

Providing landscape elements and public toilets in the park and providing awning in front of shops can protect pedestrians from the intense sunshine and rain. In order to increase pedestrian safety and enhance the quality of the pedestrian environment, it was recommended that cross lines should be raised and visible in the crosswalk area with material different from the road.

Applying curb cuts and ramps in the corners and intersections and providing street lighting can make the street safer at nights. Traffic lights, signs and traffic control devices can be installed at the intersections. Bus stops and shelters can be designed and installed. In order to create a more accessible street for disabled, elderly, and women with strollers, it was recommended that fixed bollards on the sidewalks should be removed to create a consistent, unobstructed pedestrian path.

The vegetation and water feature along the street should be provided. Some activities on the street like chicken shops should be removed. The street vendors should be arranged on the sidewalks to enhance vibrancy of the site. Figure 6 shows the master plan of the street with above-mentioned recommendations.

6. Conclusions and recommendations

Based on triangulation method which included a questionnaire with pedestrians, interview with local people and direct observation by PEDs audit tool, the following results were acquired that can influence the level of walkability in Mawlawi Street: inadequate and poor qualities of sidewalk's infrastructures; lack of street amenities; inadequate or poor qualities of the street's infrastructure. Finally, it can be concluded that the street was not comfortable and safe for walking. In addition, the street was not accessible for disabled people and crossing of the street

was not easy. This study showed that there was a strong relationship between the physical elements of street and walkability concept. The results showed that the level of walkability in Mawlawi Street was in low level due to the poor qualities of the sidewalk infrastructure, poor quality of the street furniture's amenities and poor quality of the street infrastructure. Thus, the provision and design of the physical elements have a significant role to improve walkability in the street. Finally, Mawlawi Street can be more walkable through designing physical elements, if done properly. This study focused on the relation of the physical elements of the street and walkability, while land use as the other aspect can play a major role to promote walkability.

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Figure 6: Master plan

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Outreach of Pro-poor Housing Programs and Projects: Is it sustained?

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ABSTRACT

Affordable housing for urban poor is one among the hot button issues among all policy makers and planners in countries of global south. Grand schemes with extravagant promises in the formal sector and gigantic hope for informal sector, to capture the opportunity at bottom of pyramid, are simultaneously trying to curb the problem of affordable housing shortage for urban poor. Even though private sector does not purposely seek to cater housing for lower income sections, yet large quantum of investment have been witnessed in housing for the urban poor. It is well known that in a free market tussle, the highest bidder is always the winner. This has been a major reason for creation of artificial shortage of housing for poor. And the scenario is worse in case of public housing, where, half of the units are either left purposeless or used by ineligible users, largely due to risk of impoverishment and improper post occupancy vigilance. The magnitude of post occupancy problems being unexplored, the objective of paper pertains to looks at the challenges and issues in sustaining targeted outreach to intended beneficiaries in housing supply models for urban poor. The paper elaborates distinct challenges through three housing supply models in Ahmedabad, India. The models are Rehabilitation Housing, Subsidized Housing by government and market provided Housing. The method is mixed method i.e. qualitative and quantitative research using primary and secondary data sources. The critical analysis of effective outreach is carried by studying policy rhetoric in each of the models to on ground veracity in the post occupancy stage of model by assessing end user satisfaction in each model.

1. Introduction

Fostering for socio-economic stability and promoting national development in developing countries has never proved easy. Before resolving any urban problem, the increased rate of urban population or urbanization constantly bother planners, by altering the anticipated outcomes of planning projects and policies. Certainly, urbanization offers better prospects in life. But along increasing the economic status of cities, urbanization also lead in inequitable development where the poor largely crave for more subsidies. This is very evident in the developing cities of Asian region, where the urban fabric is largely suffering from urban divide. Asia, despite having lower level of urbanization, homes 53% of total world urban population (UN, 2014). The region might feature urbanization rate of 64% in 2050 from 43% in 2010 (UN, 2014). On the darker side, about one-third of Asia's urban population lives in slums (UN, 2014) and with increase in urban population, the rate of slum population is estimated to increase further. If rapid growth cannot ensure basic minimum facilities, the fast pacing region will end up in urban squalor than urban splendor. This is where one must ensure development with performance of inclusiveness.

But, the story of inclusiveness cannot successfully end with grand schemes and extravagant promises of bureaucrats. Rather one must ensure in sustaining the actual purpose of the formulated programs. One of the examples for ineffective inclusiveness is the paradox of Indian Housing Market where large volume of housing transactions are lying vacant on one hand and massive population are yet craving for house on other hand. Around 95.6% of total 18.78 million, urban housing shortage is recorded in Economically Weaker Sections (EWS) and Lower Income Group (LIG) of country. And surprisingly, around 11 million stocks are lying vacant or unused (MHUPA, 2012a). On the other end, researchers have shown that "the units vacated are precisely the ones that would allow the more affluent slum dwellers to move out of slums and afford older units in the formal market" (Annez et al., 2010). If that was true, 11 million housing stock would not have been left vacant or unused.

In order to curb the affordable housing shortage for lower income sections, Indian housing market experienced various supply models (Batra, 2009). Many models are formulated by the government and later subsumed or discontinued with change in market dynamics. Broadly, the models are Rehabilitation housing, Government

Subsidized Housing and Private/Market based housing. Few of the programs actively working under the three models are: Basic Services for Urban Poor (BSUP) under Jawaharlal Nehru Urban Renewal Mission (JnNURM), Rajiv Awas Yojana (RAY), Slum Rehabilitation Scheme (SRS). But the myriad attempts yet, are unable to fulfil the desired goals. Out of the approved 1,517 projects in BSUP which were to cater to merely 6% of housing shortage declared in 2007 (Mahadevia et al., 2013), only 22 projects were actually completed (The Economic Times, 2012).

Apart from the government funded projects, even with huge interest of private sector in affordable housing for lower sections, so far only 78,000 units are launched all over India in past five years, costing below INR 1,000,000, which catered to only 1% of shortage recorded by MHUPA (Monitor, 2013). Monitor (2013) shows that households earning INR 10,000-25,000 can afford privately built formal housing, costing INR 400,000-1,000,000 without any assistance from the Government. It is estimated that 15 million households are part of the Lower Income Group (LIG) (Monitor, 2013) in India. Even with huge demand, the outcome discussed above contradicts the envisaged results.

1.1 Problem Statements

Firstly, the efforts to resolve the housing shortage for poor, may be the public or private, are lesser due to myriad supply side constraints. Second, the efforts to sustain the actual purpose of building LIG housing units are even lesser. Literature shows that housing stock built under BSUP, largest housing program in India, are left unoccupied despite of allotment. "Only 52 per cent of the total one million approved dwelling units were constructed and out of the approved, only 36 per cent are actually occupied (Patel et al., 2015). In most cities across India, it appears that BSUP housing stock is left largely unused and unoccupied. Around 57 per cent of BSUP housing in Bangalore was left unoccupied (Rao, 2012) and almost "90 per cent was left unoccupied in Greater Hyderabad" (Mahadevia et al., 2013). And our research shows, around 52% of housing (BSUP) are utilized by unintended beneficiaries. Our research further shows that in the private based housing, around 40% units are rented out in which more than half are purchased by the investors themselves and later rented out to the needy creating artificial shortage of supply for the poor.

Featuring major criticism on the supply models for the failure of sustaining targeted outreach - BSUP resettlement projects are largely implemented in the city peripheries, distant from workplaces, schools and hospitals, and thus not meeting the criteria of adequate shelter (Patel et al., 2015). "Contrary to the objective of providing in situ basic services to poor households, in most cities BSUP projects have funded off-site rehabilitation housing for project-affected people, thereby depriving the intended urban poor beneficiaries of outreach" ("Foisting Mass Housing on the Poor: Lessons from Social Audit of BSUP," 2013). Interestingly, one of the critical argument made by De Soto (2000) relates the role of tenure status with household living conditions. The argument is that tenure security and legality are significant parameters for improved housing conditions and consequently, settlement development. This is inquired in the case of Ahmedabad and discussed in the discussions section. In case of markets, the exorbitant land prices are the major supply constraint and contributes substantially to the dwelling unit cost, especially when it is in purview of city limits (Gandhi, 2012). This tends the private developers to locate the project sites in the periphery of city and leading high increase of transportation costs for the poor (Gandhi, 2012).

The paper here, outlines the second problem, 'reasons for the inability

to sustain the targeted outreach to intended beneficiary'. The attempt of featuring three distinct models is to emphasize, that the issues and challenges in each model has equal possibility to occur in other, resulting in unpredicted outcomes. A cautionary approach is utmost necessary to sustain the desired outcomes in planning or else we end in cross roads formulating more and more models without being informed by the previous models challenges and issues.

1.2 Objective

Towards this attempt, the objective of paper is 'to understand causes of inability of the models to reach and sustain the targeted outreach to intended beneficiaries. The three models are Rehabilitation housing, Government Subsidized housing and Private/Markets based housing.

2. Methodology

The research is based qualitative method drawing using primary and secondary data sets. The qualitative primary data sets are obtained through semi structured interviews, focus group discussions and reconnaissance surveys. To identify the post occupancy issues in public housing, in addition to site surveys and interviews of residents and association chairman, interviews of officials at Ahmedabad Urban Development Authority (AUDA) and Gujarat Housing Mission (GHM) was also carried out. To identify the post occupancy issues in private housing, interviews of developers and official at GRIHA Pravesh association chairman (not for Profit Organization working in housing finance), and residents of the site were conducted. Apart from the primary data sources, data is obtained from critical reviews of supply models through literature study.

The data obtained from case studies, are the crux of the paper, since, the objective is largely inclined to the post occupancy issues and challenges. One site study in each model is studied, for which the data is gathered from the individual site visits under respective models and the inferences obtained from primary surveys and critical literature review on housing supply models in Ahmedabad helped in implicating the results to large scale.

Based on the individual model case studies, reasons for the inability to sustain the outreach to intended beneficiaries are analyzed. This is an attempt made to understand the problems at grass root level so that the authority or developers building more low income housing can be better informed and future projects can be more target focused.

The first section features the overview of supply models and case studies elaborating rhetoric and on ground veracities in each model. In this section three major challenges under each model are recognized. In the second section, the reasons for the post occupancy failure are identified by using four point Likert type assessment to analyze the beneficiary satisfaction. Lastly, the third section summarizes the findings and suggests the policy measures that can better tackle the issues at grass root level.

3. Case studies

The seventh largest metropolis in India, Ahmedabad, hosts population of 55, 70,585 (Census, 2011). According to AMC report (AMC, 2013b), the total slum population recorded in Ahmedabad Municipal Corporation (AMC) is around 13% of 2011 AMC population and around 9.8% of households in city are living in dilapidated, congested and temporary structures. In wake to the rapid growth of population, the city of Ahmedabad experienced distinct housing supply models

based on consumer market profile. And in this housing market tussle, public and private actors are the largest facilitators followed by self-help groups, NGOs and Community Based Organizations (CBOs). As mentioned, based on consumer market profile, many models tried to fulfil the dreams of million with vivid approach. One approach under each model is studied and the selection is carried on active functioning of approach under model from 2005. The housing models in Ahmedabad for poor studied in the research are:

- Basic Services for Urban Poor (BSUP) under JnNURM by AMC as a Rehabilitation model
- Basic Services for Urban Poor (BSUP) under JnNURM by AUDA as a Government Subsidized model
- Private/Market based model

3.1 *Rhetoric and on ground post occupancy veracities of Housing supply models in Ahmedabad*

BSUP mission is adopted under the JnNURM and the main focus of the sub mission was to bring about integrated development of slums with the aim of providing shelter as well as basic minimum services and other civic amenities to the urban poor (Government of India, 2009).

Several attempts were started in late 1960's by markets to supply lower income housing e.g. Parshwanath group, to capture the opportunity in the bottom of the pyramid. Therefore, Market based housing is the other housing model to be part of the research. According to Monitor (2010) the Low-Income Housing (LIH) market in urban India is improving, with the beginnings of a robust supply equation in place for affordable and good quality housing. The study has found more than 25 developers in urban areas across India building multi-family units in the INR 300,000 to 700,000 price range.

3.1.1 Rehabilitation Housing

Even though the two models – Rehabilitation housing and Government Subsidized housing are under the same program i.e. BSUP by JnNURM with similar objectives and eligibility criteria, but they carried distinct approach in case of Ahmedabad. In case of BSUP by AMC, the program served for Project Affected People (PAP) under Sabaramati River Front Development, Bus Rapid Transit System (BRTS), Road Extensions and other development projects of the city. Relocation of slum dwellers under the project affected sites was undertaken, hence it is part of Rehabilitation Model.

Under the program, 20,160 units were sanctioned and spread across 23 sites of city. The site selected under the model is located in Western part of city (Nava Wadaj), comprising 576 units of 25 sq.m carpet area. Out of the total number, around 89% units are occupied. The allotment process was through draw system and relocation of slum dwellers from different project affected sites of city altered the anticipated results of projects. From the semi-structured interviews conducted, the allotted beneficiaries were ready to leave the site after gaining the property rights after 10 continuous years of possession.

3.1.2 Government Subsidized Housing

This was also provided under BSUP program by AUDA for beneficiary urban poor household and not project affected persons (Table 2). The objective was provision of shelter as well as basic minimum services and other civic amenities. With minimum carpet area of 25 sq.m, 13,672 units were sanctioned to AUDA, out of which around 98% are allotted and around 96% units are occupied. From the 14 sites under the model, Chandkedha site constructed in the year 2010, located in North of city is selected (Figure 1). The site constitutes 100% occupancy with total of 480 housing units. But surprisingly 52% is the rental component, against the policy guidelines. From the semi structured interviews conducted,

Table 1: Rhetoric and on ground veracities in Rehabilitation housing

Rehabilitation Housing		
BSUP by AMC		
Parameters	Rhetoric	On ground veracities
Objective	The mission for development of slums in integrated approach, aiming in providing shelter as well as basic minimum services and other civic amenities to the urban poor.	Contrary to the objective of providing in situ basic services to poor households, BSUP projects have funded off-site rehabilitation housing for project affected people
Eligibility criteria	EWS- less than INR 100,000 per annum LIG - INR 100,000 to INR 250,000 per annum	Project affected people, have income within eligibility criteria
Carpet area	EWS-25to 30sq.m LIG-31to 50 sq.m	25 sq.m
Financial share by beneficiary (INR)	Min. 12% cost of dwelling unit borne by beneficiary	Around 26 per cent of the total dwelling unit cost borne by the beneficiary (INR 6700 as down payment + EMI of INR 500 for 10 years)
Property rights	non-transferable lease rights on a housing unit for 10 years, following which, and after the beneficiary contribution has been paid, the slum-dweller will be able to sell the house but only to the government	Occupied by eligible beneficiaries. But from semi structure interviews, chances of leaving the site are maximum after the issuance of tenure rights to beneficiaries
Occupied to constructed percentage	Anticipated 100% occupancy	50% at the city level (AMC, 2013a) and 81% at site level (primary survey)
Challenge	Low occupancy rate	

the household income of units under rental component is on average INR 330,000 per annum, which is higher than the prescribed income under eligibility criteria.

3.1.3 Private/Markets based Housing

In addition to public undertaking supply models, to keep pace with the rapidly growing economy and to capture the potential at bottom of pyramid, private market interventions are effectively participating in provision of affordable housing for EWS and LIG especially in Ahmedabad. Around 10,973 (both One Bedroom Hall Kitchen also called 1 BHK and One Room and Kitchen also called 1RK) units are built for lower income sections in the city (GRIHAPraves, 2015). The case study selected under the model is Navjivan Housing, constructed by Foliage builders in the year 2010 (Table 3 and Figure 2). The project



Figure 1: Subsidized Housing

built was a mixed housing ranging from 2 BHK to 1 BHK and 1 RK. The minimum carpet area designed for project is 28 sq.m for 1RK and 43 sq.m for 1BHK. From the report by Monitor (2013), households earning INR 10,000 – 25,000 can afford privately built formal housing, costing INR 400,000 to 1,000,000, without any assistance from the Government. In case of Navjivan Housing, over past five years, 1 BHK and 1 RK units are sold with varying price of INR 0.3 Million to INR 0.7 Million, which is in the affordability limit of lower income sections. But in ground reality, around 40% of rented units are owned by investors and higher income groups and the same are rented out for poor. These speculative investments are minimizing the little options left for poor to purchase houses.

4. Uncertain challenges and changes in expectations

From the case studies, the three post occupancy challenges altering the targeted outreach are (1) Lower occupancy ratio and risk of impoverishment leading for permanent vacation of sites in Rehabilitation Housing (BSUP by AMC). (2) Presence of high rental component against policy guidelines in Government Subsidized Housing (BSUP by AUDA), (3) Speculative investments of higher income group in lower housing units creating artificial shortage of supply for poor in Private/Markets housing model.

4.1 What went wrong?

To identify the backdrop of uncertain challenges leading for inefficient outreach, semi structured interviews were conducted for existing residents/beneficiaries and co-operative association chairman. Since, it was difficult to track the profile of beneficiaries who left, examining the

Table 2: Rhetoric and on ground veracities in Subsidized housing

Subsidized Housing		
BSUP by AUDA		
Parameters	Rhetoric	On ground veracities
Objective	The mission for development of slums in integrated approach, aiming in providing shelter as well as basic minimum services and other civic amenities to the urban poor.	Open to market, for households with prescribed eligibility criteria
Eligibility criteria	EWS-income less than INR 1,00,000 per annum LIG –income INR 100,000 to INR 250,000 per annum	In contradiction to eligibility criteria, also serves households with average annual household income of INR 330,000 or more
Carpet area	EWS-25to 30sq.m LIG-31to 50 sq.m	25 sq.m
Financial share by beneficiary (INR)	Min. 12% cost of dwelling unit borne by beneficiary	50% of total dwelling unit cost borne by beneficiary (INR 125,000)
Property rights	non-transferable lease rights on a housing unit for 10 years, following which, and after the beneficiary contribution has been paid, the slum-dweller will be able to sell the house but only to the government	52% of rental stock against policy guidelines
Occupied to constructed percentage	Anticipated 100% occupancy	98% at the city level (statistics obtained from AUDA officials) and 96% at site level (primary survey)
Challenge	High share of Rental stock against the policy guidelines to unintended beneficiaries	

Table 3: Rhetoric and on ground veracities in Private Housing Model

Private based Housing		
Private market		
Parameters	Rhetoric	On ground veracities
Objective	As Corporate Social Responsibility and also to capture the large opportunity in the BOP	To capitalize the necessities in bottom of pyramid by meeting affordable standards of lower income sections (only LIG are catered and not EWS)
Eligibility criteria	Aimed to target lower income sections	1 RK and 1 BHK constructed exclusively for lower income sections are also sold to higher income consumer profiles. Around 40% of rented units are owned by investors and higher income groups and the same are rented out for poor.
Carpet area	27.7 sq.m	27.7 sq.m
Financial share	Total price of unit	Total price of unit
Property rights	owned by beneficiary	Owned by consumer who purchased.
Occupied to constructed percentage	Anticipated 100% occupancy	Only 70% occupied at site level (primary survey).
Challenge	Lower income housing units owned by high income group resulting artificial shortage of supply for poor	



Figure 2: Private Housing Model

views and satisfaction of current beneficiaries/residents helped in knowing the preferences and issues related to models leading to uncertain outcomes. Firstly, reasons to shift to current allotted or chosen location is assessed. Secondly, percentage households planning to shift is measured.

From the semi structured interviews conducted at household level, the beneficiaries under rehabilitation model shifted to allotted DU due to lack of choice (see Figure3). Whereas, the preference to purchase the unit in private model is largely due to location followed by availability of cheaper house with respect to services offered. Incase of subsidized model, the approach of BSUP by AUDA stood peculiar. Even being draw system, if at all not satisfied with the allotment, an individual can withdraw from registration.

From figure 4, large share of beneficiaries in rehabilitation and subsidized model want to shift from allotted location after issuance of property rights . The case of Rehabilitation model in Ahmedabad showcases 100% chances of intended beneficiaries to leave the allotted units. This evidently illustrate the argument made by De Soto(2000) on importance of tenure security and legality among lower income sections for improved housing conditions. In the private model, in a period of 5 to 10 years, percentage of households shifting is recorded the maximum .

The major issues leading the residents to vacate the allotted units in

the Rehabilitation model is the dissatisfaction rate of beneficiaries due to loss of employment followed by poor infrastructure (Figure 5). Interestingly, even though started five years ago, weaker community relations still exist and are reported one of the reasons for dissatisfaction among the residents. Due to this, the beneficiaries could neither develop good community relations nor create new means of livelihood by promoting community relationships. The social relations also led to ineffective functioning of Resident Welfare Association (RWA) which ended in least maintenance of neighborhood.

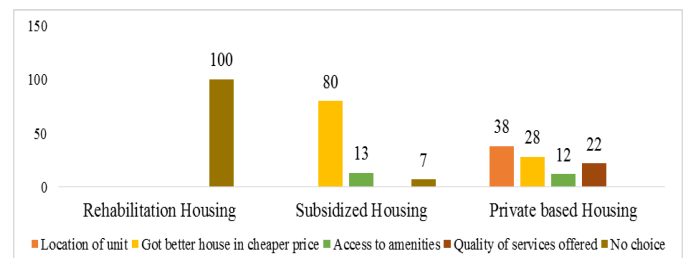


Figure 3: Reasons for shifting to current location

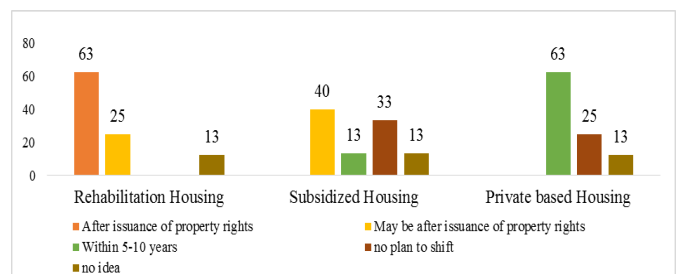


Figure 4: Percentage of Households planning to shift

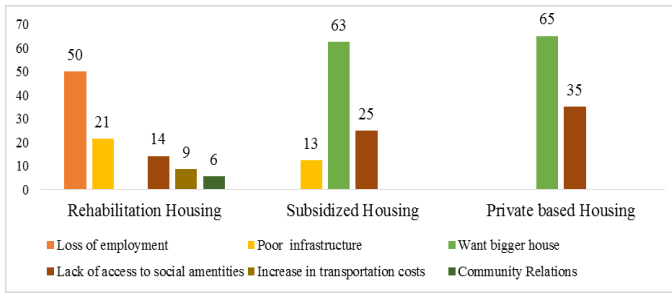


Figure 5: Reasons to shift from current location

Fascinatingly, the reasons in other models are majorly the need of bigger house. The statistics clearly shows despite beneficiaries planning to shift, the reason behind subsidized model and private approach are due to improvement in quality of life of household. Whereas, on the other hand, the rehabilitation model catering to beneficiaries with similar eligibility criteria failed in fulfilling the satisfaction of users. The same is the reason reported in private based housing, where the increase in vertical growth of household led to preference for a bigger house. But the lack of social amenities especially higher educational facilities are also the reason for shifting in private based model.

From the reasons to shift from current location, the level of quality from site survey are detailed out in the Table 4 in a Likert scale of 4.

5. Results and Discussions

The three unique challenges identified in the initial stages of paper are discussed by relating to the results from analysis and to the interviews of the officials interviewed during primary survey. Albeit the objective to address the challenges causing inability to sustain the outreach being the same, distinct approach of three models in supply of units addressed

distinct challenges with varied issues in the ground reality.

- (a) Lower occupancy ratio and risk of impoverishment leading for permanent vacation of sites in Rehabilitation housing.

The failure of rehabilitation are caused because of the imprudent attempts which largely ‘resettled rather than rehabilitated’ the slum dwellers. In the due process, the risk of impoverishment increased among the residents with lack of access to employment opportunities and urban services. This further created a tendency for the displaced to leave the allotted location and return back to the squatter settlements after receiving the tenure status This process of leaving the allotted units vacant or purposeless are resulting in low occupancy ratio of Rehabilitation sites which has also been shown by Patel in case of Ahmedabad (Patel et al., 2015). Research on resettlement of slum dwellers by Patel (2014) showcases that slum dwellers resettled on-site were substantially less impoverished than those resettled off-site. “Despite a large body of evidence on the impoverishment of displacees, there was little in BSUP policy that specifically acknowledged or targeted the various components of impoverishment” (Patel, 2014). Unless the problem is resolved at grass root level, the efforts of building low income housing will never end and the process remains futile by summing vacant deprived housing units in the city.

- (b) Presence of high rental component against policy guidelines in Subsidized Housing (BSUP by AUDA).

If the impending impoverishment was the reason for not occupying the allotted unit by the beneficiary in the rehabilitation model, the vertical growth and lack of incremental addition opportunity in the unit design (desire for bigger house) was the reason for the renting out of the allotted unit by beneficiary in the subsidized model. This explicitly shows that there is definite improvement in quality of life of allotted residents leading them to desire for bigger house. On brighter side improvement in quality of life indicates the success of model but on darker side the reluctance to leave the property rights is tending the

Table 4: Assessment of satisfaction rate of each model

Models	Rehabilitation housing	Subsidized Housing	Private based Housing
Approach	BSUP by AMC	BSUP by AUDA	Private developer
Choice of Location	Poor	Average	Good
Infrastructure			
Drinking water facility	Bad	Average	Good
Waste management	Very bad	Average	good
Sewage	Average	Good	Good
Power	Good	Good	Good
Housing condition	Bad	Average	Good
Overall quality of services	Bad	Average	Good
Access to social amenities			
Public transport	Within 1KM	Within 1KM	Within 2KM
Primary or secondary school	Within 2KM	Within 3KM	Within 3KM
Hospital	More than 3KM	More than 3KM	Within 3KM
Overall access to amenities	Average	Average	Average
Access to employment opportunities	Very Bad (immensely not satisfied)	Average (satisfied)	Good (Located in periphery but presence of Industrial estates satisfies the users)
Community Relations	Very bad	Good	Good
Community Maintenance	Bad	Average	Good
Overall performance of model	Bad	Average	Good

allottees to undergo malpractices and rent the allotted unit to ineligible user. The interesting fact emerging from our research is that the allotted households in the site are earning an average monthly income between INR 20,000 to INR 25,000 whereas the same for of the tenants is an average of INR 30,000 per month. When enquired regarding the profile of owners who rented out the allotted units RWA chairman's response was, "largely the income of families who were allotted are able to afford far better house in the city than the allotted unit". This indicates that either malpractice of allowing higher income group in the allotment process by the authority or an improvement in quality of life of the households post occupancy leading to the allottees rent it out to non-beneficiaries must have occurred. To support the former argument, tenants were questioned about the identity of the original allottees or the formal owners. But the responders were highly reluctant to disclose indicating malpractice. Whatever being the issue the challenge of high rental stock against policy guidelines is the same. The subsidized housing model case of Ahmedabad is a clear example where the authority accomplished to moderately satisfy the needs of beneficiaries but, improper post occupancy vigilance led the beneficiaries to rent out the unit to the unintended beneficiaries, altering the desired purpose of model.

- (c) Speculative investments of higher income group in lower housing units creating artificial shortage of supply for poor in Private / Markets based housing model.

In a free market tussle, highest bidder is always the winner. This behavioral biases of investors largely cause speculative investments in private model. From the primary survey, higher rate of satisfaction towards quality of services is noticed from end users in private model. Despite this, only around 70% of occupancy is recorded in private housing and also the share of lower income groups residing is less. Inhere also, in addition to interviews of residents, the RWA chairperson and committee members were also interviewed. The interviews revealed that one in fifteen units of 1RK and 1BHK were used for non-

residential purposes like household industries, commercial use, office use etc. And in the total units, a substantial 40% units are owned by investors/developers themselves and rented for low income sections. To answer where it went wrong, the geographical locations of private projects are firstly identified. Being located in the periphery of city, with high transportation costs, lower income households are reluctant to purchase the housing unit by markets unless and until they are working in the nearby locality.

One of the astonishing fact evident in Private based housing and not evident in other models, was backing out form purchase. About 43% of total clients backed out from purchasing unit after initial booking due to inability to afford down payment (GRIHAPravesh, 2015). In all the three models, the income affordability as stated by Gan and Hill (2008) as house price to income ratio is within the Indian affordable housing standards, which is 4 as per Task force (MHUPA, 2012b). But the purchase affordability, households gathering enough funds to purchase house (Gan and Hill, 2008) is not met in case of Private housing. The other finding (GRIHA Pravesh, 2015) is that a household earning monthly income less than INR10,000 cannot meet repayment affordability.

Firstly, the geographical locations are confining the options of purchasing house for poor in private model. Secondly, the low purchase affordability of the clients are leading the stock to lie vacant and owned by investors themselves. And in due process, with increase in urban sprawl, the demand of sites in periphery increases leading the poor then to rent the house since by then, the prices would have skyrocketed for urban poor to purchase.

One of the major reasons for large extent of demand-supply gap is the inability to purchase the unit which is also called the affordability level. And affordability is directly associated with the income levels of buyer. Even though large demand is to be met in lower sections of society, unless and until there is enough purchasing power ability, the supply

Table 5: Overview of Post occupancy challenges in different models

Model	Sub-Category	Problems in post-end occupancy from user perspective	Challenges	Suggested Measures
Public Undertaking	Rehabilitation Model	Loss of Employment	Lower occupancy ratio and risk of impoverishment leading for permanent vacancy of units.	Involving the PAP's in decision making, ensuring adequate urban services within accessible limits through community participation or PPP and constant scrutiny of formal sector in the post occupancy stage to curb hidden transactions and corrupt practices
		Lack of access to social amenities (education or health)		
		Poor quality of services		
		Increase in Transportation costs		
		Community Relations		
Private undertaking	Market based approach	Want bigger house	Presence of high share of rental component	Ensuring adequate urban services within accessible limits through community participation or PPP and constant scrutiny of formal sector in the post occupancy stage to curb hidden transactions and corrupt practices
		Lack of access to social amenities (education or health)		
		Poor quality of services		
		Geographical location-located in periphery of city		
		Inability to afford down payment		

side bar always remains low.

Table 5 showcases the measures to overcome the challenges leading for inability to sustain effective outreach to intended beneficiaries.

6. Conclusions and Recommendations

One of the major reasons for unending housing shortage in Indian housing market is the inability to forecast the uncertain challenges of formulated policies or projects. Certainly, even living in an orderly development, it is never easy to predict the uncertain outcomes. But exclusion of beneficiaries in crucial stage of planning process, relocation process, will never result in planned and desired outputs for them. Since it was never intentionally planned for them, rather in the name of social cause and development, they are forcefully relocated in distress. The best example is showcased in the paper under Rehabilitation model, where the beneficiaries, are ready to leave the allotted site and move back to slums, after the issuance of property rights. All these imprudent efforts by authority will never suffice the problem of homeless but rather worsen the urban fabric more with squatter settlements on one hand and old deteriorated buildings lying vacant on the other hand. To achieve end user satisfaction and to mitigate the risk of impoverishment, government must thoughtfully prevent the problem in the initial levels of allotment by ensuring adequate socio-economic facilities in the locality. To fulfil a basic need of millions, aspirations associated with challenges and opportunities of key market players are utmost necessary. Housing supply responsiveness for lower income sections can be improved by active participation of them in decision making process right from formulation to design, implementation and post occupancy.

However offering better quality of service is not sufficient to ensure sustained outreach as evidently seen in government subsidized model. Despite low satisfaction rate with quality of services, large share of responses showcased improved quality of life compared to previous location. But on darker side, the improvement in quality of life also leads to renting out by the allottees against the policy guidelines. This shows, ensuring adequate services is not the alone measure to curb the problem, but for sustaining the targeted outreach, proper post occupancy measures with constant vigilance are mandatory to curb hidden transactions and corrupt practices.

With pride of ownership and fulfilling dreams of lower income sections, private based model proved better performance rate than the other two. But the longer commuting cost and higher cost of living are pulling the large sections of poor from purchasing house under private model, despite evidence of improved quality of life of existing users. Curbing the challenge of speculative investments is a difficult but imperative task. But government support in obtaining developable land for markets can improve the results since, land cost contributes highest to the total price of unit in private model. This can improve the purchasing affordability and with access to developable land, beneficiary or user can minimize the transportation costs. Apart from public private partnerships, the lack of awareness regarding private projects is also major cause for it to lag behind. Market tie up with not for profit organizations like GRIHA Pravesh or NGOs can create awareness of the potentials of model to intended beneficiaries.

The efforts of housing models for poor with skyrocketed urban land prices, long approval process takes ages to resolve the problem of housing shortage in developing nations. And with urbanization trends, affordable housing will indeed become a serious issue and will continue to plague the lower income sections. The efforts for sustaining the targeted outreach can improve the results and can minimize the shortage

effectively. Such attempts for sustaining the positive results need a thoughtful approach, rather than naïve optimism. In addition to foreseen challenges, one must be open to the possibility of uncertain challenges before formulating any policies or projects. Then only, envisaged growth can be sustained socially and economically.

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Light Pipe Transporter for High-rise Office Building in Tropical Climate

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ABSTRACT

Daylight has known to bring benefits for human, psychologically and physiologically. It also provides better indoor environment quality and thus increase the performance and productivity of office workers as stated by Paevere (2009). However, due to economic reasons, the current practice of using deep open plan building has cause a dent to having daylight in the interior spaces, which cause a dependency on artificial lighting. Hence, to provide daylight in deep interior, light distribution system is needed. Although so, according to Hansen (2003), most of the systems can only illuminate up to 8m-10m depth. Therefore, light pipe (LP) plays an essential role where it can illuminate up to 20m depth. LP's efficiency depends on the 3 main components; collector, transporter and extractor. This research explores the effectiveness of horizontal LP through different type of transporter's shapes which includes rectangular, triangular, square and semi-circle. Previous studies have shown differences of efficiency on the shaped while using vertical LP. This research's analysis was done using a computer simulation, Integrated Environment Solution: Virtual Environment (IESVE), where DF of each shapes were compared to MS 1525:2007 benchmark. The viability of the software was also validated through an assessment with a physical scaled-model experiment that was conducted in an open car park in Universiti Teknologi Malaysia, Johor, Malaysia. The results from the simulation showed that semi-circle shaped transporter offered the same efficiency as rectangular shaped. These findings will promote the usage of LP in buildings as it decreases the costing for LP.

1. Introduction

The current rise of numbers in deep plan building has brought to an abandoning of daylighting which cause a dependency on artificial lighting. This is due to the profitable utilization of space in the office building where more usable area can be achieved by using open plan building. Though economically it brings revenue to the company, the negative impact of the absent of daylighting may dampen it. Paevere (2009) stated that daylight brings psychological and physiological benefits to human and thus, providing better indoor environment quality. Office workers under such surroundings will have better work performance and productivity that will boost the company's income.

Studies have been done on several system to bring in daylight to the interior through reflection, refraction or deflection. Such system are like louvres, blinds, holographic optical elements, light shelf, *anidolic* ceiling, *anidolic* zenithal opening and venetian blinds. However, Hansen et al. (2003) pointed out that these devices can only illuminate a room up to 8m to 10m depth, hence, unable to accommodate the deeper spaces. Therefore, light pipe (LP), which is able to bring daylight into more than 10m comes into the picture (Whitehead et al., 1987; Aizenburg et al., 1997; Hansen et al., 2001). The LP consists of 3 main parts, collector, transporter and extractor. These parts are essential to as they affect the ability of the LP to transport the light.

This research focuses on using LP as a mean to bring daylight into the interior. It emphasize on the performance of the LP in terms of quantity, rather than quality and is carried out using both scaled modelling and computer simulation method to acquire and evaluate the LP's performance in deep plan building.

2. Light Pipe

Reflectivity plays an essential role in designing a LP where a drop of 1% in reflectivity will cause the efficiency to decrease by 20% (3M, 2008). Hence, it is rational to use the best reflectivity rating of 99% in the LP. Due to this reason, there is a need to look at other aspect to develop the performance of LP; the surface area that reflects the light. The theory of reflection shows that, the larger the surface area is, the more light that can be bounced from the surface. Consequently, to achieve a larger area in a surface, modification of the LP has to be done at the largest percentage that reflects the light, which is the transporter (Figure 1).

Edmunds (2010) had done testing the effect of several shapes of transporter to LP. The shapes includes rectangular, rhombic, isosceles and equilateral triangular, circle. Although so, these research have only been conducted to a vertical LP. The difference in both type of LP are shown in Table 1.

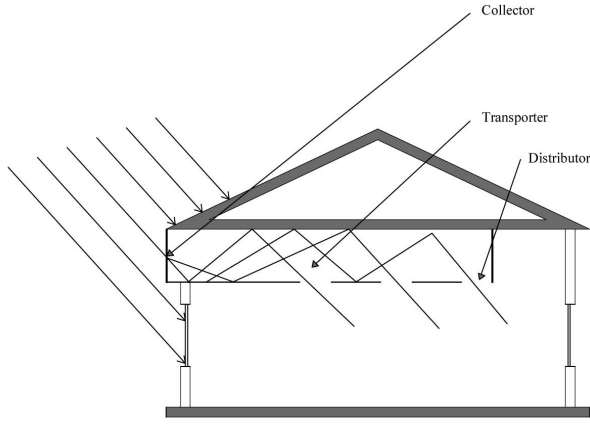


Figure 1: Components of the light pipe

Table 1: Comparison of horizontal and vertical LP.

Criteria	Typology	Vertical Light Pipe	Horizontal Light Pipe
View of sunlight		Whole day long (in a clear sky condition)	Only a few hours of a day
Ways of extraction		Colored rings, dyes	Laser cut panels, openings
Footprint		Requires a large space penetrating through the interior.	Requires some space in the headroom.
Orientation dependability		No	Yes

Besides that, the collector and extraction point are also two of the main components in a LP. Previous studies have shown that Compound Parabolic Concentrator (CPC) performs the best at collimating daylight (Wittkopf et al., 2010). This was through a comparison of various collector design, ranging from flat baffle collectors to *anidolic* collector system. Other than that, the extractor of LP comprises of a simple opening at the end of the transporter. Both these components are kept constant throughout the research.

3. Methodology

There are several methods used in the study of LP; full scale modelling experiment, scaled model experiment, mathematical calculations and computer software simulation. Although so, there are several limitations with each of the methods. A usage of full scale modelling method requires a large compound for the room to be built. Moreover, the construction costs and expertise in building a LP require a high budget allocation for the research to commence. While a scaled model may offer an alternative to lower the costing, it has certain drawback as well. Thanachareonkit et al. (2005) suggested that the results from scale modelling were generally higher than the actual readings. The discrepancy may range from 20% to 105% as stated by Cannon-Brookes (1997) and Thanachareonkit et al. (2005). The error can be minimized by exerting consideration on the model's geometrical shape and the surface reflectance (Freewan et al., 2008; Thanachareonkit et al., 2010). Other than that, mathematical calculations has a disadvantage of having theoretical data where some may differ from the real results. It also

needs a vast knowledge in the field of mathematics and physics. Another method often used in LP research is computer software simulation. There are a lot of software available which are suitable for different studies. Lim (2010) had made a comparison on various software and suggested that among those viable choices for daylighting study are Desktop Radiance, Velux Daylight Visualizer and Integrated Environmental Solutions: Virtual Environment (IESVE).

Therefore, this study employs computer simulation using Integrated Environmental Solutions: Virtual Environment (IESVE) as the main methodology in assessing the LP's performance. It uses Radiance-based engine to simulate an environment where ray-tracing calculation process will give the desired daylighting result. It also takes into consideration of distribution of emitted rays, reflection, transmission and refraction of surfaces. Moreover, based on IES Virtual Environment & Compliance with ASHRAE 90.1 (2014), rating authority has approved the climatic hourly data file of ASHRAE 90.1, which is used in IESVE.

Radiance, which is the running engine for daylighting module in IESVE, uses CIE skies model or local data input to generate the global and outdoor illuminance. Although so, these sky models behaves differently from the tropical sky (Lim et al., 2012; Shen et al., 2013). Therefore, simulating a tropical sky condition in computer software simulation is challenging due to its vast variety and ever-changing sky condition. Thus, to validate the results of the simulation, a physical scaled model experiment is carried out. Previous studies have shown that scaled mode has the ability to produce the daylight performance and accuracy of a full-scale building under actual sky condition after considering certain criteria (Ander, 2003; Baker et al., 1993; Cheng et al., 2007; Chou, 2004; Egan et al., 2002; Freewan et al., 2008; Freewan et al., 2009; Kim et al., 2011; Robbins, 1986). Furthermore, the validation process eliminates the results' inconsistency of scale modelling as explained by Thanachareonkit et al. (2005).

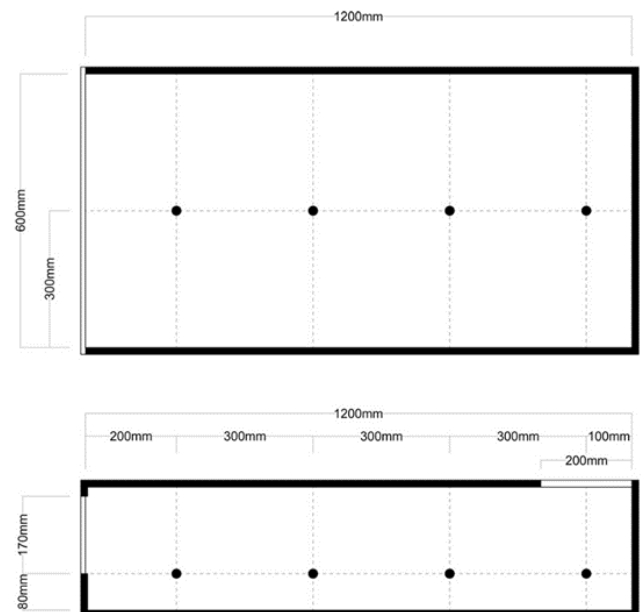


Figure 2: Test model room configuration

3.1 Validation

A scaled model room (Figure 2) comprising the size of 1200mm (depth) x 600mm (width) x 270mm (height) in the scale of 1:10 was used throughout the research. It has an opening with window to wall ratio (WWR) of 0.59, where an average WWR of office buildings in Malaysia is 0.5 – 0.6 as identified by Lim (2010) and Dahlan et al. (2009). The interior wall and ceiling surfaces for the room has a reflectance of 55% while the floor has a reflectance of 30%. Besides that, the interior surface for the LP, mainly the collector and the transporter, have been layered with an aluminum sheet that has 70% of reflectance.

The model was placed in an open car park in Universiti Teknologi Malaysia, Johor, Malaysia (latitude of 1o 3' N and longitude of 103o 37' E). The unobstructed area ensured no interference with shading from adjacent building or vegetation as that would interfere the result of the experiment. The opening of the model was orientated towards South due to the location of the site which is located above the Equator of the earth. This enabled the model to gather the most daylight throughout the whole day, which was from 9am until 3pm with regards to the typical office operating hours. The experiment was conducted for two days; 18th August 2015 and 31st August 2015 to ensure the feasibility of the experiment results.

Besides that, four probes (Delta Ohm's LP 471 PHOT) were placed inside the model to measure the illuminance level with a distance of 300mm from one another as shown in Figure 3. For measuring the outdoor illuminance, Delta Ohm's LP PHOT 02 was used. The readings were taken and recorded with a data logger (Delta Ohm's Data-Logger DO 9847) for every hour while interchanging between three variables; base case, rectangular LP and triangular LP.

Computer simulations were then done to validate the feasibility of the software using two statistical analysis; Pearson Correlation and paired T-

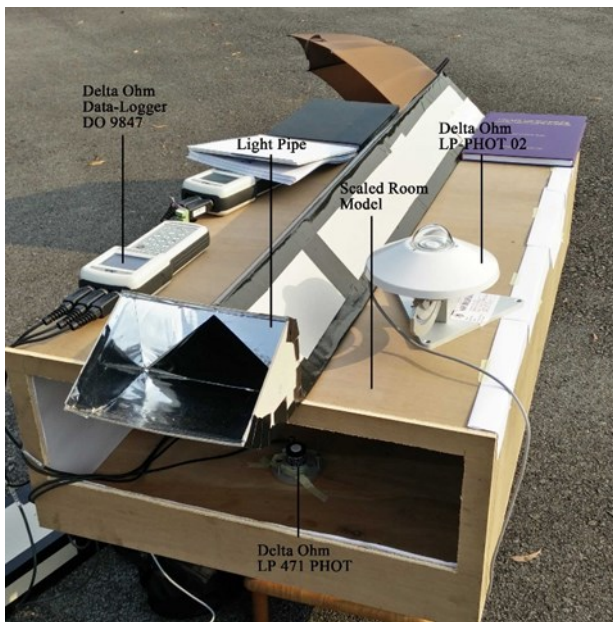


Figure 3: Instrumentation of experiment on the LP and physical scaled model.

$$\text{Daylight Ratio (DR)} = \frac{\text{Indoor illuminance}}{\text{Outdoor illuminance}} \times 100\% \quad (\text{Equation 1})$$

test. All the configuration of the simulation used the same properties as the scaled model.

3.2 Criteria of Analysis

The results from both the experiment and simulation were then converted into daylight ratio (DR) to assess the performance of the LP with Equation 1.

DR is used to determine the ratio between indoor Work Plane Illuminance and outdoor illuminance level. Based on the idea of Dahlan et al. (2009), it is a viable method that can be used only by the regions near the equator. Moreover, it is applied in tropical daylighting study as the absolute value of the illuminance will have constant changes in a short period of time. The DR was used as a measuring stick for both the validation process and the simulation of 5 different LP.

Other than that, daylight factor (DF) was used to determine the performance of the LP in the worst possible condition, which is the overcast sky. Equation 2 exhibits the formula used to obtain DF level where the indoor and outdoor illuminance will be attained in overcast sky condition setting. The DF were then being compared to the Malaysia Standard 1525: 2014 on the feasibility of the DF level for human's usage in the office as shown in Table 2. It proposed a range of 1.0-3.5% for an acceptable range for lighting, glare and thermal comfort. Readings above 6% is deemed as intolerable and uncomfortable for the three criteria. The DF was used only for assessing the IESVE's simulated results of the LP.

3.3 Computer Simulation Setup

For this study, 5 LP's transporter shapes were simulated using IESVE. These shapes are rectangular (LP1), triangular 45o (LP2), triangular 60o (LP3), square (LP4) and semi-circle (LP5) as shown in Figure 4.

$$\text{Daylight Factor (DF)} = \frac{\text{Indoor illuminance}}{\text{Outdoor illuminance}} \times 100\% \quad (\text{Equation 2})$$

Table 2: Performance indicators considered and interpretation.

Performance indicator	Interpretation		
	Lighting	Glare	Thermal Comfort
Daylight Factor < 1.0	Perceptible	Imperceptible	Acceptable
1.0 - 3.5	Acceptable	Acceptable	Acceptable
3.5 - 6.0	Tolerable	Uncomfortable	Tolerable
> 6.0	Intolerable	Intolerable	Uncomfortable

Table 3: Internal surfaces reflectance of simulation model in IESVE.

Element	Reflectance	Specularity	Roughness	Visible Transmittance
Wall	0.70	0.03	0.03	N/A
Floor	0.20	0.03	0.20	N/A
Ceiling	0.80	0.03	0.03	N/A
Light Pipe	0.99	0.05	0.03	N/A
Glazing	N/A	N/A	N/A	0.75

The width of all the transporters are 2m except for the 60o triangle and the height are 1m. The length of the transporters spanned through the 12m depth of the office room. The room model has the same dimensions as the scaled model, which represented an office room. The reflectance, specularity and roughness of the wall, ceiling and floor used in IESVE are shown in Table 3. The glazing that occupied the opening of the room has a visible transmittance of 0.75%. All the properties of the components were constant throughout the simulation.

The simulation in IESVE consisted of three timing for each LP, as shown in Table 4, for the designated days throughout the year which are 21st March, 22nd June and 22nd December; 0900h, 1200h and 1500h. These represent the different critical angles of the Sun in tropical region. The results for 21st September was not simulated as the Sun angle was the same as 21st March where the Sun is directly on top at noon time. Besides that, an overcast sky condition which is set to 10k lux was used to assess the worst case scenario for the LP.

3.4 Validation Results

Table 5 shows the Pearson correlation and paired T-test between the results of simulation and both dates of experiments. For each sets of data, there were 84 readings taken. When compared to 18th August 2015, the Pearson correlation test gives a value of 0.9170, while for the later date, it was 0.9544. This shows the data obtained from the simulation software were reliable as the values were near to 1. Meanwhile, for the paired T-test, the results shows that the mean difference between both respective dates and IESVE are in between 0.2731 to 0.5591 for the former and the latter is 0.3991 to 0.6518.

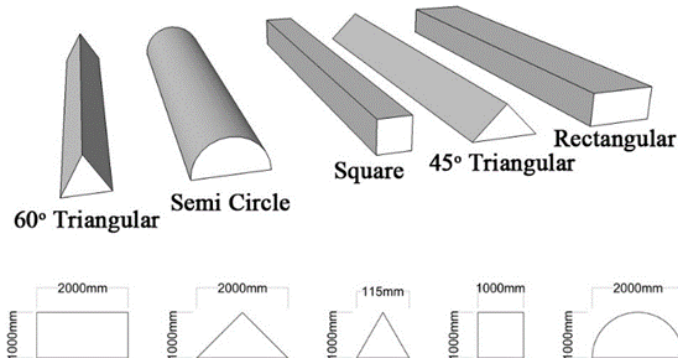


Figure 4: LP transporter's shapes and dimensions. From the left: Rectangular (LP 1), Triangle 45° (LP 2), Triangle 60° (LP 3), Square (LP4) and Semi circle (LP5).

Table 4: Days and hours studies

LP's Shape	Transporter	CIE Intermediate Sky with					CIE Over-cast Sky
		2	1	2	2	22	
		March		June		December	
Base Case							
LP1 Rectangular		0900h					One Hour
LP2 Triangular 45°		1200h					(10 000 lux)
LP3 Triangular 60°		1500h					
LP4 Square							
LP5 Semi Circle							

Hence, there's only slight deviation between the simulation and experiment data.

A comparison of DR of all the three sets of data are shown in Figure 5. The IESVE's results consistently showed the lowest among the three except for 0900 hours and 1000 hours. This outcome coincides with the study done by Thanachareonkit et al. (2005) where the scale modelling experiment's data will exceed the actual reading. Besides that, although there were larger differences between 1200 hours and 1400 hours, the DR values from IESVE were similar to both the experimental results. Therefore, IESVE is a viable simulation software for the conduction of this study.

4. Results and Analysis

4.1 Daylight ratio

Figure 6, 7 and 8 show the DR on 21 March, 22 June and 22 December for 0900 hours, 1200 hours and 1500 hours respectively for 6 cases of transporter shapes which were simulated thorough IESVE. The DR of all the cases at different dates hit the highest point at 0900 hours followed by 1500 hours and 1200 hours. Due to the sun path angle in the tropics, the readings in 22 June show the lowest DR among the three timing where the sun shines directly on top of the model. In contrast, the high angle of sun path in both the other two timing causes the sunlight to penetrate more into the room and thus, resulting in higher DR. All the results also demonstrate a drastic drop between the first meter which is the nearest to the window and the 4m region.

Besides that, out of all the 9 timing, Base Case generally showed the highest DR for all the three dates in the region of 1-4m and the use of LP lower the DR with the value at the first point of 21.36%, 6.19% and 9.68% on 21 March, 15.45%, 6.13% and 8.62% on 22 June and 14.38%, 17.20% and 21.34% on 22 December. The second and third highest DR is shown by LP 3 and LP 4. On the other hand, LP5 has the

Table 5: Results of Pearson Correlation and paired T-test

Date	N	Pearson Correlation	Paired T-Test	
			Lower Level	Upper Level
18 th August 2015	84	0.9170	0.2731	0.5591
31 st August 2015	84	0.9544	0.3991	0.6518

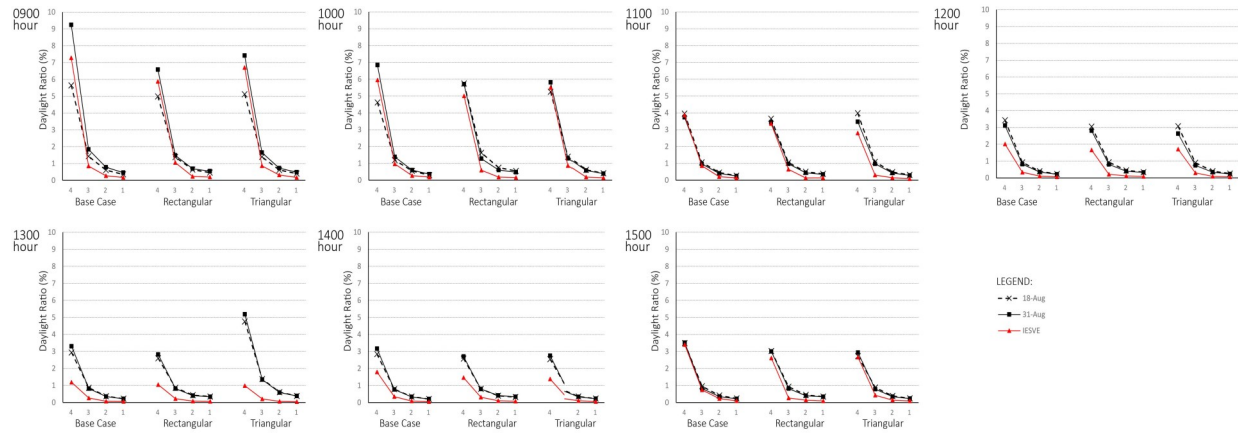


Figure 5: Daylight Ratio comparison of experiment and simulation

lowest DR in the stated region especially on 21 March (0900 and 1200 hours), 22 June (1500 hours) and 22 December (1200 hours) with the DR of 15.77%, 3.65%, 5.73% and 10.50% respectively. LP 2 has the lowest DR with 11.48% (0900 hours, 22 June), 68.31% (0900 hours, 22 December) while LP 1 has the lowest with 6.04% (1500 hours, 21 March), 3.95% (1200 hours, 22 June) and 14.91% (1500 hours, 22 December).

As for the 8m to 11m region which is located at the deepest end of the room, LP 5 is able to increase the DR of Base Case (at least two of the four deepest point in the room) for all the 9 timing except 1500 hours on 22 December. Furthermore, on 21 March (1200 hours), 22 June (0900, 1200 and 1500 hours) and 22 December (0900 hours), LP 5 has performed better for all the four points. Based on the three dates, the improvement of DR for the furthest point in the room (11m point) are 0.13%, 0.32%, 0.14, 0.20% and 0.61% compared to 0.10%, .027%, 0.11%, 0.15% and .051%. LP 2 on the other hand, is able to increase the DR for all the simulated timing. Therefore, it is one of the best performing LP. The third best performing LP is LP 1. With the same measuring stick used, it

increases the DR of Base Case on 4 occasions throughout the simulation, where the DR achieved at 11m point are 0.11% (1200 hours, 21 March), 0.24% (0900 hours, 22 June), 0.11% (1200 hours, 22 June) and 0.14 (1500 hours, 22 June).

In the month of March, the highest DR at 0900 hours was produced by the Base Case and followed by LP 4 with the value of 21.36% and 19.16%. These values was the point nearest to the window. The lowest DR seen at the same time was LP 5 with 15.77%. As the values deteriorated across the room, LP 5 produced the highest DR at the 11m point with 0.56%. LP 4 and LP 1, however, had the lowest DR with the percentage of 0.29 and 0.35. Besides that, at 1200 and 1500 hours, the same pattern were exhibited on the 1m point where Base Case and LP 4 had the highest DR. However, LP 5 and LP 1 showed the lowest value at the respective timing with DR of 3.65% and 6.04%. At the depth of 11m in the room, LP 5 remained the highest DR percentage with 0.13% and 0.21%.

Moving on to the date of 22 June, both the Base Case and LP 4 showed the highest DR at the three period of time at 1m point with DR of 15.45% and 13.77% in the morning, 6.13% and 5.12% in the afternoon

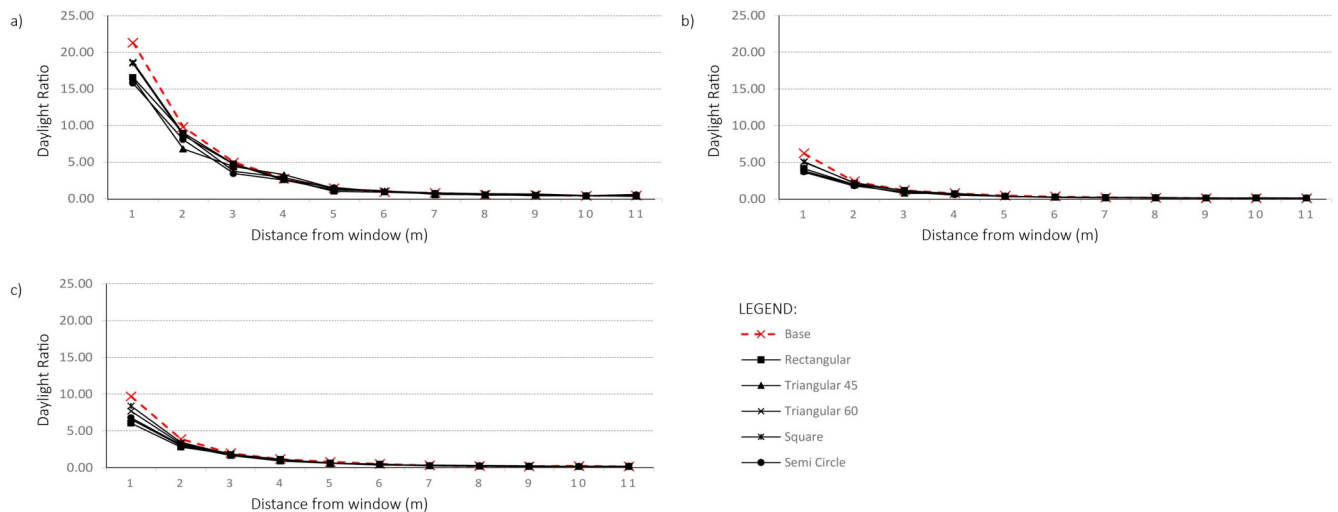


Figure 6: DR for 21 March at 0900, 1200 and 1500 hours

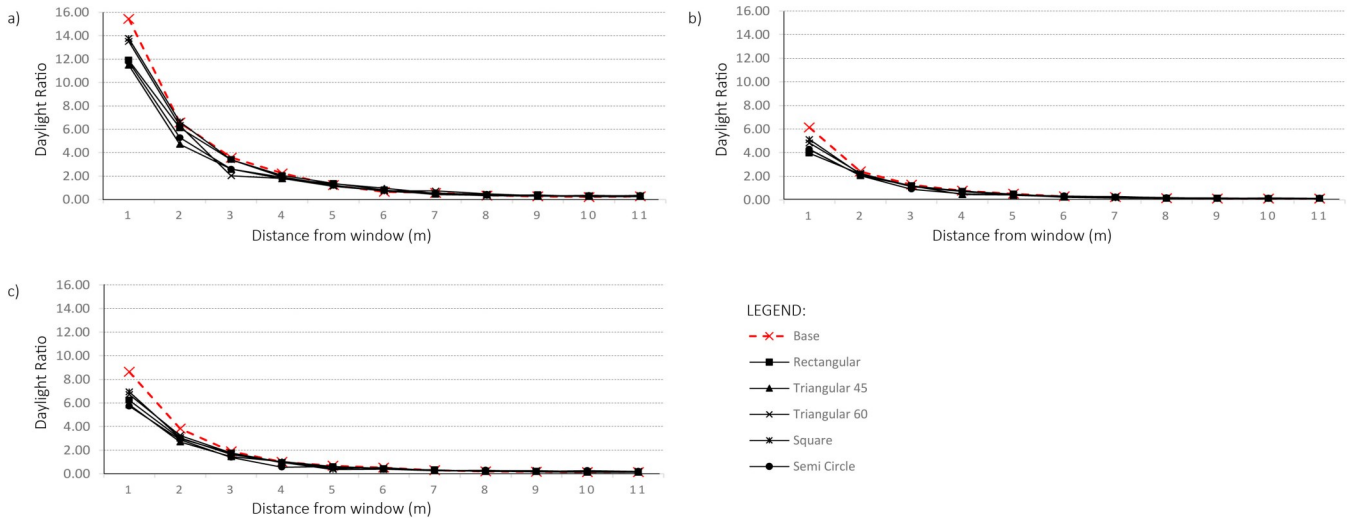


Figure 7: DR for 22 Jun at 0900, 1200 and 1500 hours

and 8.62% and 6.93% in the evening. As for the lowest DR, it was shown by LP 2 with 11.48% and trailed by LP 5 with 11.76% at 0900 hours. In the afternoon, LP 1 has the lowest DR with 3.95% whereas at 1500 hours, LP 5 had a DR of 5.73% while LP 2 came second with 5.85%. Meanwhile, the highest DR at the end of the room was displayed by LP 3 and LP 5 for all the three timing of the day with 0.35%, 0.14% and 0.20%. However, LP 4 had the same result in the afternoon with 0.14%. On the other hand, the lowest DR percentage were shown by LP 1 at all times.

Lastly, although there was a huge hike of DR value on 22 December, the highest DR at 1m point was shown by Base Case with 75.68% in the morning, 17.20% in the afternoon and 21.34% in the evening. The second highest DR were LP 3 at 0900 hours (72.32 %) and 1500 hours (18.28 %) and LP 4 at 1200 hours (14.84%). LP 2 has the lowest DR at 0900 hours with 68.31% while at 1200 and 1500 hours, LP 5 and LP 1

scored the lowest DR with 10.50% and 14.91%. LP 2 continued to possess the highest DR at the 11m point with 0.68% 0900 hours. The highest DR at 1200 and 1500 hours was LP 5 and LP 3 with 0.37% and 0.52%.

4.2 Daylight Factor

To take things to an extreme, an overcast sky condition was used in the simulation to evaluate the performance of the LP under the worst case scenario. The average DF for all the LP's transporter cases are shown in Figure 9. It also shows that in all the cases, the average DF falls under the category of tolerable lighting, uncomfortable glare and having tolerable thermal comfort, which is according to MS 1525:2014. LP 2 and LP 5 (DF 3.55% and 3.59%) came the closest case to comply with the standard level of DF that is in between 1.0% to 3.5%, followed by LP 1, LP 3 and LP 4 with DF of 3.67%, 3.98%

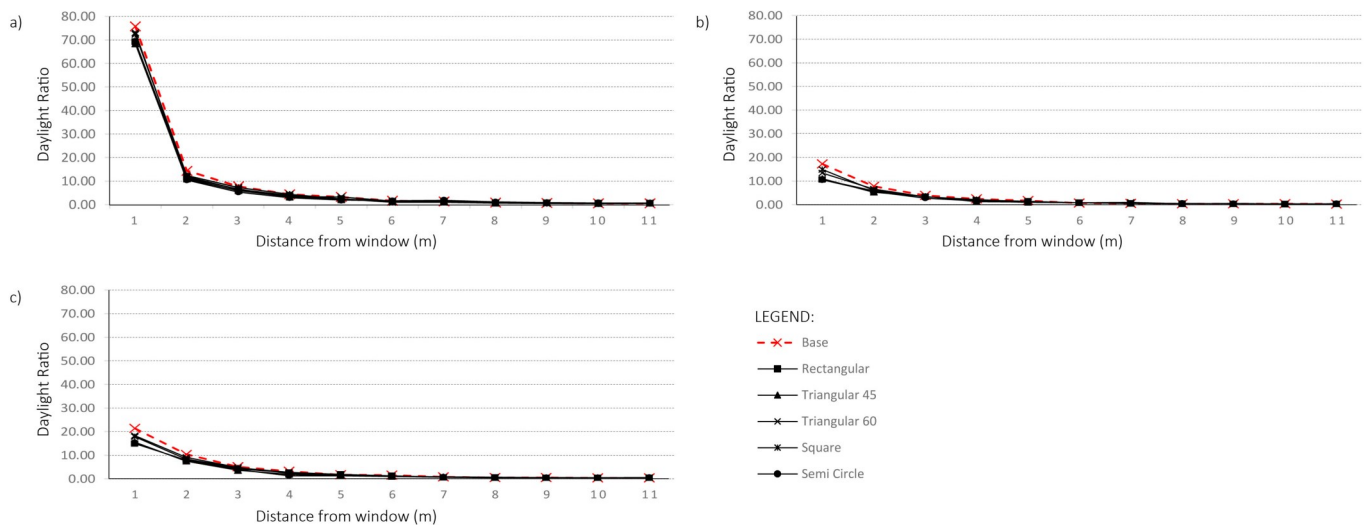


Figure 8: DR for 22 Dec at 0900, 1200 and 1500 hours

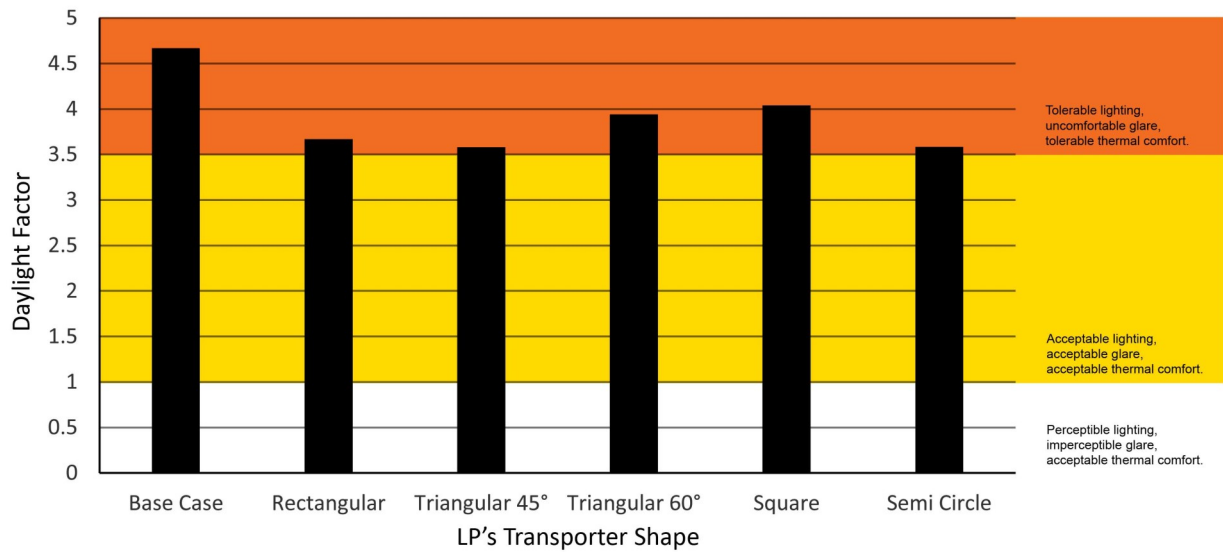


Figure 9: Daylight Factor for different light pipe's transporter shape

and 4.04% respectively. Therefore, all the cases with LP improves the DF of the base case (4.67%).

5. Discussion

Previous studies have been done on a number of shapes for vertical LP. However, it is not feasible to be implemented in a high-rise building due to the space limitation and the height of the building. Hence, this research focuses on the performance of horizontal LP when it is employed in a deep plan high-rise office. The impact of five shapes of LP's transporters was investigated using the simulation program IESVE.

As a general observation, the horizontal LP decreases the quantity of daylight in the area nearest to the window as the LP's collector provides shading for the room. This was more evident as the low Sun angle in 22 December caused bright sunlight patches on the work plane and walls. Moreover, in that period of time, the illumination in the room was significantly higher than the other two period of time where the difference in the morning was 72% when comparing to 21 March and 80% on 22 June. Furthermore, the illumination across the room was more uniform at the 1200 and 1500 hours compared to the morning. Hence, there is a need for shading to prevent an over illuminated area at the space nearer to the window especially in the morning.

To further discuss the LP's shape performance, the following sections are divided into two categories; daylight ratio performance and daylight factor performance.

5.1 Daylight Ratio Performance

From the result of DR analysis, the worst case scenario of all the simulated period is on 22 June where the Sun shines directly above the building. This decreases the overall DR level in the whole room as the daylight reflects more times in the transporter before entering the room, which caused the loss of light intensity. Films which has high

reflective surface can be used in the transporter as to reflect the daylight to prevent this dampening effect.

The percentage difference of DR when comparing to Base Case ranged from -1% to -50%. Therefore, the LP helped in increasing the uniformity of the space. Furthermore, LP 1, LP 2 and LP 5 showed significant improvements to the Base Case as they increase the DR up to a maximum 42% at the innermost area of the 12m depth room. Therefore, the three shapes; rectangle, 45° triangle and semi-circle, provided a potential reflection surfaces for the LP's transporter.

In a contrary, LP 3 and LP 4 showed low potential for a good LP shape. These cases failed to produce a good uniformity along the work plane as they unsuccessfully blocked the direct sunlight near the window and created low illuminance at the back of the room. Moreover, the acute angle of the 60° triangle and small cross section of the squared shaped transporter caused the ineffectiveness of those particular LP.

5.2 Daylight Factor Performance

Daylight Factor was used to further discussed on the performance of the LP. Based on the performance of every LP shapes, all the average DF falls under the category of 3.5-6% where the lighting and thermal comfort are still tolerable while having glare problems. This shows that on an overcast sky condition, the room will have excessive lighting throughout the space. Though, it should be noted that the average DF was taken into consideration rather than the value of each point in the room. Hence, with the evaluation on the DF performance, there might be areas which adhere to the acceptable MS 1525:2014 range.

All the LP cases were able to lower the DF value of the Base Case. The first cause for this occurrence are the shading provided by the collector of the LP. The collector acts as an overhang above the opening that prevent high intensity daylight from penetrating into the room. This also helps with in providing a uniform distribution in the office itself.

Secondly, the lowering of DF is caused by the application of LP. A rectangular, 45° triangular and semi-circle shaped transporters provide the almost optimum DF result and therefore, shows that the lighting in the end of the room though the opening of the transporter elevates the illuminance of that area. Thus, this also lead to a more uniform distribution all over the room.

5.3 Limitation and future research

This research used a computer software simulation and scale modelling experiment as tools for obtaining the results. These tools may give a quantitative picture of how the illuminance level of the office room will look like but it bears the limitation of the quantitative aspect of daylight. Moreover, as claimed by Veitch et al., (1995), lighting quality can only be assessed through behavioral pattern studies. This implied the significant of having surveys in achieving the optimum data for the study. However, other methods such as study of uniformity on work plane illuminance and glare analysis may also help to provide the data needed to give an estimation of the LP's potential.

Besides that, another limitation of this research was the room used was completely empty. The absence of furniture did not represent the reality of a utilized office and it also significantly affected the light levels of the room. There would be a reduction of illuminance level if furniture were present during the simulation process and it will give a better result to the DF performance.

Finally, this study employed only the South elevation for the simulation. A more thorough research on four orientations are needed to provide a full picture of the LP's performance. It can also determine which LP's shape corresponds to respective orientation to maximize the potential of the LP.

6. Conclusions and Recommendations

In conclusion, LP 1, LP 2 and LP 5 give an optimum design on an intermediate while LP 3 and LP 5 edged the rest in overcast sky condition. Consequently, a set of two shapes, 45° triangle (LP 2) and semi-circle (LP 5) provide alternatives to the conventional rectangular shaped transporter. The difference in surface area for each of the LP brings a potential of cost saving especially the usage of highly reflective films which are expensive in the market. This may encourage developers to incorporate the daylighting distribution system in their buildings as the current trend goes into the world of sustainability.

Besides that, the transporter shapes also give an opportunity to incorporate mechanical and electrical system into the negative space of the LP's transporter above the ceiling level and thus, promoting the usage of the daylight distribution system. Further studies are necessary to assess the qualitative performance, thermal and energy performance of the LP's shape to provide a clearer view on the feasibility of each shape as mentioned in the previous section. Moreover, studies on the daylight quality where glare and uniformity of the room can be improved by manipulating the extractor of the LP also can be done.

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An Approach to assess the Urban Management Performance of Municipalities in Sri Lanka

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ABSTRACT

Urbanization tends bring out a number of problems, such as inadequate housing and urban services, increase land prices and construction costs, propagation of slums, pollution and deterioration of the urban environment. Currently, spatial development activities focusing on major cities of Sri Lanka are demanding urban infrastructure and services where municipalities are facing challenges on provision of the infrastructure and proper urban management too. This study seeks to identify the relevant criteria, indicators and a method for assessing the urban management performance of municipalities in Sri Lanka since specific measurement criteria and related indicators are not yet identified to evaluate urban management by the central government or local government levels. Based on Literature review, five criteria and 25 indicators were selected considering their applicability for the context of Sri Lanka. The Full Permutation Polygon Synthetic Indicator Method (FPPSI) was applied to synthesize indicators and the Synthetic indicator has been used to show the performance of each criterion in terms of urban service delivery. Colombo Municipal Council (CMC), Sri Jayawardenapura Kotte Municipal Council (SJKMC) and Moratuwa Municipal Council (MMC) have been selected as the case studies for this research. Although selected cases are within Colombo Metropolitan Region, none of the municipalities were achieved the "High" or "Very High" level of synthetic indicator ($SR \geq 0.50$) that shows the standard of municipal service delivery of Sri Lanka as a whole. This research lays the platform to evaluate the functional performance of Municipal Councils to guide the future scenario and to make decisions at the grass root level for managing the urbanization related issues in the country. Also this research helps the government to know the current trends of development impact and to take necessary policy level decisions to guide the economic growth in a correct direction with the political manifestoes.

1. Introduction

Many authors have defined the process of urbanization in different ways and analyzed the urban management of both developing and developed countries. With the existing trend, developing countries face accelerated development and it's significant in South Asian context. Sri Lanka is one of the fastest growing nations in SAARC region. Current on-going development projects and spatial development focusing on cities such as Hambantota, Trincomalee, Colombo are demanding urban infrastructure and services where municipalities are facing challenges on provision of the infrastructure and its management aspect. Hence this study seeks to identify the relevant criteria, indicators and a method for assessing the urban management performance of municipalities in Sri Lanka and apply them in to three selected municipalities in Sri Lanka. There are number of criteria has been used by many professionals for assessing the urban management. However in Sri Lanka, there is no a specific criteria and indicators used to evaluate urban management by the central government or local government levels. The responsibility on urban management will not only lie upon central government, but on the bottom level organizations such as Municipal Councils, Urban Councils and Pradeshiya Sabhas. There are several key issues to

undertake such performance criteria such as lack of reliable and realistic data, lack of co-ordination between physical planning and financial planning authorities, division of powers and functions of urban management among central government and local governments and passing of responsibilities among different governmental agencies. In terms of Municipal Councils, the powers and functions have been clearly delegated from the laws, but poor management and lack of attention on performance evaluation is evident among such bodies.

2. Theoretical Background

2.1. Urbanization and Urban Management

It is suggested that from a city manager's perspective, urban management in developing countries must achieve two things. First, it must understand the nature of the urban environment it is dealing with. Secondly, it must organize the instruments of intervention in such a way that the institutions conducting urban management are in a fit state, organizationally and financially to do so (McGill, 2001). Thus,

urban management in developing countries is concerned both city building with its insatiable need for infrastructure and services and council building with its seemingly endless need for increased capacity to perform (McGill, 1995). Urban management is therefore considered to be conceptually holistic in its approach to towns and cities in developing countries. At its core, this study requires that urban issues and institutional responses be considered simultaneously to ensure integrated structure of urban management.

The urbanization related issues and the urban management approach of a developing country will vary with a developed country. Kotter (2008) argue that in developed countries, urbanization has mainly taken place in the second half of the 19th century. Developing countries are now in the middle of their urban growth. In Europe already 72% of the population lives in urban areas (UN, 2006). The urbanization process has come to stand still and a process of dis-urbanization and suburbanization caused by a high rate of motorization combined with prosperity and the development of traffic and communication infrastructure are noticeable. But in developing countries, high birthrate combined with an increasing migration from the rural areas is reinforced by the so called push-factors of unemployment, low standards of housing and infrastructure, lack of educational facilities and pull-factors of economic opportunities, attractive jobs, better education and modern lifestyle.

2.3. *Urban Management in Sri Lanka*

The historical livelihood pattern of Sri Lanka used to be an agrarian economy, so the urbanization is quite controversial with the traditional livelihood pattern. Sri Lanka is a fast developing country with urbanization trend by growing urban centers as it named 'Cities are engines of economic growth' (Asian Development Bank, 2010). According to Census data in year 2012, about 15.2% of the population of Sri Lanka lives in urban areas with an annual urbanization rate of 1.36%. However, with the restoration of peace in the country after War situation in year 2004, urban development trends would change and effective urban management practices to be adopted across the whole country to avoid the problems associated with urbanization in Sri Lanka. There are 51 cities in Sri Lanka having population over 50,000 and 16 cities which are located in the Colombo Metropolitan Region of the Western Province have over 100,000 population, 3 cities have between 100,000 and 500,000 population and one (Colombo) over 650,000 population (ADB, 2010). Based on Census data (2001), the total estimated population of these 51 cities is over 5,740,000 about 63.7% of the total urban population of Sri Lanka.

In this context, there are several government organizations responsible for managing the urban development in Sri Lanka. Urban Development Authority (UDA) which is established under the parliament act No 41 in 1978 is the prime organization for managing the development of urban areas in Sri Lanka. But UDA is an organization which guides the urban development where the management and maintenance of actions are directly handled by local authorities. In this scenario Municipal Councils (MC), Urban Councils (UC) and Pradeshiya Sabhas (PS) are managing the development of respective areas with the legal provisions on the development process under the Municipal Council Ordinance (No. 29 of 1947), Urban Council Ordinance (No. of 1940) and Pradeshiya Sabha Act (No of 1987). Accordingly the respective local authorities are responsible in providing basic facilities on public health, public utility services, public thoroughfares, socio-economic development, environmental protection, and ensure the comfort, convenience and welfare of the people in the area.

2.4. *Assessment of Urban Management*

Performance of the urban management will be assessed through multi criteria, which provide a relevant and meaningful summary of the conditions of interest. Furthermore, for the satisfaction of the wider community, they must be transparent, testable, and easily understandable and scientifically sound (Moussiopoulos et. al, 2010). Indicators are necessary to demonstrate the selected criteria. An indicator is also a measure, gauge, barometer, index, mark, sign, signal, and guide to, standard, touchstone, yardstick, benchmark, criterion and point of reference (Fraser,et.al,2006). Indicators can provide crucial guidance for decision making, by translating the collected data into manageable units of information. As an outcome of literature review, ten list of criteria and related indicators which were developed and applied by international organizations and in research studies were identified. They are urban indicators checklist (C01) (Mc.Gill, 2001), urban sustainability indicators for Thessaloniki, Greece(C02) (Moussiopoulos, et. al,2010) ,indicators for urban land use planning and management in Thies-Senegal and Geneva-Switzerland (C03) (Repetti, 2005),sustainable urban indicator identification for participatory process & environmental management (C04) (Frazer, 2005), Millennium development goals and urban indicators guidelines (C05) (UN, 2004), developing urban indicators for managing mega cities (C06) (Kotter, 2007), delivering effective urban management (C07) (Shanghai Manual, 2011),Urban management criteria in Malaysia (C08) (Muhammad, 2000) , Key performance urban indicators for divisional Secretariat divisions in Sri Lanka(C09) (Ministry of Finance, 2009) and Urban governance: an essential determinant of city development (C10) (Lange, F.E., 2009). Table 01 shows identified criteria, indicators, remarks and related reference number.

The Millennium Development Goals which were established under the Millennium Summit of the United Nations (2000) contain indicators to monitor the progress of eight goals to attain corresponding targets. There are 20 key indicators, 09 checklists (to assess the areas that cannot easily be measured quantitatively) and 13 extensive indicators (to complement the results of the key indicators and qualitative data) to assess the urban management with the point of view of urban agglomeration. McGill (2001) shows that infrastructure development and institutional development should need to be taken in to account when consider on urban management and its role. The Infrastructure development consists with network infrastructure, formal sector development, informal sector development, buildings, basic services and financing. The Institutional development consists with integration, decentralization, sustainability, organizational development, financial development policy and budgetary development. Moussiopoulos et. al, (2010) develop a criterion to assess the urban management of urban area based on sustainable development. The selected criterion is based on the sectors of economy & population, land use & urban planning, energy, transportation, agriculture, livestock & fishery, industry, tourism, air pollution & climate change, water resources & sea environment, solid waste, bio diversity, health, education and research & technology.

3. *Methodology*

The overall list of criteria and related indicators that were identified from literature review has been short listed as indicated in table 01 by conducting perception surveys considering their applicability in the context of Sri Lankan Municipalities. Perception surveys were conducted with ten officers of selected three municipal councils and ten officers who engage in urban planning and urban management related

activities in Sri Lanka. Five new indicators which are more suitable to evaluate each criterion also were identified through the perception survey. They are percentage of voters' turnover during last election, percentage of people under poverty line, percentage of unemployment out of total labor force, filed court cases from Dengue inspection, and number of Community Based Organizations (CBO) registered under MC. The data collection for each indicator was based on latest data available within each local authority and other missing data was obtained from latest research documents and reports.

Full Permutation Polygon Synthetic Indicator (FPPSI) method has been used to analyze the performance level of each Municipal Council under each criterion and related set of indicators.

3.1. Full Permutation Polygon Synthetic Indicator (FPPSI) Method

Wu et al. (2005) developed the Full Permutation Polygon Synthetic Indicator (FPPSI) method to synthesize indicators and evaluate the comprehensive level. In the FPPSI method, an n-sided polygon (Figure 2) is created to represent the theoretical maximum values of each of n indicators, with the radius at each vertex (the distance from the center of the polygon) defined by the upper limits of the standardized value for each indicator. Thus, there are aggregately $(n-1)!/2$ n-sided polygons.

Table 1: Final List of performance criteria and indicators

Criteria	Selected Indicators and Reference number	Remarks
1. Standardization of Service Delivery	Percentage of real time service delivery given as online services (C02,C09)	Calculation of number of services offered by respective Municipal Council and target should be 100%
	Time period taken for CoC, Building permits to be passed / processed (C02,C10)	The international standards and local situation was studied and maximum limit was derived through professional interview.
	Citizen satisfaction on municipal services (C04,C05,C06,C07,C09)	Primary data (sample survey) based data collection and maximum was taken as 100%
	Percentage of budgetary allocation for social welfare (C05,C06,C08,C09)	The total percentage of expenditure for the social projects by MC out of allocation from the budget has been taken. The maximum of 100% (spending of total allocation) was the target.
	Percentage of Voters Turnover during last Election*	The results based on Provincial Council Elections in 2014 were taken. The target was the total number of voters eligible for voting should vote in the elections.
2. Housing & Amenities	Housing deficit (C01,C05,C06,C07,C08, C09)	Difference between the total housing stock and total households were taken for data collection. The target was taken as the total number of households should have a house with proper materials & infrastructure.
	Percentage of families have proper sanitation facilities (C01,C02,C05,C06,C07, C08,C09)	Deducted the families have 'no toilets', 'common toilets' and 'shared with another' categories out of the Census, 2012. The target was taken as the proper sanitation should be available for every family.
	Percentage of families have permanent shelter (C01,C05,C06,C07, C08,C09)	Based on Census of 2012, categories of 'twin houses', 'line rooms', 'shanties' & 'other' was deducted from the total housing stock. Target was the families who have permanent shelter to be 100%.
	Percentage of open areas availability (from total land use activities) (C02,C03,C04,C07, C08)	The standard used by UDA is that the open areas within Colombo Metropolitan area should be 1ha. Per 1000 persons. For other areas, it is 1.4ha per 1000 persons. This was the target for each Municipality.
	Percentage of people under poverty line*	"Samurdhi" recipients within each municipality were taken for the demonstration of the indicator. The target was set as to be no Samurdhi recipients or number of families does not receive Samurdhi subsidy scheme should be 100%.
3. Obligation of the Law & Order	Percentage of unemployment out of total labor force*	This has been amended as to be the employed population out of total labor force should be the maximum. The government policy (MahindaChinthana) has been targeted this to be 98% within Western Province.
	Percentage of passed CoCs or building applications from total applications (C09,C10)	The total number of applications for the Certificate of Conformity or building permits within a year was considered here. The passed percentage by first instance was targeted to be 100%.
	Percentage of encroached population (C01, C06, C09)	Encroached families to the government properties, reservations and other illegal households were considered here. The target was reverted as the legally living families to be 100%.
	Percentage of crime activities reported (C01,C04,C05,C06,C08,C09)	Reported crimes within a period of one year were considered and target was reverted as to be the crime-less population as 100%.
	Filed court cases from Dengue inspection*	The ratio between legal actions and identified positive Dengue breeding locations were considered here. The legal actions properties should be minimum or houses with Dengue preventive measures should be 100%.
4. Health Care & Social Well-being	Percentage of people reported with vector borne diseases (C02,C05,C08,C09)	The indicator reverted as the people without vector borne diseases to be 100% out of total
	Mortality rate (both maternal and infant) (C02,C04,C05, C08,C09)	For the infant mortality, the indicator was taken by deducting the deaths under 01 years of age from the total infant population. The target was set by taking the inverse of targeted infant mortality rate. Maternal mortality indicator was calculated by reducing the maternal deaths during pregnancy and child delivery from the total pregnancy population for normalized value of 100,000.
	No. of pre-schools operated by MC (C01,C03,C04, C09)	The Municipal Council operated pre-school availability within each GN Division was taken into consideration. The standard was kept as that each GN Division within Municipality should have at least one pre-school.
	No. of Community Based Organizations (CBO) registered under MC *	The registered CBO's with DS division of each municipality was taken into consideration here. The standard was kept as that each GN Division within Municipality should have at least one CBO in operation which was taken from the literature review and professional interviews
	Frequency of maintaining public parks (C02,C04,C05, C08,C09)	The frequency was taken as the daily cleaning service with allocated laborers by the respective MC.
5. Physical Infrastructure facilities	Percentage of solid waste recycling and composting (based on composition) (C01, C02,C04,C05, C06, C07, C08,C09)	Due to non-availability of reliable data, the calculation was taken from the percentage of solid waste collection by MC out of total generation within each day.
	Percentage of paved road network out of class "E" roads (C01,C03,C06, C08)	With central government initiative "MagaNeguma", each Municipality has allocated road improvement projects. So the indicator was taken as the number of road projects completed within MC out of total allocated projects per year.
	Frequency of maintaining the drainage (C01,C02,C06, C08)	The frequency was taken as the daily cleaning service with allocated laborers by the respective MC.
	Percentage of families have access to safe drinking water (C01,C04,C05, C06, C07, C08,C09)	The data collected for the families with protected wells and pipe borne water supply within governing area based on Census, 2012. The target was taken from the government target of 99% within Western Province.
	Percentage of families have access to electricity (C01, C02,C05, C06, C07, C08,C09)	The data collection was based on the households with electricity as the principal source of lighting within Municipality based on Census report of 2012. The target of 100% was set by government policy initiative, "MahindaChinthana".

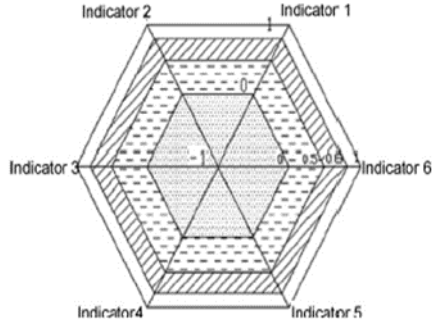


Figure 1: Full Permutation Polygon

The synthetic indicator is defined as the mean of the ratios of the area of any n-sided polygon to the area of the polygon defined using a normalized value of 1.0 for each indicator.

$$F(x) = a \frac{x+b}{x+c} \quad a \neq 0, x \geq 0$$

(Equation 1)

Where F(x) meets the following conditions:

$$F(x)/x - L = -1, \quad F(x)/x - T = 0, \quad F(x)/x - U = 1$$

Where U, L, and T represent the upper limit, the lower limit, and the threshold for parameter X respectively. Thus:

$$F(x) = \frac{(U - L)(X - T)}{(U + L - 2T)x + UT + LT - 2LU}$$

(Equation 2)

When $x \in (L, U)$, F(x) has the following characters:

- (1) F(x) has significance, that is, it has no singular value in its domain;
- (2) $F(x) \geq 0$
- (3) When $x \in (T, U)$, $F'(x) > 0$
- (4) When $x \in (L, T)$, $F'(x) < 0$

The equation can then be standardized for each indicator:

$$S_i = \frac{(U_i - L_i)(X_i - T_i)}{(U_i + L_i - 2T_i)X_i + U_iT_i + L_iT_i - 2L_iU_i}$$

(Equation 3)

- S_i = Standardized indicator value
- U_i = Upper value of the existing value
- L_i = Lower value of the existing value
- X_i = Present value of the indicator
- T_i = Target value for the indicator

An outer regular n-sided polygon can be formed by n indicators, where n vertices represent the instance of $S_i = 1$; the central point represents $S_i = -1$; and the radius from each vertex to the central point represents the value of the corresponding standardized indicator. An inner polygon that lies midway between the outer polygon and the center of the polygon represents the threshold values of the indicators, where $S_i = 0$

($x_i = T$). Inside the inner polygon, the values of the standardized indicators are less than their thresholds and are negative; outside the inner polygon, the values are greater than their threshold values and are positive.

The n indicators can form $(n - 1)!$ different polygons containing $n!$ triangles. In all these triangles, the number of different triangles is $n(n - 1)$, and the total area of all these different triangles can be calculated as follows:

$$S = 0.5(\pi/n) \sum_{i \neq j}^{i,j} (S_i + 1)(S_j + 1)$$

(Equation 4)

Where, S_i represents indicator i, and $(S_i + 1)$ represents the distance from the endpoint of indicator i to the central point. The standardization interval is $[-1, +1]$.

Thus, the sum of $(n - 1)!$ areas of the polygons is:

$$S_t = \frac{n!}{n(n - 1)} \times \frac{1}{2} \sum_{i \neq j}^{i,j} (S_i + 1)(S_j + 1) \sin \alpha_i$$

(Equation 5)

The areas of the $(n - 1)!$ regular outer polygons (with a side length equal to 2 units) can be calculated as:

$$S_{st} = (n - 1)! \times \frac{1}{2} \times 4 \times \sum_{i=1}^n \sin \alpha_i$$

(Equation 6)

Thus, the value of FPPSI is obtained by calculating the following ratio:

$$S = \frac{S_t}{S_{st}} = \frac{1}{4(n - 1)} \frac{\sum_{i \neq j}^{i,j} (S_i + 1)(S_j + 1) \sin \alpha_i}{\sum_{i=1}^n \sin \alpha_i}$$

(Equation 7)

- S = Synthetic indicator value
- S_i = Minimum value of the standardized value
- S_j = Maximum value of the standardized value
- n = Number of indicators

Where S is the value of the synthetic indicator, which represents the sum of the values for all indicators at a lower layer in the hierarchy and it can be standardized to account for the immediately higher layer in the hierarchy. For the application of FPPSI method, the collected data has to be converted in to equitable form for evaluation. Therefore the indicator list has been amended to denote the target values to be the maximum level being 100% of achievement gives best (or maximum) level of success where 0% gives lowest success. But in some cases, it is the opposite where, the encroached families should be 0% for the best achievement by local authority and population with access to safe drinking water should be 100% for the highest level of achievement by local authority. For FPPSI calculation, the maximum and minimum limits of the indicator should be the same as they are considered together in same format. So for the indicators those target should be 0% have been reverted the opposite way for the calculation purpose.

For an example targeted encroached families of LA area should be 0% and it was reverted as targeted non-encroached families of LA area should be 100%. Percentage of encroached population, housing deficit, percentage of people under poverty line, percentage of crime activities reported, filed court cases from Dengue inspection, percentage of people reported with vector borne diseases and Mortality rate have been reverted based on the above principle and percentage of budgetary allocation for social welfare, percentage of solid waste recycling and composting and percentage of paved road network out of class "E" roads have been amended depending on the availability of data and information in the Municipal Council Level. Based on Full Permutation Polygon Synthetic Indicator values (Wu et al, 2005), as well as values in national and international standards (Li, F. et al.,2009), the following qualitative classification of four performance level was identified (Table 2).

3.2. Case Studies

Western Province can be identified as the fastest growing region in Sri Lanka and as the center for trade and economic agglomeration. MCs in Western Province have been largely influenced by the development initiatives and assigned with many responsibilities and functions in terms of urban management since many urbanization related issues are common. Therefore, it is essential to measure the urban management performance and to identify the development trends of the region with its maturity level of economic agglomeration. In this background, three MCs in Western Province, namely Colombo Municipal Council (CMC), Sri Jayawardenapura Kotte Municipal Council (SJKMC) and Moratuwa Municipal Council (MMC) were selected as the case studies for this study. CMC is the largest local authority in Sri Lanka and one of the oldest in South Asia, established in 1865. According to the census data in year 2011, it has grown into a large organization catering to the needs of resident population of 555,031 and floating population of nearly 500,000 (estimated). SJKMC area is highly urbanized due to some factors like being a main administrative capital and locating parliament complex. It has become highly populated with the developed road network and infrastructure facilities. MMC is highly urbanized due to the impact of industrialization which took place in Colombo during the 1970s. MMC forms part of the Ratmalana industrial area, which has a wide variety of modern industries providing employment for the population of its hinterland areas.

4. Analysis and Discussion

Each indicator under each criterion was standardized by calculating standardized indicator value applying above equation 01, 02 and 03. The identified upper limit (Ui) and the lower limit (Li) values of each indicator, existing value that relevant to each indicator and

customized targets values (Ti) were substituted to equation 03 to calculate standardized indicator value. Table 3 shows the calculated standardized indicator values for all 25 indicators under five criteria.

Full Permutation Polygon Synthetic Indicator values were calculated for each criterion representing the sum of the all standardized indicator values. The Full Permutation Polygon Synthetic Indicator values of each criterion have assessed performance level of municipal service delivery and management. Average value of all FPPSI values of five criteria and its related qualitative measure can be used to have an idea about the overall performance level of municipality if all criteria are considered as equally important. Although selected three MCs are located within Colombo Metropolitan Region, none of them were achieved the "High" or "Very High" level of synthetic indicator ($SR \geq 0.50$) that shows the standard of the performance of municipal service delivery of Sri Lanka as a whole. The services related to Health care and social wellbeing and housing and amenities show moderate performance level being other sectors as low performance level. Three MCs do not achieve a considerable success in the service delivery phase. Therefore they should consider on the improvements on the field. CMC should more focus on the social welfare programs and to reduce the voters' turnover while MMC and SJKMC required to more focusing on online services and gaining the trust of the people in terms of the services. CMC has achieved 19% of performance level in providing housing and amenities while MMC and SJKMC valued as 28% and 29% respectively. So CMC is still in the "Low" stage where MMC and SJKMC have been achieved into "Moderate" level. The main improvement indicators or sectors for CMC are the sanitation of people and permanent shelter. CMC has the highest population density in Western Province which increases the demand for the land due to high population attraction. Land values are eventually high and that leads to scarcity of land for the habitation. This resulted in permanent shelter related issues as well as issues related to health and sanitation within the Municipality. MMC has not sufficient open spaces for the people and the unemployment rate is comparatively high. SJKMC has the issue with open spaces due to increasing urbanization.

All three (03) municipalities show low performance level in providing and managing services on obligation of law and order. CMC falls into the worst situation (0%) being MMC as 10.8% and SJKMC as 2%. The main reason behind this is the land encroachment or illegal occupation of land by violating the rules and regulations. Out of total population of CMC, approximately 51% are living in underserved settlements in government reservations, river or railway reservations without having basic infrastructure for living (Census Report, 2011). This has caused for the crimes and spread over of diseases such as Dengue, Malaria within the city limits. Capacity improvement of the administration and physical planning interventions are needed for upgrading the obligation level of people on law & order. MMC has the comparatively low level of encroachers and crimes when compare to other two MCs but the Bolgoda Lake which is a boundary of municipality has certain encroachment issues. SJKMC is also has encroachment problem but the loop holes in legal and administration system has drawbacks on municipal service delivery as well.

CMC has achieved 32% of moderate performance level in providing and managing services on health care and social wellbeing while MMC and SJKMC valued as 12% and 18% respectively. MMC has to improve on the social infrastructure such as preschools, CBO service gain. CMC has the majority of healthcare service providers including private sector contribution which has to be a limiting factor for MMC. Under physical infrastructure provision, CMC and SJKMC have 2% of low performance

Table 2: Qualitative evaluation for the Synthetic indicator values

Level	Full Permutation Polygon Synthetic Indicator values	Qualitative evaluation
1	> 0.75	Very High
2	0.50–0.75	High
3	0.25–0.50	Moderate
4	< 0.25	Low

Source: Li, F. et al. (2009) Measurement indicators and an evaluation approach for assessing urban sustainable development: A case study for China's Jinling City.

Table 3: Standardized indicator values of 25 indicators of related 5 criteria for three Municipal Councils

Criteria	Indicators	$S_{(CMC)}$	$S_{(MMC)}$	$S_{(SJKMC)}$	Comparison of Standardized Indicator Values of three MCs
1. Standardization of Service Delivery	Online Service Delivery	0.00	-0.94	-1.00	
	Time period for CoC/ BP to be passed	-1.00	-0.38	-0.72	
	Citizen satisfaction on municipal services	-1.00	-1.00	-1.01	
	Percentage of social expenses over allocation	-1.00	1.00	1.00	
	Percentage of Voting Population out of eligible	-1.00	-0.88	-0.97	
2. Housing and Amenities	Percentage of households have dedicated house	0.00	0.65	0.10	
	Percentage of families have proper sanitation facilities	-1.00	0.21	0.08	
	Percentage of families have permanent shelter	0.42	0.40	0.15	
	Percentage of open areas availability	0.00	-1.00	-1.00	
	Percentage of families above the poverty line	0.06	-0.72	0.39	
	Percentage employment out of total labor force	0.00	0.57	0.79	
3. Obligation of Law & Order	Passed CoC percentage from total applied	-0.87	-0.41	-0.98	
	Percentage of legal (non-encroached) residents from total families	-0.91	0.08	-0.85	
	Percentage of Crimeless people from total population	0.07	0.01	0.99	
	Dengue Prevention controlling from total detected areas	-0.98	-1.00	-1.00	
4. Health Care and Social Wellbeing	Percentage of healthy people	1.00	1.00	1.00	
	Infant living percentage	-0.66	-0.62	-0.44	
	Maternal living percentage	-1.00	-0.71	-0.44	
	No. of pre-schools operated by MC	0.00	-1.00	-1.00	
	Percentage of CBO distribution upon number of GN Divisions	0.00	-1.00	0.00	
	Daily maintenance of public parks	1.00	0.00	0.00	
5. Physical Infrastructure Facilities	Percentage of solid waste collection out of total generation	-1.00	-1.00	-1.00	
	Number of road projects completed out of total allocated per year (2012)	-1.00	0.00	-1.00	
	Frequency of maintaining the drainage	0.00	-1.00	0.00	
	Percentage of households with access to safe drinking water	-0.63	-0.15	-0.48	
	Percentage of families with access to electricity	-1.00	-1.00	-1.00	

level being Moratuwa as 0%. Physical infrastructure provision has been a responsibility of central government as well as the local government which may be a reason for achieving lower values for every municipality. Also lack of attention on infrastructure improvement and corruption issues are other reasons behind this. MMC has the poor records in road and drainage maintenance. The monitoring mechanism for the maintenance work should be strengthened in MMC and the attention should follow to the sufficient resource provision for each sector to provide frequent service for the people. The private sector participation is being

utilized for CMC and SJKMC which should be a trend for municipal infrastructure provision as well as the maintenance.

5. Conclusion

Based on the results, it is obvious that municipal council services in Sri Lanka have not been up to the standards expected. FPPSI method has been proved as a rational indicator to assess the performance of urban management. This method is useful for scenario building and analyzing development trends based on predicted values for each indicator for making crucial decisions. In practical situation, it is impossible to foresee the future scenario especially due to political instability. The

Table 4: Full Permutation Polygon Synthetic Indicator values & their Qualitative Evaluation

Criteria	FPPSI _(CMC)		FPPSI _(MMC)		FPPSI _(SJKMC)	
Standardization of Service Delivery	0	0%	0.0141	1%	0.0029	0%
	Low		Low		Low	
Housing and Amenities	0.1892	19%	0.2796	28%	0.2872	29%
	Low		Moderate		Moderate	
Obligation of Law & Order	0.0083	0%	0.1080	11%	0.0201	2%
	Low		Low		Low	
Health Care and Social Wellbeing	0.3201	32%	0.1190	12%	0.1844	18%
	Moderate		Low		Low	
Physical Infrastructure Facilities	0.0156	2%	0	0%	0.0216	2%
	Low		Low		Low	

government policies will be changed and the action projects will vary in terms of the politician's agenda. The trend of urban service delivery will be fluctuated if there are any policy level changes affected. Due to non-availability of similar research findings in Sri Lanka, the basic understanding on urban management and assessment of its performance was assessed based on studies done in international context. Some of the criteria were eliminated due to non-availability of data even in the Municipal level while some of the data and information has errors in collection and verification. Poor co-ordination among other divisions of MC and the limited data availability in soft versions are identified as limitations which created unnecessary delays in collection and compilation of data and information. This study can be further developed to refine the perfect model for assessing the performance level of urban management by adapting the external forces (positive and negative) in to the municipal service delivery. (i.e.: Impact of mega infrastructure projects such as expressway construction, relocation of underserved settlers and any other nationally and regionally important projects).

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Understanding the Acceptance of Local Public Officers on Computer-based Urban Spatial Information System

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ABSTRACT

Information technology is developed to assist people in minimizing processing time, reducing errors, increasing the accuracy and simplifying the overall process. The process of recording, retrieving and displaying data and information can thus be easily and accurately undertaken. Information technology in its initial development, however, tends to be too costly and complicated to make a real particularly for people in developing countries. Fortunately, universities as the centers of innovation, can be a game changer for the adoption of the innovative processes, for the benefits of the community at large. In all Indonesian universities, this role is associated with a, so called *Tri Dharma Perguruan Tinggi* (Three Devotions of Higher Education, TDHE). This paper examines the acceptance of the collaborating officials and the obstacles i.e. internal and environmental factors. We proposed the use of GIS-based technology to coordinate the administrative units of local government at all levels, particularly the *Kelurahan* as the lowest hierarchy of the administrative unit in local government system. The *Kelurahan* will then be the spearhead in a local government system in Indonesia in promoting administrative services to all Citizens. We undertook an integrated training and tutorial for select official staff of the *Kelurahan* on the system. Evaluation of shows that the information system can be used to simplify the collaborators' activities. The evaluation was done through in-depth interview to the collaborating officials. The collaborators interested in learning more about the system as an innovative way in providing service to the community as well as spatial data input to support urban planning and management.

1. Introduction

1.1 Spatial Information System for Local Government in Data Collection

Along with the history of human advancements, technology plays significant roles in the dynamic and ever changing life (Mincer, 1991). The human civilization have been going along with the technology. Human-beings have been supported and entertained by the technology. A very visually clear and easily found example, technological inventions from handheld axes to smartphones have helped human-beings in simplifying their tasks, progressing their accessibility, increasing productivities and advancing life, particularly in the era of this advancing mobile phone (Park and Lee, 2012). Indeed, the advance technology is the answer of almost human needs for simplifying tasks and saving times (Kamibepu and Sugiura, 2005), as well as generating the negative sides of smartphone as a product of technology such as addiction (Park and Park, 2014), health problems (Thomee et al., 2011). Technology is deemed useful if only we can utilize, apply and implement in everyday life. For example, for the jobs, in social life, or just merely for fun. To

be fully implemented and utilized, the technology must be properly introduced to their potential users to gain their interests. By this notion, the advance of technology must be kept adapting and utilizing. Technological advancement is basically the innovation by people towards the increasing productivity and progressing life. It may need expensive inputs and continuous investments in human capacity and knowledge (Hughes, 2014). Ramey (2012) also argued that technological advancements have also helped businesses and organizations save time and cost of production, which has been an advantage to all businesses. They manage these advancements to gain competitive advantage. A good example is the 3G/4G broadband, small businesses have taken advantage of this super fast internet to reach target markets with less costs of operation.

In the developing cities, universities and other research institutions are one of the change agents, and they can play their essential roles as the main front-ends of technological innovations and applications to support local government in organizing and managing good urban governance towards the accomplishment of their mission. These research institutions can be independent or commercial research institutions, research institutions those associated to technological

manufacturing companies, or research institutions in the universities, meanwhile, a research university, which is a university with the main role of research, is yet to establish in Indonesia by the authority. A research institution in a university is therefore an important university's wing and is a manifestation of research services as one of the TDHE functions of universities. An innovation delivered by a research institution is a manifestation of knowledge advancements that have been accumulated and bred in universities along with their learning process. The technological innovation produced by a research institution is expected to be able to bridge the gap between science and industry. Powel and Micallef (1997) argued that technology, however, is never only meant as a statement of the advancement of human knowledge, rather technology is a cultural output that is created to make life easier. Hence, the last item of the Three Devotion of Higher Education (TDHE) of a university is to transfer knowledge into a practical form that is applicable for the community at large. The transfer of knowledge as exhibited by a service to the communities by the university is to ensure that technological innovations generated by the universities can be properly and effectively disseminated to public at large and available all times. This is an important step to accomplish the true purpose of technological advancement activities by universities in Indonesia.

In the mean time, the urban planning domain as a branch of science is often defined as a part of a public engineering domain that is ultimately linked to services for the general public (Friedmann, 1987; Forrester, 1990). In the context of public services, the planners are committed to ascertain that public interests will be well served. Good public services can therefore be said as services that are signified by effectiveness, efficiency and responsiveness to the needs of the communities (Widodo, 2001). There are several approaches can be employed to create good public services. For example, the strategic location of a service center, which reflects the spearhead of a service. The location should be easily accessible, flexible service hours, dedicated service officials, and valid service outputs. Public services that are frequently needed by the community at large, in Indonesia, are any kind of administrative services provided by *Kelurahan*. *Kelurahan* office provides many kinds of public services, such as issuing Identity Card of the Citizens (*Kartu Tanda Penduduk, KTP*), Family Registration Card, Birth Certificates, Domiciliary and Changes of Address, and the likes. The *Kelurahan*, as the spearhead of local government and the lowest administrative units of local government, can also be utilized to assist the other administrative data completion, demographic survey, basic infrastructures inventory and urban planning and management. These services are heavily dependent upon archiving, recording/documenting, updating and retrieving databases. Unfortunately, the database on spatial compositions, such as demographic distribution maps and infrastructures is rarely updated and left obsolete for a long time. Data renewal is often neglected because of some reasons such as lack of human and financial resources. This obsolete data makes the validity of product/output is being questioned by the potential users.

The data and information required for public services in *Kelurahan* offices and must be readily available can be statistical data and spatial data. Statistical data administers demographic developments in quantity terms, while spatial data shows the phenomenon of administrative boundary and spatial distributions of the social and economic attributes. The practical usage of spatial data is directly linked to the general public. Publics can, for example, directly observe the layout illustrations of certain areas, looking for various potential aspects of their interests and using the insight as an input for decision making process. *Kelurahan* as a public service agency is strategically positioned for providing these spatial data providing their strategic role as the spearhead of the local

administrative service unit. This is also because of their familiarity with their local communities and conditions at their localized areas. The data validation can therefore be conducted in a smaller scale, localized and with higher accuracy.

In presenting the spatial data, the concept employed was a geographical information system. Geographic Information System (GIS) is an information system that is designed to work with spatial-references or geographical-coordinates data. As Puntodewo et al. (2003) asserted that Geographic Information System as an information system with basic components in the form of hardware, software, geographical data and human resources that work effectively together to collect, store and repair, renew, manage, integrate and display the data in the form of spatial-based information, the GIS then a suitable tool to accomplish this work. However, to what extent the level of acceptance by the local public officers is, we need to reveal the fact prior to further development and dissemination of the system to the whole municipality by our university as a change agent.

1.2 *Implementing Spatial Information System in Kelurahan Kepatihan Wetan, Surakarta, Indonesia*

Surakarta is a city with dynamic and prominent developments, particularly during the last five years (2010-2015). However, this rapid development has not been equipped with sufficient data-collection and processing capacity by the local government officials. To make the system swiftly available, the structuring of the geographical information systems for *Kelurahan* is one of the crucial steps to disseminate an applied information technology for the publics and communities at large in assisting the processes of data collection, data storage, and data retrieval to be displayed as a service product/output. As a case, the dissemination and establishment of the system was organized in *Kelurahan Kepatihan Wetan*. *Kelurahan Kepatihan Wetan* has been selected as a showcase for the study for their geographical location suitability and readiness with respect to human resources and workload of this *Kelurahan* comparing with others. The activity was organized by the State University of Sebelas Maret (UNS), as one of the prominent change agents in the municipality. UNS organized the activity for some *Kelurahans*, called collaborating *kelurahans*. However, the focus of activity was centered in the *Kelurahan Kepatihan Wetan*.

The purpose of the activity was to introduce and establish a geographical information system to the officials in the collaborating *Kelurahan*. The activity was conducted in three stages: (1) identifying the need for a geographical information system, which in this case was the identification of the needs of *Kelurahan* officials to support their tasks and responsibilities for better services to the citizens; (2) building and installing a geographical information system for collaborating *Kelurahan*; and (3) providing tutorials for the implementation and application of a geographical information system for collaborating *Kelurahan* officials. The identification of users' needs and/or demands was conducted using a limited discussion method that resulted in a list of data requirements based on users' activities. The next stage was creating a geographical information system and installation of the system at the *kelurahan's* computer as needed and the last stage was providing tutorials about the application and the practicability of this dedicated geographical information system. The participants in this training and tutorial session were from the collaborating *Kelurahan* with five officials from each *Kelurahan*. We considered the training and tutorial as important as the essential part of the sustainability of the system. Otherwise, the system will not be sustainable.

1.3 Evaluation of System Implementation

Evaluation of this activity was conducted in three months after the third stage of the program took place. Using the methods of in-depth interview, evaluated officials were questioned about the usage of the spatial information system in data renewal and their daily activities. Early findings showed that the officials did use the spatial information system in their daily activities of providing services to the citizens. The service, for example, providing map on request basis and map of the basic infrastructure including attributes data. The service was free, or service charge will be applied in a very low and affordable rate. Even though the use of the information system was at a good rate in few early weeks, only few collaborating *kelurahans* were interested to develop the information system furthermore. This is particularly due to GIS needs high maintenance costs, while limited budget available in each collaborating *kelurahans*.

Although the user interface of the spatial information system has been made simple and customized to the needs of the *kelurahan* official, the intense use of the spatial information system seems to only occur in the early weeks after the system was handed over to the *kelurahan*. Low level of acceptance toward new technology was the background of the issues raised in this paper. This paper will discuss the factors that led to the low level of acceptance of village officials to the spatial information system disseminated by the UNS through Three Community Devotion of the Higher Education.

2. Methodology

This paper discusses the evaluation of the community service activities through the establishment of *kelurahan*-based GIS focusing on its sustainability i.e. long-term benefits gained by the *kelurahan* as service provider and citizens as the customers. In general, the evaluation method was undertaken by an ex-post evaluation system that assesses the dissemination of technology after full implementation process is completed. The success indicators of the spatial information system implementation was measured by the characteristics of practical use and the level of acceptance of the relatively newly introduced system. This study used an inductive approach to identify the research problems that focus on two issues, namely acceptance of the *kelurahan* official towards spatial information system technology and the factors affecting the level of acceptance and practicability of the implementation in collaborating *kelurahans*. The conclusions drawn by this study was based on the results

of the surveys. This study employed primary data collected through observation and in-depth interviews. Observation was held three months after the full implementation and completion of the program. The interview was undertaken with the system operators and his/her supervisors in the *Kelurahan*, Head of *Kelurahan*, and other relevant officers at *Kelurahan* Office as respondents.

The variables in this study were derived from two groups, i.e. group variables to measure the use and level of acceptance and group variables to identify the factors affecting the main variables (Figure 1). The first variable group consists of two set of variables namely the level of use as suggested by Breilling (1996) and the level of acceptance as confirmed by McCall (2004). The second variable group consists of two sets of variables, namely internal factors introduced by Breilling (1994) and environmental support factors coined by Yeh (1991). Interview transcript was then processed by classifying data into these two groups.

3. Dissemination of Technology and Level of Acceptance by Public Officials

3.1 Dissemination of Technology to Kelurahan Kepatihan Wetan

The purpose of building a geographical information system in this study is to integrate spatial data and statistical or attribute data in the collaborating *Kelurahan*. The data presented in information system is the latest data that has been validated in the field (ground authenticated). The process exhibits an improvement in data quality that will become the inputs to the potential *kelurahan* to support their daily tasks and responsibilities. Others customers such as students and academics can also get benefits from the accuracy of the data presented in rapid manner and readily available. They can use the timely updated data in their research, delivering lectures and providing other services. For this activity, both hardware (Computers and Global Positioning System device, GPS) and software i.e. ArcGis were used to compile database, create spatial data and update data. The earth contours map was used as the basis map and was validated based on the results of field surveys.

We organized the activity in three stages in sequence. The stages are (1) Identifying the users' need for a geographical information system

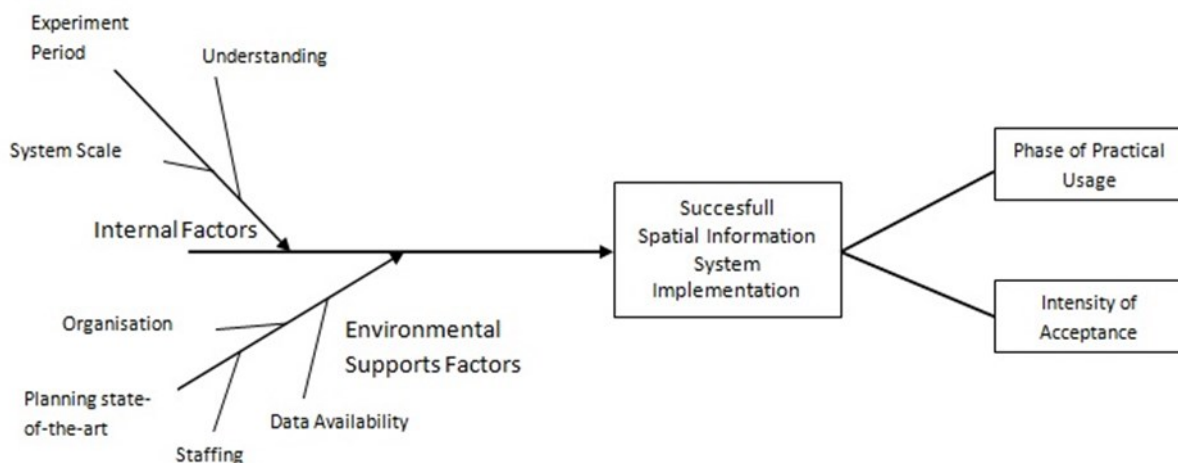


Figure 1: Analytical Framework

(2) Building spatial and attribute data (3) Training and tutorials for the relevant officers in the selected collaborating *kelurahan*s.

3.1.1. Identifying the users' needs

In GIS, the display design and the mechanisms for information and data retrievals must conform to the need of its user. Conformity between information system features and its users' need will ascertain its efficiency and effectiveness. The users' needs, in this case, were the needs of *Kelurahan* officials in *Kelurahan Kepatihan Wetan*. We conducted the identifications through limited group discussions that is focused on routine activities and important information needed to showcase the potential aspects of *Kelurahan Kepatihan Wetan* that may be of citizens' or others' interests. For instance, to start-up business and industries in the municipality. Identification of users' needs has been conducted through limited focus group discussions. The outputs of the discussion are the list of users' need including wish list. The users need to retrieve information on (a) daily and regular activities by using geographical information system, such as creating maps of *Kelurahan*, compiling *Kelurahan* profiles, and introducing the potentials of *Kelurahan*; (b) data required to support regular activities such as numbers and distributions of citizens, government and public services facilities, educational facilities, economic infrastructures, religious service facilities, and roadways; (c) person in charge regular activities including the operators of spatial information system; and (d) the geographical information system displays, in the form of maps.

3.1.2 Building spatial and attribute data

In post-identification of the users' need, we conducted a survey to acquire both spatial and non-spatial data. The survey was conducted by

using the marking and tracking methods. All the road paths and socio-economic infrastructures identified in the first stage were surveyed and their Cartesian coordinates were recorded. This data was then used as the basis data for the integration into the basic map. Since the data were recorded directly based on the field measures, the validity of the data was high. Data collected during the surveys are (a) *Kelurahan* boundaries; (b) Lower Neighborhood units (RT) and Upper Neighborhood unit (RW) boundaries; (c) roadways; and (d) governmental and public services facilities (education, health, religion). Then, the integration of spatial data and non-spatial data. This stage was conducted using ArcGIS software which was a tool to plot basic data attributes such as infrastructure data on the basic map displaying administrative boundaries in the collaborating *Kelurahan*. As the result, data on the potential attributes of the collaborating *Kelurahan* can be displayed in the form of a digital map. The map can be updated anytime, not merely on obsolete statistical information. Data about the potential attributes of the collaborating *Kelurahan* can then be accessed and displayed in the form of spatial distribution. This innovation will enrich the information and can be accessed as one of the products of public services in the collaborating *Kelurahan*.

3.1.3 Providing tutorials about geographical information system for Kelurahan

Training and tutorial sessions were held to directly introduce spatial information system to the collaborating *Kelurahan*. Five officials from *Kelurahan* were participated in this training sessions. In general, all the participants have learned how to use the geographical information system to update and add new data, to perform simple analysis, and to print a map as required. The output was a map of the potential



Figure 2: Map of Kelurahan Kepatihan Wetan as the Output of Computer-based Information System

attributes of collaborating *Kelurahan*. These maps were subsequently be used as teaching materials during tutorial sessions (Figure 2).

Rogers (1983) asserted that dissemination of technology is a process of diffusing a proprietary technology owned by an institution or an individual via certain channels of society members (Rogers, 1983). In similar manner, Barton (1995) argued that technological introduction based on its practicability is also a technological dissemination by utilizing a certain approach in practicability and suitability. Meanwhile, another notion in same line of thinking on the dissemination of technology was offered by Havelock (1973). According to him, there is a technological diffusion using a different approach that tries to change users' perceptions in order for them willing to adopt that new technology. In this activity, utility approach was employed by providing tutorials about a geographical information system in the collaborating *Kelurahan* so that the potential users can learn on the practicability of this technology and their willingness to implement it.

According to Rogers (1983), in the process of technological dissemination, there are several distinct stages: (1) receiving a new knowledge, (2) request to adopt it, (3) decision whether to adopt it or not, (4) implementation of the new technology, and (5) believing in the benefits and usefulness of the new technology. When the potential users decide to reject the new technology, then obviously, there are no fourth and fifth stages. When the decision is to adopt the new technology, then naturally, it carries on to the fourth stage, the implementation of the new technology. In this fourth stage, the usual ways the potential users do their things need to be adjusted to accommodate the implementation and the application of the new technology. While technological dissemination can also be categorized based on the sources of innovation, the act of technological dissemination can be one of two types, either bottom-up or top down dissemination. Bottom up dissemination is a process in which the innovation is created by a community to be spread out to other communities which include governmental agencies, academic communities, and scientists as part of the general communities. The other type, top-down dissemination, is a process in which the innovation is created either by scientists, academics, or governmental agencies and be spread down to the general public. Based on this categorization, our servicing activity was a top-down diffusion of innovation.

Based on the above theory of technological dissemination, the targeted people, who is in this case is the officials at the collaborating *Kelurahan* have undergone all four stages of technological dissemination, down to the implementation of the new technology. The first stage, technological introduction, was conducted during proposal preparations and collaboration offerings. This stage has been accomplished easily since our proposals offer many benefits of this project activity. Moreover, geographical information system is usually implemented and employed only by officials in municipal and national government agencies with a relatively large resources. Our collaboration to introduce this technology was very well received by officials in the collaborating *Kelurahan*.

In the second stage, requests to adopt the new technology were constantly brought to front during the identifications of users' need and data surveying processes. The students and the assistants conducted surveys using simple devices that were rarely used by the collaborating *Kelurahan* officials. The information system created was attractive as was indicated by the officials' curiosities and their

willingness to discuss about designing a similar system. And in the next stage, they are judged whether or not they accept the new technology by inviting them to attend a tutorial session. By attending the tutorial session, the *Kelurahan* officials gained insights about a geographical information system that changed their perceptions and how they do their daily tasks. We installed the spatial information systems in the computers of collaborating *Kelurahan*. The next stage was to confirm and justify the benefits of this new technology. This can only be recognized some times after the technology has been implemented. The sustainability is then the crucial matter.

The evaluation was done three months after implementing technology in collaborating *Kelurahan*. Early findings through preliminary surveys revealed that spatial information system had been implemented in a computer system at the *Kelurahan*, but active utilization was only intense in the first few weeks. In three months during the evaluation, routine work using the system was only completion of the data that has been taught in the tutorial stage. Once the infrastructure data completed, the spatial information system was no longer optimally utilized.

3.2 Factors Affecting Acceptance of Kelurahan Official towards Computer-based Information System

Spatial information system, particularly computer-based information system, is a tool for local government officials in doing their daily routine tasks. Breilling (1996) suggested three practical use of spatial information system for local government to include (1) presentation tool, (2) coordination tool and (3) public participation tool. These three uses of spatial information system do likely form phases in accordance to the practical benefit and complexity in implementing the system. During the first phase, spatial information system produced maps of both spatial data (natural landscape, man-made infrastructures, land-use) and attributes data (demography, economic productivity, etc.) of the area. Various maps can be prepared by using spatial information system based on the detailed information needed by the users.

Maps are a better way to present detail information of an area compared to big number of tables and list. On the second phase, maps, which are generated by the spatial information systems, must be combined with other perspectives of the area to induce a general overview and link different information from different disciplines. This coordination phase gives way to new information for planning purposes, including constraints and conflict across the disciplines. In this phase, spatial information system becomes a strategic platform for local government units from different disciplines to talk in the same language. The last phase in spatial information use is the public participation tool. By using the maps produced by spatial information system, local government may invite public at large to raise their concerns and opinions on various information and plans embedded in the maps. Thus, public participation may occur during the whole process of planning, i.e. (1) public crosscheck the data compiled by the local government with their own information, (2) public may actively giving opinion and raise concerns through the planning process, (3) public may monitor the implementation of the plan, and (4) public may continuously evaluate the changing environment of the area by comparing it to the plan.

In the case of spatial information system implementation in *Kelurahan Kapatihan Wetan*, Surakarta, the practical use of the system was at the first phase. Public officials in *Kelurahan* office are only producing maps of the *Kelurahan*, and are mostly to present infrastructure data. The maps produced by operator were based on the data that had been compiled. In *Kelurahan Kapatihan Wetan*, until three months after the training was

held, the data compiled into the system was simply infrastructure data of *Kelurahan*. It was not much different from the results of the previous tutorial.

In addition to analyzing the phase of spatial information system use on *Kelurahan Kapatihan Wetan*, this study also found that the level of acceptance of the officers was also at an early stage, namely at the stage of information sharing. As McCall (2004) identified four levels of acceptance in spatial information participation for local planning, i.e. information sharing, consultation, involvement in decision-making, and initiating actions. The highest level is initiating the actions. Initiating the action level in this case may be signified by the ability of the local government to plan a development action using data and decision-making procedures provided by the spatial information system. The key indicator of this level is any system development initiated, owned and implemented by local government. Public officials in *Kelurahan Kapatihan Wetan* was yet to achieve this level since there was no difference on the spatial information system during three months after the tutorial took place.

The second highest level is involvement in decision-making process. The key indicator of this level is the inclusion of the person in charge and the spatial information system to the decision making process. In this particular case, the decision making that takes place in *Kelurahan* level is not strategic decision. Daily routines are well described in the guidelines provided by the City Government or Central Government. Thus, the spatial information system and *Kelurahan* officials are only providing input for the planning. The involvement in decision-making process was also yet to be achieved.

The third level of intensity is the consultation. In this level, spatial information system is used as a practical tool for the public official to give consultation to end-user data. In many cases, end-user have already had data they need from other sources. They need to crosscheck on the validity of the data to *Kelurahan*. In this case,

Kelurahan officer then give a consultation on the data. The key indicator in this level is the presence of updating mechanism to make sure that the data provided in the spatial information system is not obsolete. In *Kelurahan Kapatihan Wetan*, there is no guidelines for updating mechanism, rather the officer in charge updated the data whenever they know that some changes took place. The updating data activity was neither periodical nor comprehensive. Some data may be more obsolete than others.

The lowest intensity level is information sharing. In this level, the key indicator is map-producing activity. This activity has happened in *Kelurahan Kapatihan Wetan*. The *kelurahan* official produced maps based on the request from the end-users. During three months, there were approximately five maps per months produced by *Kelurahan*, mostly to present infrastructure data and borderline of the *Kelurahan* and the sub-areas.

Based on the findings above, the level of use and acceptance of public official in *Kelurahan Kapatihan Wetan* was at low level. *Kelurahan* was basically used it for only presenting data for other users. As Breilling (1996) argued that low practical usage of spatial information planning is caused by three practical obstacles, i.e. (1) understanding of the spatial information system, (2) the scale of the system, and (3) experimental period. While Yeh (1991) considered four factors, i.e. (1) organization of the decision support system, (2) data availability, (3) state of the art of planning, and (4) staffing. McCall (2004) underlined internal factor of the spatial information system operators, while Yeh focused more on the environmental support of the system.

In-depth interview with the operator of the spatial information system in *Kelurahan Kapatihan Wetan* revealed key information from each factors. Generally, both internal capacity of the operators and the environment support were yet good enough to ensure better use level and better level of acceptance. With respect to the internal factor, the most affecting factor is the experimental period of the system. Three months were such a short time considering that spatial information system as a new thing

Table 1: Internal Factors and Environmental Factors

Factor	Sub-factor	Findings
Internal	Understanding of Spatial Information System	Understanding the system, introduced in the training, was sufficient to build more complex spatial information system or simply broaden the scale of the system
	The scale of the system	The scale of the system has fitted the need for data in <i>Kelurahan</i> level since the planning activity in <i>Kelurahan</i> level is mostly the implementation of city planning program
	Experimental Period	Experimental period was too short, the official still trying to figure out how to utilize the spatial information system in the daily activities
Environmental Support	Organizational Factor	- No guidelines for the utilization of spatial information system in daily activities - No specific role of the spatial information system in planning in <i>Kelurahan</i> level
	Data Availability	Spatial data are mostly available although some surveys may be needed Non-spatial data are available
	State of the art of planning	- Planning procedure theoretically recommends the use of spatial information system and maps produced from it - Planning procedure normatively considers spatial information system as a tool in urban planning
	Staffing	No staff were responsible to run and ensure the sustainability of the system Any staff in <i>Kelurahan</i> office can access the spatial information system

on the table. Meanwhile, from the environmental support factor, the organizational and staffing aspects are the most affecting factors. There were no changes in organization in Kelurahan so that the spatial information system has no specific role besides presenting data. Kelurahan officers said that there should be new guidelines that include spatial information system in daily routine activity. Without any guidelines, the spatial information system will be treated as extra activity with no obligation to work with it. Along with new organization, staffing in the system may become more transparent. During the evaluation, there were no particular officer that has the obligation to run the system. Findings from in-depth interview can be seen in Table 1.

4. Conclusion and Recommendation

4.1 Conclusion

From the above findings, we can conclude that the environmental support factors are more likely to affect the success in implementing computer-based spatial information system in *Kelurahan Kepatihan Wetan*. This condition supported by arguments of Yeh (1991) that even though the system had been designed as simple as possible in its user interface, the sustainability of the system still lies in the hand of the decision-makers. The internal factors are relative easy to intervene through practice and tutorial, while the environmental support factors are more complex and has many things to do with the planning system as a whole.

Staffing is the most crucial factor for the sustainability of the system. The underlying factor on staff was basically because of the existing working culture of public sector staff, where if an unclear responsibility was assigned to a group of staff, the “if no one else take the work, that is not my business” prevails. The solution is actually quite clear, assign one staff to be responsible for this GIS for urban planning and management with clear guidelines, clear key performance indicator, clear objectives and sufficient support from the top management. By this, the sustainability of the system will be higher.

4.2 Recommendation

Further study will be necessary to focus on the environmental support factor to gain broader understanding on the practical obstacles in implementing computer-based spatial information system. In Indonesia, the planning procedure is some kind normative issue with a little room to accommodate the changes. To implement a sustainable spatial information system as a tool for local planning, the guidelines in preparing city and region plans need to be revisited. From the planning perspective, it requires a fundamental changes in planning mechanism in Indonesia, although the changes may be technical instead of philosophical nature. Academic perspective on this matter is important to provide a theoretical basis on the implementation of spatial information system to ensure better urban planning process. From the local authority side, the change on working culture needs to be introduced. The culture of everyone’s business must take precedence over no-one business. It means that if no one do it, some one must be able to do it.

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Effects of Neighborhood's Built Environment on Physical Activities in Gated Communities: A Review

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ABSTRACT

The emergence of gated communities throughout the world has generated significant academic interest. Several studies have been carried out that can be found in the body of literature, which have attempted to investigate the various aspects of life within the gated communities. The range of subjects studied within this context includes the types of gated communities, the associated social and governance issues, the travel patterns, and the daily physical activities. The focus of most of these studies, however, has been on the social and governance issues while a little research on the mobility pattern (i.e. walking, cycling and public transport) and physical activities in gated communities has been reported, the available literature suffers from major shortcomings such as identification of suitable indicators to investigate whether these communities have same effects on mobility patterns and physical activities as non-gated communities. The present paper, therefore, attempts to identify the methods for objective as well as subjective study of the mobility patterns and neighborhoods design which affect the physical activities through a systematic review of available literature. The paper identifies suitable indicators to investigate the rate of physical activity in gated communities. Attempt will be made to clearly chart the differences as well as similarities between the issues concerned with physical activity in gated communities and non-gated communities and attempts to introduce new objectives for future studies. The findings of this study are expected to help design an investigation into the merits or otherwise of the active living neighborhoods.

1. Introduction

1.1 Background

Urging by wellbeing experts and organizations on physical activity (PA) notwithstanding, numerous grown-ups are not sufficiently active to accomplish ideal medical advantages (Bauman, et al., 2011). Therefore, there is a requirement for enhanced systems that support and promote PA at the populace level. In the past 15 to 20 years, there has been a significant increase in the research interest about aspects of the built environment (BE) at neighborhood level supporting PA. In comparison to other approaches promoting health, the adaptation of BE to support PA is more effective and sustainable strategy for encouraging people to increase the levels of PA. This has become robust area of research investigation now (Day & Cardinal, 2007). On the other hand there is another type of neighborhood called gated communities. These communities have recently emerged and gained popularity around the world among consumers. Many social aspects of these communities have been investigated up till now but its effect on mobility patterns and physical activity has not studied that much. So the purpose of this paper is to find out proper indicators for investigating the effects of these communities on physical activity.

In this field of investigation the indicators of neighborhood environment are classified into three important categories such built environment at

neighborhood level indicators, social indicators and physical activity facilities. The built environment indicators at neighborhood level are the land use patterns, transportation systems and design features which can affect physical activity (Handy, et al., 2002; Humphrey, 2005). On the other hand Sallis, et al. (2009) concluded that social aspects and sports facilities also affect physical activity at neighborhood level.

Land-use patterns are measured through land-use mix, housing density and connectivity while transportation is measured through the accessibility. The design features are known as aesthetics of the area and are measured through the buildings and streetscapes of neighborhood. Land-use mix is diversity of land-use and provides different destinations to physical activities (Bourdeaudhuij, et al., 2003). In addition, the neighborhood is especially considered important where there is land-use mix because it encourages majority of physical activity, including walking and cycling for different purposes (Giles-Corti, et al., 2008). Similarly the higher housing density is also positively associated with physical activity (Coogan, et al., 2009; Strath, et al., 2007). Connectivity is the third important indicator of land use patterns. It is measured with density of intersections in sqkm or number of cul-de-sacs in a neighborhood. Grid like street patterns for example, is more supportive to walking in contrast with fewer intersections. This is partly because grid-like pattern offers alternative routes to destinations (Li, et al., 2005). Transportation is measured through the accessibility. It is investigated that the access to diverse destinations of both recreational

and utilitarian nature is positively associated with physical activity (McCormack, et al., 2008). The third important indicator of neighborhood built environment is the design features (aesthetics). Design features are measured through buildings (i.e. attractive facades and maintenance) and streetscape (i.e. shaded pathways, street lights, street furniture etc). The lighting, shade and the presence of street furniture also plays a positive role in this regard (Witten, et al., 2012; McCormack, et al., 2008). There is an association between aesthetical aspects of a neighborhood such as landscaping and cleanliness and leisure walking (Cohen, et al., 2010; Hoehner, et al., 2005).

The social indicators (i.e. perception of crime, physical disorder and traffic) and sports facilities (i.e. parks, gym public pools, jogging tracks etc) also effect physical activity. Lack of personal and traffic safety have been found inversely associated with physical activity (Strath, et al., 2007; Miles, 2008; Weir, et al., 2006). The sports facilities also affect the physical activity at neighborhood level (Bourdeaudhuij, et al., 2015).

1.2 Significance and Objective

The above discussion points to many aspects of neighborhoods which can effect physical activity, however, it is necessary to investigate the physical activity level in a new form of neighborhood, which is growing very fast; the Gated communities (GCs). These are the types of built environments that are walled or fenced from the rest of the communities in a city (Blakely & Snyder, 1997). It emerges about gated communities that the aim of these communities is to provide prestigious life in a secured area. These communities are mostly governed by private home owner associations (Blakely & Snyder, 1997). The property values are very high and, in some cases, it is found that the values increase in the vicinities of gated communities as well if the demand is high (Blandy, 2006). Therefore, it is hard to find mixed economic groups in these communities. It is found in many studies that these communities are creating segregation among gated and non-gated, and social exclusion, for example, general public has no access to parks inside gated communities. At the same time Burke and Sebaly (2001) claim that the streets of gated communities are less walk-able as compared to non-gated as they calculated the number of children playing in street to be less in gated communities. Miao (2003) claims that because of less connectivity of these communities with the rest of the city, the streets near gated communities are deserted in China. Landman (2000) says that these communities are affecting urban sustainability due to fragmentations and separation into small pieces. It is observed that there is lack of research on the physical activity level of these communities to provide appropriate policies to the policy makers.

The aim of this paper is to systematically review the literature on said topic and select appropriate indicators for conducting this research in gated communities.

2. Methodology

The study reviews existing literature on the subjects relevant to the built environment and the associated physical activity. We identified the relevant literature, sorting and screening them based on the relevance, and then do the critical assessment.

2.1 Data Sources & Search Strategy

Computer based search on studies on the effects of neighborhood built environment on physical activity from Active Living Literature, Sage

journals and Google Scholar were conducted to examine the English-language literature published between years 2001 and 2015, with the following search terms: built environment, active travel, leisure walk, utilitarian walk, moderate to vigorous physical activity (MVPA) and gated communities. Additional articles that appeared relevant were selected from citation lists of articles identified in the initial search. Specific journals – American Journal of Preventive Medicine, Health and Place, Bio Med, Journal of Physical Activity and Health, Journal of Environmental Health, Journal of Public Health Policy, American Journal of Epidemiology, Journal of Urban Health, Journal of Planning Education and Research, Journal of Planning Literature– were frequently assessed for relevant articles with the same search criteria.

2.1 Inclusion and Exclusion Criteria

The basic inclusion criteria, was the relations between the built environment of neighborhoods and physical activity in gated communities and non-gated communities. There were only two studies found specifically relevant to this topic, therefore, the screening criteria was expanded to include studies that assessed physical activity more broadly including the effects of neighborhood built environment on physical activity without any specific reference to gated communities. The review articles were excluded from this study. Initially eighty (80) studies were included. Forty eight (48) of those studies that solely used qualitative methods or only discussed socio-economic aspects were not retained for further review. Only those studies that attempted to or did quantitative assessment of built environment with some reference to the associated physical activity were reviewed. The method adopted for this study is, therefore, a qualitative approach to summarize the key aspects in this area.

2.2 Study Sample Characteristics

Once the set of studies to be included in this literature review was finalized, certain characteristics of the study sample emerged. The majority of the studies were conducted in the U.S and a few in other parts of the world like Canada, Australia, Europe, UK, Brazil, New Zealand and Hong Kong, which were included in this study. These studies were published between 2001 and 2015. The mean ages among samples ranged between 18 and 65 years, although a couple of studies (Boone-Heinonen, et al., 2010; Weir, et al., 2006) are about children and adolescents. Most of the samples included both men and women except two, which are solely about women (Coogan, et al., 2009; Kerr, et al., 2104). Studies covered all income groups; a few solely focused on low-income (Neckerman, et al., 2009; Bracy, et al., 2014).

3. Results and Discussion

The effects of different indicators and methods on neighborhood level have been systematically reviewed for this study to identify key indicators for conduction of this study in Gated communities. The list of 31 important literatures which is reviewed for this study is given in Table 1 for reference. The indicators which can affect PA are categorized into three sub-parts like the indicators of built environment at neighborhood level, the social indicators at neighborhood level and physical activity facilities. The details of indicators of 31 studies are as follows.

3.1 Built Environment Indicators

The indicators of neighborhood built environment are classified broadly into three categories such as the land-use patterns, transportation and

design features. The land-use patterns are mainly measured with the land-use mix, housing density and connectivity. These were investigated through many studies and it was identified that there is a mix of results with physical activity. A few studies have concluded that land-use mix is associated with moderate level of physical activity (Frank, et al., 2005; Strath, et al., 2007; Aytur, et al., 2007; Sallis, et al., 2009). On the other hand Wineman, et al. (2014) unexpectedly found that increase in land-use mix was associated with less physical activity. According to them, the land use mix at neighborhood level does not facilitate physical activity as it facilitates at city level. In another study, land-use mix was found positively associated with both leisure and transportation activities (Aytur, et al., 2008). The findings of this study are based on a survey in North Carolina involving more than 6000 survey participants as opposed to the study of Wineman et al. (2014), which was based in Detroit, a low to moderate density city, and the outcomes drawn from it cannot be generalized to other areas, especially metropolises.

Housing density is the second important measure for land-use patterns and many researchers have concluded that there exist co-relations between residential density and different levels of physical activity. It has concluded in four studies (Frank, et al., 2005; Aytur, et al., 2007; Witten, et al., 2012; Sallis, et al., 2009). According to Kerr, et al. (2104) and Coogan, et al. (2009) conclusions the residential density is associated with moderate levels of physical activity in older women. While in the Twin Cities Walking Study, it has been concluded that density is not meaningfully related to overall mean miles walked per day or increased total physical activity (Oakes, et al., 2007). The discrepancy in the outcomes of different studies regarding the association between density and physical activity can be attributed to different factors. Two of the studies reporting a positive relationship, for example, focus on women only (Coogan, et al., 2009; Kerr, et al., 2104). However, the other studies claiming a positive association thereof have used either objective measurement (Frank, et al., 2005) or a wide range of data, from 11 countries (Sallis, et al., 2009), for example. Their findings, therefore, seem to be more reliable compared to the studies denying the relationship, one of which was based in Detroit (Wineman, et al., 2014), a low to moderate density city. The other study denying the positive association between density and physical activity used clustered data sampling, which might have impacted their outcome. (Troped, et al., 2010).

Connectivity is third important indicator of land-use patterns and it is measured by counting the number of intersections in a square kilometer and number of cul-de-sacs in a neighborhood. It is concluded by Frank et al. (2005) that street connectivity is associated with moderate levels of physical activity. Similarly, it has been concluded in another study that neighborhood features alone (i.e. sidewalks, front porches, small set-backs) are not enough for walking or to be physically active but street patterns like fewer cul-de-sacs can play a role for walking and to be physically active (Wells, et al., 2008). Boone-Heinonen, et al., (2010) have concluded that streets connectivity within 1km buffers demonstrates the most association with physical activity. At the same time it is concluded by Giles-Corti, et al.(2008) that neighborhood designs that follow the guidelines for livable neighborhoods are more connected and walk-able and are more physically active than those which do not. Wineman et al. (2014) in their study based in Detroit have also observed if the street is connected within locality and integrated; it creates more walk-able or physically active neighborhoods than less connected streets. So it can be concluded through the above literature about land-use patterns (i.e. land-use mix, housing density and connectivity) has positive association with physical activity at neighborhood level. Therefore, these three measures are needed to be

investigated in gated communities because gated communities have shortcomings of land-use mix, housing density and connectivity with other neighborhoods.

Transportation: The indicator of transportation is accessibility to different destinations (i.e. public transport, school and work). It is measured through the presence and proximity of destinations and destination access. For example Witten et al. (2012) in their study concluded that the three measures including destination access were associated with 7% increases physical activity when it is measured objectively through accelerometer. This is an important indicator for gated communities to be investigated because the accessibility of gated communities is limited. These communities have guarded or gated access to the other areas to their vicinity.

Design Features: The design features of a neighborhood are also known as aesthetics of the area. These are measured through the buildings and streetscape of neighborhoods. Buildings measurements are classified as the attractive facades as well as the maintenance of buildings in a neighborhood. The streetscape of neighborhood is the infrastructure availability, shades paths ways, street lights, benches and hard and soft cape of streets. Strath, et al. (2007) and Craig, et al. (2002) concluded that aesthetics are positively associated with physical activity. Poor neighborhoods having fewer, dirty, less landmark buildings, non-availability of sidewalks and high crime rate are less physically active than affluent areas which have more aesthetics and safety (Neckerman, et al., 2009). It is evident from the above that better accessibility and good design features within neighborhoods are associated positively with physical activity; it is agreed upon by all the studies. This indicator is also an important indicator for investigating physical activity in gated communities because these communities have very attractive and maintained buildings and good streetscape.

3.2 Social Indicators

Social indicators are also found very important in these reviewed studies to effect physical activity. The social indicators are the perception of crime; physical disorder and traffic safety etc. Sallis et al. (2009) concluded that the perceptions of crime have a negative association with physical activity. At the same time it is found in some other studies that high physical disorder (litter, graffiti, lack of greenery) of neighborhood is negatively associated with physical activity (Miles, 2008). Similarly in case of children the inner city children engage in less physical activity than suburban and inner city parents are more concerned about safety of neighborhoods for physical activity of their children (Weir, et al., 2006). Traffic related characteristics like traffic control is found positively associated with active travel (Strath, et al., 2007; Neckerman, et al., 2009). At the same time a significant interaction was observed between number of street intersections and perception of safety from traffic in older adults (Li, et al., 2005). The sense of neighborhood safety is significant and it has been generally concluded that it encourages physical activity through reviewing the above mentioned literature.

3.3 Sports Facilities

Physical activity facilities are also very important indicator to enhance moderate to vigorous physical activity (MVPA) at neighborhood level. It is measured through the availability of sports grounds, indoor games facilities, swimming pools, jogging tracks and public parks etc. Physical activities facilities are positively connected to vigorous activity (Mdpi Ag, 2015). Residential outdoor table tennis courts and public indoor

Table 1: Summary of Literature Review (1 of 4)

No	Author/Year	Country	Built Environment (BE) variables at neighborhood level	Physical Activity (PA) variables	Research methods	Outcome
1	Craig et al., 2002	Canada	- No of destinations - Social dynamics - Walking routes - Transportation system - Visual interest - Visual aesthetics - Threats from traffic and crime	PA in 27 neighborhoods of Canada Observational method for BE and Questionnaire for PA and 1996 Canadian census	Cross-sectional Hierarchical linear modeling	Neighborhood aesthetics such as visual aesthetics have positive associations with leisure walk physical activity are important factors
2	Berrigan & Troiano, 2002	US	- The neighborhoods built before 1946 - The neighborhood from 1946-1973 - The neighborhood after 1973 Observations and Objective method of data collection Third National Health and Nutrition Examination Survey data	Nonworking, leisure-time physical activity for 1-mile for 20 times in a month and home age in U.S. adults in urban/suburban and rural areas. Self-reporting (Questionnaire)	Logistic regression was used to estimate odds ratios	Social variables like home age is an important factor because the people who have lived before 1946 and from 1946 -1973 walked more 1mile 20 times per month as compared to houses built after 1973 but this association was just in urban areas and suburban not in rural counties
3	De Bourdeaudet et al., 2003	Europe	- Residential density - Land-use Access to local shopping - Availability of sidewalks/bike lanes - Neighborhood aesthetics - Perceived safety from crime and traffic - Connectivity - Satisfaction with neighborhood and its services Layout plans / survey	- Sitting time - Walking - Moderate activity - Vigorous activity International Physical Activity Questionnaire (IPAQ)	Cross-sectional analyses	<i>Long time sitting of physically inactivity was related to more perceptions of crime and long distance form shopping areas.</i> Walking was also related to less land-use mix and accessibility to shopping
4	Li, et al., 2005	US	- Neighborhood Vs. Resident level walking/PA - density of places of employment - household density - green and open spaces for recreation - number of street intersections - perception of crime - Recreational facilities Geocoding at neighborhood level	- walking at the resident level, - walking at neighborhood level Self-reporting (Questionnaire)	Cross sectional, multi-level design multistage sampling	At Neighborhood level the density of places of employment, household density, green and open spaces for recreation, number of street intersections were positively associated with walking At resident level the perception of safety, number of recreational facilities nearby was positively associated with PA.
5	Addy et al., 2004	US	- People active in neighborhood - Presence of side walks - Street lighting in neighbors - Use private recreational facilities - Neighbors can be trusted - Community malls - Community parks	Social and environmental support to walking and physical activity Self-reporting (Questionnaire)	Cross-sectional	Good street lighting trusted neighbors and private recreational facilities (i.e. parks, playgrounds, and sports fields), access to malls were positive association with walking and PA at neighborhood level and community level
6	Frank et al., 2005	US	- Land mix of 1sq km of residential, commercial, office - Connectivity - Housing density	Instrumental method the use of accelerometer for 2 days for PA.	Cross-sectional Linear and logistics regression	Land use mix, connectivity and housing density were important for moderate level of physical activity by having >30min/day walk.
7	Hoehner et al., 2003	US	- No. of destinations - No. of recreational facilities - Side walk/bike lane and public transport present - Feel safe from traffic - Neighborhood pleasant - Trees along neighborhood - Free of garbage, litter - safe from crime	Engage in <i>Any transport activity</i> Recreational activity MET/did not meet the health recommendation for 30 min/day PA by any of above two Self-Reported (Questionnaire)	Cross-section study of high and low walkability neighborhoods	<i>Transportation activity was negatively associated with sidewalks and aesthetics but positive association was with no. of destinations and public transit</i> Recreational activity was positively associated with recreational facilities.
8	Evenson et al., 2005	US	New trail construction effects on PA - Walking, bicycling and jogging on new trails - People who were living within 2-mile area of multi-trail	10 minutes' walk for any purpose leisure, work or physical activity Self-Reported (Questionnaire)	Quasi-experimental Multi variable logistic models	<i>No increase in physical activity was found due to new trail.</i>

Table 1: Summary of Literature Review (2 of 4)

No	Author/Year	Country	Built Environment (BE) variables at neighborhood level	Physical Activity (PA) variables	Research methods	Outcome
9	Weir, Etelson & Brand, 2006	US	Low income Inner city and middle class suburban neighborhood parent perception about safety for their children PA - gangs, - child aggression, - crime, - traffic and personal safety 20 item Questionnaire was used	Participation of outdoor sports and dance run by school after school Plays/walk/bike outdoors with adults/alone Plays neighborhood park and play grounds	Cross-sectional	Inner city children were less physically active than suburban children Inner city parents were much concerned about safety than suburban But inner city children's physical activity levels were negatively correlated with parents perception of safety compared to suburban
10	Strath, Isaacs & Greenwald, 2007	US	- Infrastructure - Land-use - Landscape - Aesthetic Safety Ortho-photographs (aerial photographs), Census block information (GIS), field visits were used	Walking and cycling using 15-min walk 10 min cycling from an individual place of residence Self-Reported (Questionnaire)	Cross-Sectional Correlation	Infrastructure, land use, landscape, aesthetics were positively associated with PA Poorly maintained or missing sidewalk, crosswalks, and bike paths and traffic safety discouraged PA
11	McCormack, et al., 2008	Australia	- Destination present - Destination mix: Count of recreational destination Count of utilitarian destination Survey / Plans	walking for transportation walk for recreational vigorous walk (last 2 weeks) Self-Reported (Questionnaire)	Cross-sectional Stratified sampling	Proximity and accessibility were positively related to active transportation not with leisure walking or vigorous activity
12	Giles-Corti et al., 2008	Australia	18 livable, 45 conventional and 11 hybrid neighborhood attitude towards PA - No. of recreational destinations within a 15-min walk of home for recreational walk - No. of Transport destinations within 15-min of home mean for transport walk Survey/ Plans	Self-efficacy Social support; walked with family Walk with the dog in neighborhood Instrumental method: use of pedometer for 7 days	Longitudinal quasi-experimental	The neighborhood have livable guideline were more walk able and physically activity than those which were not.
13	Aytur et al., 2007	US	Land-use Mix, non-motorized transportation improvements and implementation tools (30 plans studied) - No mixed-use classification, no NMTI, no implementation tools - Mixed-use classification or NMTI; 0-4 implementation tools - Mixed-use classification and NMTI; moderately comprehensive implementation tool set (1- 4 tools) - Mixed-use classification and NMTI; most comprehensive implementation tool set - NMTI=non-motorized transportation improvements	No. of leisure time PA, Leisure-time walking 150 minutes of leisure-time walking per week. self-reported (Questionnaire)	This cross-sectional study	The neighborhood which had land-use mix, non-motorized transportation improvements and implementations tools were more associated with leisure walk, active travel and even the low income people living in higher county were more physically active for transport. Land-use and transport plans encourage physical activity if they are implemented properly
14	Oakes et al., 2007	US	Density Land-use Mix Connectivity Street pattern Infrastructure Presence of destinations Safety and interest Plans/questionnaires/interviews	Travel walk Leisure walk Mean mile walked/day Mean total activity count/day Objective method (i.e. Accelerometer for 7 days)	Cross-sectional observational study	Travel walking was associated with PA in higher density neighborhoods Leisure walk was associated with low connectivity Neither density nor connectivity was associated with mean mile walk /day or mean total activity count /day
15	Wells & Yang, 2008	US	- Total linear length of street (1/2mile) - No. of street intersections - No. of cul-de-sacs - Employments/housing and service density - Service-job/population ratio - Job/residence ratio - Land-use mix	Are there differences in weekly walking between women living in neo-traditional (experimental) neighborhoods and those living in conventional (control group) suburbs Self-reporting (Questionnaire)	Quasi-experiment of cross-sectional and longitudinal data	Women who moved to new places with fewer cul-de-sacs on average walked more but Unexpectedly land-use mix were associated with less walking Neo-Traditional features were negatively associated with PA
16	Miles, 2008	US	- Land use - Neighborhood disorder (litter, graffiti, lack of greenery, traffic disorder) - Perceived safety Directly observed by trained surveyors	Encouragement of use of playground by children and level of physical activity Self-reporting (Questionnaire)	Cross-sectional	Neighborhood disorder was associated with adults occasional involvement in sports only among women Safety was not associated with PA Disorder had no association with children use of Playground

Table 1: Summary of Literature Review (3 of 4)

No	Author/Year	Country	Built Environment (BE) variables at neighborhood level	Physical Activity (PA) variables	Research methods	Outcome
17	Neckerman et al., 2009	US	Aesthetic in neighborhood Safety in streets Poor census tracts had significantly	Field survey of poor and non-poor neighborhood Observations	quintile and logistic reg	Improved neighborhood conditions (i.e. aesthetics and safety) was associated to reduce disparities and increase PA
18	Sallis et al., 2009	Hong Kong	- Land-use Mix; many stores around - Residential density - Access to transit - Infrastructure side walk/bike lane - Free/ low cost recreational facility - Perceived crime	3 days vigorous-intensity PA for 20 min/day 5 days moderate level of PA for 30min/day 5 days for combination 600MET minutes/week Self-Reported (Questionnaire)	Cross-Sectional Logistic regression analysis	Five variables had positive association with PA Low cost recreational facilities to side walk Neighborhood environment had strong potential to effect physical activity
19	Coogan et al., 2009	US	urban form level vs. Individual covariates - Street interconnectedness and traffic - Availability of public transit and buses. - Presence of sidewalks and distance to parks. - Housing density and average block area - Intersections density and with 4 ways	<i>Utilitarian walk</i> <i>Exercise walk</i> <i>Vigorous walk</i> >5 relative to <5 hours physical activity/ week Self-Reported (Questionnaire)	Cross-sectional	Housing density has strongest association with utilitarian walking followed by availability of public transit <i>Women who were moved to low density 31%decrease in utilitarian walk</i>
20	Cohen et al. 2010	US	Five intervention parks had been scheduled for major improvements and each intervention park was matched with a similar park (i.e., Comparison Park) which was not planned to receive budget for upgrades by the city.	Self-reporting in two shifts before and after the improvements	Experimental design	<i>Overall park use declined in both types of parks although the perception of safety increased in intervention than comparison park but this alone was not enough to result in increased park use</i>
21	Troped et al., 2010	US	- Intersection density(1-km) - Land-use Mix(1-Km) - Population and housing density(1-km) Vegetation Index(1-km) Surveys	Wearable Geo Logger is a GPS device which records speed and position	Cross-sectional Multiple regression model	All had positive association with PA except vegetation index
22	Fitzhugh, Bassett Jr. & Evans, 2010	US	Retrofitting of urban greenway/trail 5 control and 5 intervention neighborhood - Land-use mix - Population density, ethnicity, Intersection connected to 3 or more streets Survey	2 hours of physical activity was directly observed in neighborhood and school children using trial for active travel to school	Quasi-experimental (control group)	<i>For physical activity there was increase in intervention neighborhood and decrease for control but for active travel to school no difference was noted</i>
23	MacDonald et al., 2010	US	Body mass index (BMI) Obesity Physical activity levels comparison of these above factors pre - and post-light rail transit (LRT) construction Propensity score weighting approach adjusted for user and non-users of LRT	Public transit use Plan to use LRT LRT usage Self-reported (Questionnaire) and observation	Cross-sectional	The construction of Light transit rail had positive effect on PA and reduction in BMI and obesity.
24	Boone et al., 2010	US	- number of links (street segments) - number of nodes (intersections); Intersection density is the number of 3 or more-way intersections/square km. Plans/surveys	Facility counts weighted by the inverse distance from each respondent (facilities between 1 and 8 km)	Negative binomial regression models	PA facilities within 3 km buffers and intersection density within 1k buffers exhibited the most consistent associations with MVPA
25	Bauman et al., 2011	20 countries	Sitting time in 20 countries Age Gender Income group Education Questionnaire	How much time was spend in sitting in weekdays Self-Reporting (Questionnaire)	Cross-sectional	Median sitting time varied widely across countries
26	Witten et al., 2012	New Zealand	- destination access - street connectivity - dwelling density - land-use mix - streetscape quality Plans/surveys	Transport walking Leisure walking Self-Reported (PA at Light, moderate and vigorous level at least 10 minutes) Objective Method (accelerometer 7 days)	Cross-sectional multilevel regression analyses	Street connectivity was associated with leisure PA. Destination accessibility was associated with transport walking. Street connectivity, destination access, dwelling density with self-reported and objectively measured PA had strong association for moderate level PA
27	Kerr et al., 2014	US	Land use mix was calculated as the evenness of the distribution of acreage Residential Commercial Office Institutional land (spatial data of census)	Recreational walking Moderate recreational PA Strenuous recreational Self-Reporting - World Health Improvement (WHI) (Questionnaire)	Linear regression	Total walking was associated to walkability index of half mile (recreation facility, density and distance to coast) <i>Total physical activity was negatively associated with distance to coast and positively with recreational facilities</i>

Table 1: Summary of Literature Review (4 of 4)

No	Author/Year	Country	Built Environment (BE) variables at neighborhood level	Physical Activity (PA) variables	Research methods	Outcome
28	Wineman et al., 2014	US	- high density: - Land use mix: - Street network Integration Plans/survey	Physical Activity (MET minutes) Transportation Physical Activity (MET minutes) Leisure Physical Activity Overall (MET minutes) Transportation + Leisure Self-Reported (Questionnaire)	Correlation	Independent predictors, higher density and multiple land-uses tended to were not that much effective to encourage walking. However residents of neighborhoods with strong well connected streets networks have high walkability as compared to those which have less connectivity
29	Dill et al., 2014	US	Pre- post installation of bicycle boulevard Rain Being women Living closer to down town Attitudes towards bicycle Walking and car safety Education(4-year of college degree) Married Mean age (35-44) BMI (body Mass Index =height x weight)	>10 min bicycle >20 min walk Physical activity and active travel Objective Method (i.e. Accelerometer and GPS was worn for 5 days)	Natural experiment Multivariate regression model	No correlations was found in experimental area with MVPA and active travel Study could not confirm an increase in physical activity or active transportation among adults with children living near newly installed bicycle boulevards
30	Bracy et al., 2014	US	A GIS-based walkability index was calculated for a street-network buffer around each participant's home - Perceived crime - Traffic - Pedestrian safety	Total physical activity measured using accelerometers Transportation and leisure walking measured with self-reports (IPAQ-long).	Exploratory analyses used two cross-sectional	No evidence that safety concerns reduced the beneficial effects with physical activity outcomes, possibly because pedestrian safety items (cross walks, sidewalks) were not as subjective as those on crime and traffic safety
31	Health gov, 2015	Hong Kong	Number of neighborhood recreational facilities (indoor and outdoor, public and residential) Observations and Geographical Information System data	Objective method (i.e. ActiGraph accelerometers for >= 4 days)	Correlation	The number of public recreational facilities was associated with the corresponding facility perceptions but the size of effect was generally lower than for residential facilities

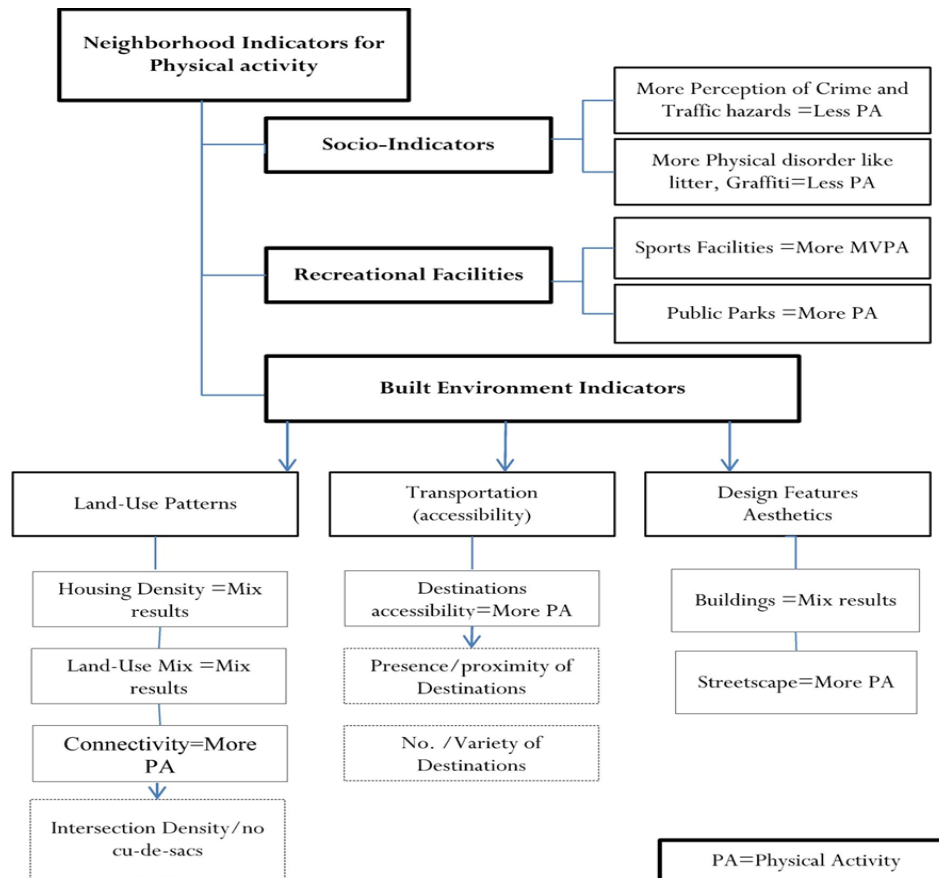


Figure 1: Indicators of Built Environment at Neighborhood level

swimming pools, the observationally-assessed presence of tennis courts and swimming pools, and the perceived presence of bike lanes and swimming pools were positive determinants of MVPA. Sallis et al. (2009) have also concluded that presence of free or low cost recreational facilities is positively associated with physical activity. Parks located within 1-mile radius from homes are positively related to physical activity in older women according to Addy, et al., (2004). Most of the studies reviewed have shown positive association between physical activity facilities and physical activity. However, a study has concluded that improvements to parks may not automatically result in increased use and physical activity (Cohen, et al., 2010). It can be broadly concluded through literature review that sports facilities whether indoor or outdoor have positive association with moderate to vigorous physical activity at neighborhood level and gated communities provide many sports facilities to attract many people attention towards them. The details of above discussed indicators are given in the Figure 1.

4. Conclusion

It is concluded that most of the indicators like indicators of neighborhood built environment, social indicators, and physical activity facilities at neighborhood level affect physical activity to some extent. The promotion of walking and vigorous activities is contributions of built environment at neighborhood level to facilitate not only moderate to vigorous physical activity (MVPA) but also to bring about the behavior change among individuals and communities.

The measures of land use patterns of built environment like land-use mix and housing density show mix results on physical activity while the connectivity represented positive association on physical activity. Similarly transportation, the second important indicator of built environment, which is measured through accessibility also affect positively to physical activity at neighborhood level. Design features are the third important indicator of built environment, which is measured through building and streetscape. Buildings have mixed effects on physical activities in neighborhoods while streetscape has positive association with physical activity.

Social indicators are the perception of crime and physical disorder which affect physical activity at neighborhood level. If there is more perception of crime, there will be less physical activity. Same is the case with physical disorder (litter and graffiti). When there is more litter and graffiti, there will be less physical activity.

Finally the physical activity facilities like sports grounds, gyms and jogging tracks also play a vital role in moderate to vigorous physical activity. If the neighborhood has physical activity facilities, the residents will be more physically active.

5. Recommendations

From the review of the literature, following recommendations are summarized for future research on gated communities.

It has been generally concluded by researchers that the land-use patterns (i.e. Land-use mix, housing density and connectivity) promotes physical activity. This conclusion may suggest that physical activity levels are expected to be lower in gated communities, where the land use is seldom mixed, housing density is low and there are dead end streets in gated communities. However, this needs to be

investigated along with exploration of other factors that may be involved.

The second important indicator for built environment is accessibility of gated communities. It is needed to be investigated how the limited accessibility with its vicinity of these communities affect physical activity.

The design features at neighborhood level like building and streetscape which can affect physical activity. this is a very important feature of gated communities to attract people through aesthetics of the area. Therefore this needs to be investigated that whether the aesthetics of gated communities has increased physical activity of the residents of gated communities.

Social indicators like the sense of neighborhood safety and traffic safety are significant, and it has been generally concluded that it encourages physical activity. It is expected that the safety perception is found more in the gated communities because it is the main objectives of gated communities for coming into existence; hence increased levels of physical activity should be observed. An investigation is required in this regard.

Finally the physical activity facilities like gym, jogging tracks, sports facilities also encourage moderate to vigorous physical activity (MVPA) and it is found that gated communities provide more physical activity facilities as it is one of the marketing tools of these communities to be popular so the effects of these facilities on PA among the residents of gated communities need to be investigated.

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