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Urban Optimum Population Size and Development Pattern Based on Ecological Footprint Model: Case of Zhoushan, China

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ABSTRACT

The agglomeration of population in the city can reflect the prosperity in the economy, society and culture. However, it has also brought a series of problems like environmental pollution, traffic congestion, housing shortage and jobs crisis. The results can be shown as the failure of urban comprehensive function, the decline of city benefits, and the contradiction between socioeconomic circumstance and ecosystem. Therefore, a reasonable population capacity, which is influenced by ecological resources, urban environment, geographical elements, social and economic factors, etc., is objectively needed. How to deal with the relationship between the utilization of natural capital and development of the city is extremely essential. This paper takes Zhoushan Island as an example, which is the fourth largest island off the coast of China. Firstly, the interactively influencing factors of urban optimal population are illustrated. And method is chosen to study the optimal population size. Secondly, based on the model of ecological footprint (EP), the paper calculates and analyzes the ecological footprint and ecological capacity of the Zhoushan Island, in order to explore the optimal population size of the city. Thirdly, analysis and evaluation of the resources and urban environment carrying capacity is made. Finally, the solution of the existing population problems and the suggestion for the future development pattern of the city are proposed in the urban eco-planning of Zhoushan Island. The main strategies can be summarized in two aspects: one is to reduce the ecological footprint, the other is to increase the ecological supply. The conclusion is that the current population of Zhoushan Island is far beyond the optimum population size calculated by the ecological footprint model. Therefore, sustainable development should be the guidance for urban planning in Zhoushan Island, and a low-carbon development pattern for the city is advocated.

1. Introduction

In the early phase of urbanization, big cities usually have suitable location conditions, reasonable spatial structures and good development conditions with high efficiency while compared to the small ones, which means better service facilities, higher living standards and more job opportunities for the city inhabitants. At the same time, the agglomeration effect of population can bring high socioeconomic efficiency and rapid expansion for the city development.

However, as increasing population gathering in the city, some negative effects appear constantly. When the population is beyond the maximum capacity ecological environment can carry, disorders of the urban system will be caused by the impact of ecological environment deterioration. In numerous large cities in Asia, traffic congestion, environmental pollution, resource shortage and other negative issues occur in varying degrees. The population concentration with the rapid urbanization process, which leads to the population exceeding the supporting capacity of the urban ecological environment, is one of the primary reasons for the contradictions in the process of urban development. Therefore, researches on the optimal population size of the city are of great importance, and must be an indispensable part in the study of urban development.

On the other hand, scientific measurement of the urban population size and understanding of the resources carrying capacity of the city can be helpful to control the influence which urban activities have on the environment within the adjustment ability of ecological system. In addition, they would be important reference indexes of urban planning, and of great significance to the sustainable development of the city.

As the population size is one of the important factors for the urban sustainable development, in this paper, the ultimate goal of the research is to explore urban optimum population with the ecological footprint model. And the solution of the existing population problems and the suggestion for the future development pattern of the city are supposed to be proposed according to the analysis of the model.

2. Urban Optimum Population Size

2.1 Theory of Optimum Population

Optimum population is a concept of population theory, which means an moderate quantity of population for the development of a country or a region. It refers to a stable population which can bring the maximum economic benefit under a certain level of productivity.

The concept was firstly proposed by Edwin Cannan (1888). He emphasized the maximizing revenue of the industry, which is the standard of the economic moderate population. The concept refers to a

stable population which can bring the maximum economic benefit under a certain level of productivity. And Cannan (1964) proposed that population should keep proper relationship with the capacity of industrial and agricultural production, in order to achieve the maximum benefit for nation economy. Later the theory was developed by Sauvy (1970), who studied the relationship between population growth and economic growth and proposed the dynamic optimum population theory. The theory not only developed from a static state to a dynamic one, but it also focused on other elements like welfare, population quality and employment besides the economic benefit. With the issues of ecological environment becoming increasingly important, more researchers, such as Forrester (1971), Meadows (1972), and Vitousek (1986), started to focus on the limit to the population, which has a strong relationship with environment carrying capacity. In the phase after 1990s, more studies on the Theory of Optimum Population occurred in China. Many scholars began to study the moderate population size with the perspective of sustainable development, which has been an highlight. The theories are mainly about the population development strategy, balance of population and ecosystem, population system with different elements (Gao, 2010).

As a conclusion, the studies of early optimum population theory paid more attention to economic factors, while later the environment carrying capacity began to be involved in the measurement of population size. And now the theory has been furthered with sustainable development strategy.

2.2 Effect Factors

The carrying capacity of urban population is limited with certain condition. And the population size is determined by numerous factors which interact with each other and have combined effect on the population. The factors mainly includes environment and resources, location, urban evolution, economic and social conditions.

2.2.1 Environment and Resources

The natural ecosystem is the physical material basis for human to live. If the pressure of the human is not beyond the bearing capacity, the urban ecosystem will be under a safe condition, which can be the foundation of a sustainable development for economy and society. On the contrary, the ecological resources and environment will suffer from unrecoverable damage, and city development will be influenced. Therefore, the optimum population is under the restrictions of resources and environment, which is the indispensable part determining the population size. This basic factor applied in the study of ecological footprint and ecological capacity to calculate the optimum population size of a city or a region.

2.2.2 Location

The location of a city represents the basic difference, which is determined by geographical conditions, transportation conditions and the role of the city within the whole urban region. The geographical location represent the natural condition, which has a great influence on the development of a city. For example, the coastal cities usually have better chances and rapid development speed than other cities. And transportation conditions also affect the development of a city. For instance, a city with inconvenient accessibility usually has a relatively smaller size. In addition, the regional specialization will have impact on the city function. In general, different locations will cause the adjustment of city function and land use, which will stimulate the change of spatial form and population capacity.

2.2.3 Urban Evolution

According to the model proposed by Peter Hall in 1984, the development phases of urban evolution mainly include urbanization (population concentration in the city center), suburbanization (population spread to the suburbs) and counter-urbanization (the increasing of the population spread). During the different phases, the distribution of the population changes between the center and edge of the city, which presents the dynamic change of the population capacity of the city as well. In conclusion, the evolution of the population experiences the phase of urbanization with population concentrating in the city center, and the phase of suburbanization with migration to the suburbs.

2.2.4 Economic and Social Factor

Firstly, the economic and social factor is related to the level of economic development, which is a comprehensive indicator. The influence of the economic development level on the urban population capacity can be reflected through the living standard and the number of jobs provided. The job opportunities supplied are the primary factor affecting the population capacity.

Secondly, change of economic and social activities is influenced by city function, which has a deep relationship with the industry structure. In the different phases of economic development, the adjustment of the urban industry structure can promote the replacement and upgrade of the industry, which would lead to the transformation of urban land utilization and urban spatial form. At last, it will cause the labor migration and the fluctuations of population.

Thirdly, the carrying capacity of urban facilities is an important factor, which contains the aspects of goods supply and waste disposal. The population capacity cannot be enlarged if the living standards are improved without good urban facilities. And the carrying capacity is affected by city economy. If the economic strength is powerful enough, the population capacity can be increased.

Based on the different factors, there are numerous kinds of mathematical model for calculation and research on urban optimum population size. For example, there are multi-objective decision making approach (Jin et al, 2010) for multi-factor evaluation, short board principle of minimum volume factors(Xu, et al, 2003), concept model based on the urban ecology (Ren, 2006), etc. However, the above methods with complicated factors which contain more or less subjective factors, and among which there is no acknowledged quantitative method. In this paper, the study mainly takes the ecological environment and resources as the main factor. Through the analysis of ecological footprint, the article calculates the urban optimum population size and explores how to achieve sustainable development.

3. Method

3.1 Concept of Ecological Footprint

The concept of ecological footprint was proposed by Willian E.Rees (1992). Further it was improved by Wackernagel (1996), which is an innovative development of quantitative measurement in the field of sustainable development. Ecological footprint is mainly used for the calculation of biological production area, which could maintain the resource consumption and waste elimination under the certain

population and economic size. Ecological carrying capacity means the sum of biologically productive land area provided by a district. After comparing the resources and energy consumption of a country or a region to the ecological capacity it has, we can estimate the development of the country's or the region's ecological safety. If ecological footprint is less than ecological carrying capacity, ecological remainder appears, which indicates that human influence is within the scope of ecological carrying capacity provided by the region. Then the ecosystem is safe. Otherwise there will be an ecological deficit, which indicates that the human needs for products and services have exceeded the supply of the ecosystem.

The calculation of ecological footprint is based on two facts: (1) for the vast majority of resources consumption and waste generated, people can determine the quantity (2) the resources and waste can be converted into a corresponding biologically productive area. Therefore, ecological footprint of any known population (an individual, a city or a country) is the total biologically productive area (including land and water area) that produce all the resources consumed by these population and absorb the waste generated.

3.2 Calculation Model

Ecological footprint can be used to compile population, resource consumption and resource efficiency into a simple and convenient means, which makes the comparison between different cities easier as well. In the concept of ecological footprint, there are 6 types of biological productive land, including cropland (providing food crops and economic crops), grazing land (suitable for the animal husbandry), forests (including plantation and natural forest), carbon uptake land (absorbing the waste generated by fuel) built-up land (including residential area and roads) and fishing grounds (mainly providing aquatic products).

According to the model of Wackernagel (1996), The following one is the formula for the calculation of ecological footprint:

$$EF = N \times ef = \sum_{i=1}^{n} aa_i = N \sum_{i=1}^{n} \left(c_i / p_i\right) r_j$$

Where:

EF is the total ecological footprint.
N is the population size.
ef means the per capita footprint - by summing all the ecosystem areas appropriated.
i is the type of consumption item.
aa_i is the per capita land area of the type i.
c_i is per capita consumption of type i.
p_i is the average annual productivity or yield of type i.
r_j is the equivalence factor.

For the ecological capacity, the formula is:

$$EC = N \sum ec = N \sum (a_j r_j y_j)$$

Where:

EC is the total ecological capacity.
N is the population size.
ec means the per capita ecological capacity.
j is the type of land.
a_j is the per capita land area of the type j.
r_j is the equivalence factor.
y_j is the yield factor.

***Figure 1**: Location of Zhoushan Island*
(Source: base map is available from http://chiangbt.github.io/webcontent/Mapboxmap.html)

For the calculation formula above, the ecological footprint (EF) essentially measures the human demand for basic subsistence from ecological service. While the ecological capacity (EC) is the service which can be provided by the natural ecosystem. By comparing the gap between Ecological footprint (EF) and ecological capacity (EC), it can quantitatively reveals the impact human beings have on the ecosystem. The index is a quantitative analysis about the influence of human social activities on the natural ecological environment.

4. Urban Optimum Population Size of Zhoushan Island

4.1 Introduction of Zhoushan Island

Zhoushan Island is the main island of Zhoushan Archipelago. It is located in the southeast of Hangzhou Bay and in the northeast area of Zhejiang province. The whole island is oriented northwest-southeast. Zhoushan Island is the largest island in Zhejiang province, and the fourth largest island off the coast of China (Figure 1). The closest point of the island to the mainland is about 8.1km. The island is surrounded by sea, which forms an independent ecosystem. The scenery is beautiful with mountainous terrain, which is a combination of mountains, city and sea. The total area of the island is 502.65 km2. According to the Sixth National Population Census (2010) in China, the total population of Zhoushan Archipelago is 1,221,261, and the population of Zhoushan Island is 660,900. With the special natural conditions, Zhoushan Island can be regarded as an independent ecosystem model, which is suitable for the calculation of ecological footprint.

4.2 Ecological Footprint of Zhoushan Island

Based on the concept of the ecological footprint, the method mentioned above, and the data information mainly extracted from Zhoushan City Statistical Yearbook (2011), the calculation of the

***Table 1**: Ecological footprint of Biological Resources in 2010*

Biological resources	Global average annual production (p_i) (kg/gha)	Consumption per person* (c_i) (kg/person)	Per-capita ecological footprint (aa_i) (gha/ person)	Type of ecologically productive land
Grain	2,744	60.90	0.022194	Cropland
Vegetable	18,000	85.80	0.004767	Cropland
Oil	1,856	7.70	0.004149	Cropland
Pork	285	12.00	0.042105	Grazing land
Beef and mutton	33	1.00	0.030303	Grazing land
Poultry	940	5.10	0.005426	Grazing land
Dairy products	502	11.40	0.022709	Grazing land
Poultry and Eggs	400	7.90	0.019750	Grazing land
Fruit	18,000	44.20	0.002456	Forest land
Tea	566	0.06	0.000106	Forest land
Aquatic products	29	29.9	1.031034	Fishing grounds

*Source: *Zhoushan City Statistical Yearbook (2011),* pp: 11-27.

ecological footprint in Zhoushan Island is mainly composed of two parts: biological resources consumption and energy consumption.

4.2.1 Biological Resources Consumption

Biological resources consumption can be divided into several categories like agricultural products, animal products, forest products, fruit, wood etc. And there are further classifications. The main types of production and the results of calculation are shown in Table 1.

4.2.2 Energy Consumption

The part of the energy consumption mainly deals with the data of coal, gas, electricity and other energy source. And the energy consumption will be converted to land area when calculating the ecological footprint. Main energy sources in Zhoushan Island are coal, gasoline, diesel oil and electric power. The conversion factor is according to the average calorific value of fossil energy production land in the world. And the results in Table 2 shows the conversion result from energy to the area of ecologically productive land.

4.2.3 Calculation of Ecological Footprint

The above process has illustrated the calculation of different consumption separately. Big difference exits in the production capacity of different land. Therefore, it is essential to multiply the area of each category of land by the equivalence factor, which can convert the result to a unified and comparable standard. Thus, various productive areas are summed up, and the results are multiply by the corresponding equivalence factors. The following table 3 shows that the ecological footprint of Zhoushan Island in 2010 is 1.006 gha per person.

4.3 Ecological Capacity of Zhoushan Island

4.3.1 Equivalence Factor and Yield Factor

Generally, the qualities of resources are totally distinct in different countries and districts. Therefore, the area of the same land type cannot be compared directly, which needs to be adjusted. And the distinction could be expressed by yield factor. Specifically, yield factor refers to the difference between the local production of a certain biological production area within a country or a region, and the average one of the world. The yield factor in the paper is from the average number of

***Table 2:** Ecological footprint of energy Consumption in 2010*

Type of energy	Global average annual production (GJ/ha)	Conversion factor (GJ/ ton)	Net Consumption[a] (ton)	Per-capita eco-footprint (gha per person)	Type of ecologically productive land
Coal	55[b]	20.934	1,668,916	0.520134	Carbon uptake Land
Gasoline	93[b]	43.124	4,386	0.001665	Carbon uptake Land
Diesel oil	93[b]	42.705	54,315	0.020422	Carbon uptake Land
Electric power	1000[c]	11.840	213,838	0.002073	Built-up land

[a] Source: *Zhoushan City Statistical Yearbook (2011),* pp: 1-10.
[b] The unit is GJ/ha
[c] The unit is kilowatt-hour./ha

Table 3: *Ecological footprint of Zhoushan Island in 2010*

Land use type	Demand area (gha per person)	Equivalence Factor[a]	Equivalence area (gha per person)
Cropland	0.031110	2.82	0.087730
Grazing land	0.120293	0.54	0.064958
Forest land	0.002562	1.14	0.002921
Fishing grounds	1.031034	0.22	0.226827
Built-up land	0.002073	2.82	0.005846
Carbon uptake Land	0.542220	1.14	0.618131
Ecological Footprint			1.006413

[a] *Equivalence factor used in the table is from the calculation of FAO in 1993 (The common standard is used to make the results comparable with other countries and regions).*

China used by Zhang, Xu, and Cheng (2001). While the equivalence factor, which has the function to convert the land area of different type to a comparable standard, is chosen from the world average production of biological resources calculated by FAQ in 1993.

4.3.2 Calculation of Ecological Capacity

In order to get the ecological capacity, the first step is to have the statistics of biological productive land area, which including the different type of the land use (cropland, grazing land, forest land, fishing grounds, built-up land and carbon uptake land). The following steps are to multiply each type of land area by the equivalence factor and yield factor, sum up the results, and then divide the total one by the population. The result is the ecological capacity, which means the per-capita ecological space for urban development Zhoushan Island provide. Table 4 shows the biological productive land area of the island is 672866.84 gha. With the subtraction of biodiversity protection, the ecological capacity is 0. 451521 gha per person.

4.4 Optimum Population Size of Zhoushan Island

In the model, ecological capacity can represent the condition of resources and environment provided by a country or a region. While the ecological footprint refers to the consumption level of the population. When it comes to the calculation of optimum population size, population based on the calculation of per-capita ecological footprint can be a ecological modest population, and a sustainable population capacity for the region within the ecological capacity.

The population can be calculated by the formula below, which is the optimum population size based on the ecological footprint.

$$\mathbf{P} = \mathbf{N} \times \left({}^{ec}/_{ef} \right)$$

Where:

N is the population size.
ec is the per capita ecological capacity.
ef means the per capita ecological footprint.

After generating the status into the formula (N=660,900, ec=0.451522 gha per person, ef = 1.006416 gha person), the optimum population size of Zhoushan Island is 296,508, which is only half of the current population size.

5. Evaluation of the resources and environment carrying capacity

5.1 Ecological Deficit and Remainder

The ecological deficit or remainder, means the result of the difference between ecological footprint and ecological capacity. If can reflect the utilization condition of the natural resources in one region. Ecological

Table 4: *Ecological capacity of Zhoushan Island in 2010*

Land use type	Supply area (gha)	Equivalence factor	Yield factor[a]	Adjust area[b] (gha per person)
Cropland	11,939.19	2.82	2.61	0.132962
Grazing land	505.54	0.54	0.19	0.000078
Forest land	21,657.18	1.14	1.28	0.047817
Fishing grounds	717,325.71	0.22	1.00	0.238783
Built-up land	13,193.79	2.82	1.66	0.093453
Carbon uptake Land:				
Total	764,621.41	-	-	0.513092
Biodiversity protection[c]	91,754.57	-	-	0.061571
Ecological capacity	**672,866.84**	-	-	**0. 451521**

[a] *Yield factor is the difference between local production of a certain country (or area) and the average output of the worldThe yield factor here is acording to the average data of China.*
[b] *The population of Zhoushan Island is 660,900.*
[c] *Source: Minus 12% of the total, which is suggested by Our Common Future (1987), pp: 27.*

Table 5: *Ecological deficit/remainder of Zhoushan Island in 2010*

	Ecological demand footprint[a] (gha per person)	Ecological supply footprint[b] (gha per person)	Ecological deficit/remainder (gha per person)
Biological resources	0.382439	0.419640	0.037201
Cropland	0.087730	0.132962	0.045232
Grazing land	0.064958	0.000078	**-0.064880**
Forest land	0.002921	0.047817	0.044896
Fishing grounds	0.226830	0.238783	0.011953
Energy resources	0.623977	0.093453	**-0.530524**
Built-up land	0.005846	0.093453	0.087607
Carbon uptake Land	0.618131	0	-0.618131
Minus 12% biodiversity			
Total	**1.006416**	**0.451522**	**-0.554894**

[a, b] Statistics of ecological demand and supply are from the results in Table 4 and Table 5.

footprint can measure the biological production area required with a certain level of consumption. When compared with the ecological carrying capacity, which reflects the productive area that can be provided by a country or a region, the result can supply the quantitative basis for the judgment: whether the productive and consumptive activities are within the range of ecosystem carrying capacity. Ecological deficit can reflect that the human influence has exceeded the ecological capacity. Then with the intention to satisfy the requirements, the region has the requirement to import resources or consume of the insufficient natural capital to balance the ecological needs. In both cases can reflect the unsustainable pattern of regional development. And the unsustainable level are measured by ecological deficit. On the country, the ecological remainder demonstrates that ecological capacity is enough to support the population pressure. The natural capital has the chance to be accumulated and the consumption pattern in the region is relatively sustainable.

The above table 5 shows the ecological deficit/remainder of Zhoushan Island in 2010. According to the table, the per-capita ecological deficit is 0.55 gha, and the total ecological deficit has reached 366729.6 gha. Ecological supply footprint takes 44.86% of the ecological demand footprint. And the compound ecosystem of the island are in the situation of "ecological overload", which means the ecological footprint is far beyond the ecological capacity.

5.2 Analysis of the Ecological Overload Issue

According to Figure 2, Cropland, forest land, built-up land and waters have the remainders, while Carbon uptake land and the grazing land are with the ecological deficit. It can be found that Zhoushan Island has no supply for carbon dioxide absorption, and the proportion of grazing land is only 1%. The excessive consumption of the fossil energy is a main reason of the overload Issue. Therefore, the ecological footprint of the energy consumption is the component which has the potential to be changed. As a result, low carbon development could be the direction for improving the situation. The promotion of low-carbon mode for the supply and consumption of energy is essential. The result also shows that these two kinds of resources are mainly provided by external cities. At the same time,

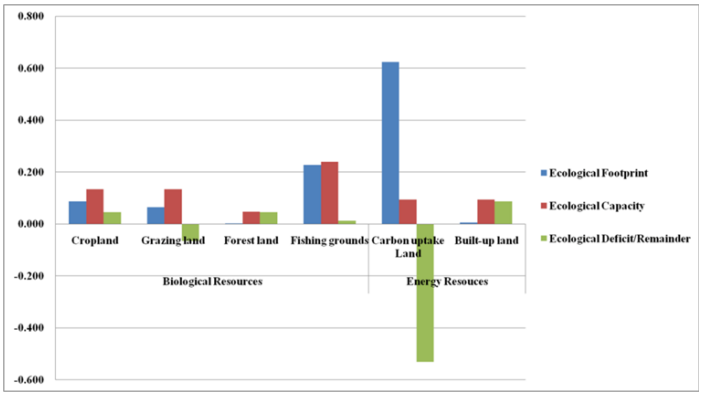

Figure 2: *Ecological footprint, capacity, deficit/remainder of Zhoushan Island (unit: gha per person)*

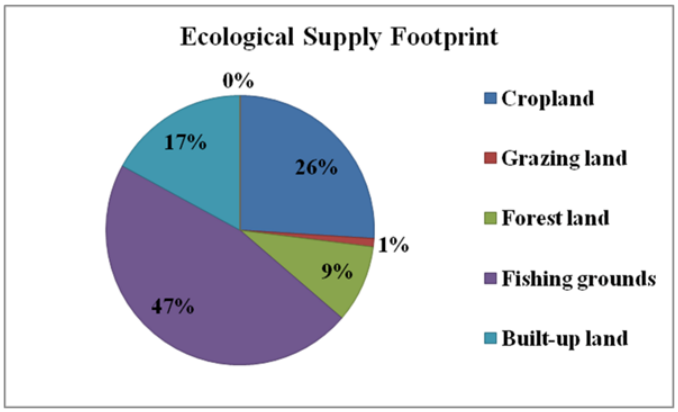

Figure 3: *Ecological Supply Footprint of different type of land*

the supply of water area accounting for 47% of the total, while other ecological supply footprints only take the percentage of 53% totally. The imbalance between supply and demand is obvious (Figure 3).

When comparing the ecological footprint of Zhoushan Island(1.0) with the average data of world(2.7), China (2.1) and Zhejiang province(2.5) (Figure 4), the result shows that the consumption of the resource and

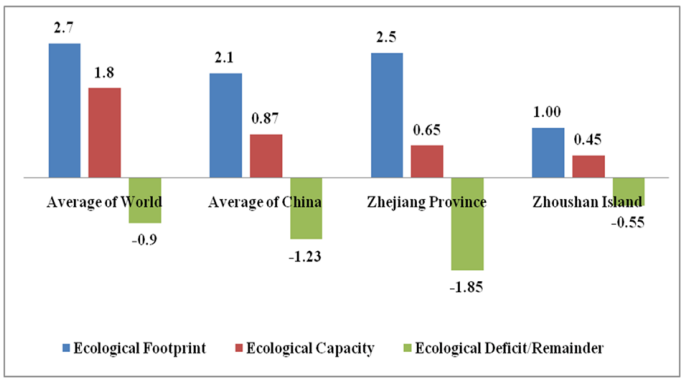

Figure 4: *Comparison with the average of World, China and Zhejiang province (unit: gha per person)*
Data Source: China Ecological Footprint Report 2010, pp.12.

energy is relatively lower than the average, which indicates the lower level of economic development in Zhoushan Island. Therefore, more emphasis should be put on the new mode of development in the future. As to the ecological capacity, which is also lower than the average ones, it reflects the less ecological resources and energy sources supplied, as well as the fragility of the ecosystem. However, the ecological deficit of Zhoushan Island (-0.55) separately takes 61.1%, 44.7%, 29.7% of the average ecological deficit of World, China and Zhejiang Province, which is much smaller than the average ones and shows a big potential of the development in the future.

6. Suggestions for the Urban Planning and Development Strategy

Based on the ecological footprint model, the optimum population scale is only half of the current population. The population has already beyond the ecosystem carrying capacity. Currently, economic development of Zhoushan Island rely mainly on the external resources. Although the life of people has not been affected by now, the ecological environment might face resources shortage in the future. Without the water area, deficit would sharply occur in other types of land. Therefore, the solution to the ecological overload issue is of great significance. The main strategies can be summarized in two aspects. One is to reduce the ecological footprint, the other is to increase the ecological supply, which means to improve the ecological carrying capacity. As an island city, the experience of Zhoushan a great reference significance for cities of similar type.

6.1 Reduction of the Ecological Footprint

6.1.1 Sustainable Use of Resources

The development of circular economy can realize high efficiency and recycling of the resources, which means to improve of utilization efficiency and reduce of the consumption. The other way is to advocate energy conservation and emission reduction. Low carbon target can be used, with less land of waste and pollution to reduce the ecological requirements.

6.1.2 Utilization of New Energy

There is a big scarcity of the energy resources in Zhoushan Island, leading to a large dependence of economic development on other regions. The best way to change the situation is to develop new energy to save the consumption of the traditional energy resources. For instance, with the adequate wind resources and sea resources, development of wind power and hydropower can be a good way to reduce the consumption of the traditional energy. The result can be the improvement of the overall efficiency, and reduction of the carbon dioxide emission, which can directly reduce the ecological deficit brought by energy consumption.

6.2 Improvement of the Ecological Capacity

6.2.1 Rational Use of Cropland

The land of Zhoushan Island is limited. As the increase of population on the island, the pressure of the space for survival will increase, especially the requirement of cropland. Thus, the protection of the cropland is essential, which should be emphasized in the urban planning. The methods can be strict control of land use, as well as relevant examination and approval procedures. At the same time, situations like cropland occupied by buildings and roads should be avoided. In addition, methods can be used to enlarge the ecological capacity of the land. Specifically, increasing investment in the area of science and technology would increase the production of per unit area.

6.2.2 Proper Urban Planning

Comprehensive and integrated research and strategy planning are required to be emphasized in the urban development. The urban construction land should be planned reasonable with the farmland with good productive quality. The natural features about the mountains and marine resources are essential to be considered in the comprehensive study and strategic planning. Eco-planning is also essentially needed to guide the construction of the ecological space, as well as the protection of the resources and ecosystem. Not only the planning of urban construction land, but also detailed ecological construction planning should be made to guide the rehabilitation and construction of the ecological space. For example, there is protection and control plan of ecological zone with urban growth boundary and ecological corridor.

6.2.3 Optimization of the Industrial Structure

In the constituents of the ecological capacity, the sea capacity accounted for nearly 50%, makes a large contribution to the ecosystem. The primary industry in Zhoushan Island has a large percentage. However, the Marine biological resources has been under great pressure with overfishing and pollution. As an island, the better pattern of the industry might be taking good use of the local feature to develop the high technology industry based on the sea environment, and coastal tourism. These new types of industry have the characteristics of low ecological cost and high added value, when compared to the industry with high energy consumption.

7. Conclusion

According to the theory of ecological footprint and the related calculation model, the current population of Zhoushan Island is far beyond the optimum population scale calculated by the ecological footprint model, more attention should be paid to the sustainable development with a harmonious relationship with the environment and resource. Although there are some shortages in the concept and model of ecological footprint, it can provide a direction of thinking and planning the city as a whole system. With the intention to find the

balance between economic consumption and ecological capacity, the optimum population is also a good tool that can be used to measure the development phases of the city.

The goal of urban planning is to improve the living standards of people and promote the social, economic and ecological aspects in the sustainable process of the city. Planning the population scale which is appropriate to the urban development conditions is the key element to the protection of urban sustainable development. According to the constraint of the resource and environment carrying capacity, in order to solve the problem of " ecological overload", sustainable development should be the guidance for urban planning in Zhoushan Island, and a low-carbon development pattern for the city is needed.

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Conceptual Framework of Ecosystem Services in Landscape Planning, Malaysia

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ABSTRACT

This paper presents the concept of ecosystem services and its trend, scale and gradient, through reviewing articles, books and internet sources. Result shows that evaluation of ecosystem services in small towns within urban-rural gradient in developing countries still not being scrutinized explicitly, especially trade-offs' concern. Environmental damages in the developing countries are burgeoning. As land conversion from natural capital to built capital is also keep on rising for temporal economic interests. Therefore, it has induced changes in ecological functions and affected the ecosystem services supply. In the context of Peninsular Malaysia, ungoverned built capitals and flaw of policy further contribute to fallacious decision making. And yet, there is still no specific framework or initiatives directly deals with ecosystem and biodiversity. A conceptual framework has been proposed to assess and value ecosystem services through integration of InVEST model (Integrated Valuation of Ecosystem Services and Tradeoffs) and bundle of ecosystem services. The framework allows stakeholders to have an insight of the pros and cons about the landscape changes, be it in ecological, economic or social-cultural perspectives. Therefore, it may help to ameliorate the trade-offs and enhance the synergies of ecosystem services that eventually can contribute to attaining human well-being, and to promote sustainable growth.

1. Introduction

To date, more than 7 billion people inhabit the Earth, an increasing of more than 4 billion of people for the past 53 years compared to 1960 (World Bank, 2014). Overpopulation has brought undesired environmental and social problems such as shortages of all resources, climate changes, war and social conflicts, habitat fragmentation, limited space and overcrowding (IPS, 2014). However, in a recent study, dense population not necessary leads to environmental problem. But urbanization appears positively contribute to environmental problems such as raise in energy consumption and carbon emission (Liddle, 2013). Rapid urbanization has inducing change of natural capital such as habitat fragmentation, reduction of cultivated fields as well as deprivation of open space for recreational uses (Shrestha et al., 2012). Thus, it has changed the ecological function and process and affecting the flow of ecosystem services that can contribute to human well-being. In fact, the consideration of urban ecosystem is becoming difficult under the growing development pressure especially inappropriate policies and ineffective planning (UN-Habitat, 2011). Meanwhile, most nations are not explicitly measured and assessed the value of ecosystem services (Seppelt et al., 2011), especially values to be factored into trade-offs' consideration (IPBES, 2013). This consideration is pivotal for making effectual decisions in sustainable planning because attempts to enhance certain service often lead to neglect of other services (Bennett et al., 2009; Grêt-Regamey et al., 2013). For example, multi-functional landscape that caters rafts of ecosystem services were converted into single-function land use that only provides a few services for temporal economic profit (De Groot et al., 2010). Hence, this paper explored the concept of ecosystem services that may assist in trade-offs' amelioration of multiple ecosystem services in landscape and urban planning which essentially can contribute to the betterment of environment, human well-being and economic progression. But the question is, to what extent of this conceptual framework can assist in trade-offs amelioration? Are certain services should be given more weight than other services in certain scenario? If improvise certain services and neglect other services, how they influence toward human well-being?

2 Concept, Trend, and Scale

We conducted a broad range of literature review from 1990s to 2010s. We explored the concept, trend, and scale of ecosystem services through books and peer-reviewed journals, particularly from the disciplines of landscape and urban planning, ecological economics, population and environment, urban forestry and urban greening, landscape ecology, biological conservation, land use policy and others. We used Goggle Scholar engine to identify relevant literature with the combination of keywords, including ecosystem services, biodiversity, land use/ cover, trade-offs, scales, model and urban-rural gradient. We integrated three conceptual ideas to assess and value ecosystem services. More importantly, our intention is to emphasize the ecosystem services assessment in developing country for better-

coordinated decision making and policy innovation. This section comprised three sub-sections. Section 2.1 explained the doctrine of ecosystem services. Section 2.2 illustrated the patterns and trends in the literature. Section 2.3 explicated the appropriateness of scale and gradients that need more attention.

2.1 Definition and Concept

Ecosystem can be defined as "a dynamic complex of plant, animal and microorganism communities and the non-living environment, interacting as a functional unit" (MEA, 2005; pp. v). The functioning of ecosystem is subjected to the balance of biotic and abiotic factors such as nutrient cycle, food chains and energy fluxes. And these functional ecosystems are pivotal to support life system whereby people utilize the properties and process of ecosystem functions to cater food and manage waste (De Groot et al., 2002).

Ecosystem functions are defined as the processes of transformation matter and energy within the ecosystems (Costanza et al., 2006). These processes of ecosystem supply heaps of benefits to human, directly or indirectly. For instance, food derives from ecosystem are the 'goods' that benefits human for consumption. While, air purification from the functioning of ecosystem processes are the 'service' that nature provided (Costanza et al., 1997). Therefore, ecosystem services can be defined as tangible or intangible goods that human derive from the processes of functional ecosystem. Ecosystem services are divided into four categories: provisioning, regulating, supporting, and cultural services (TEEB, 2010, 2011, 2012). Four type of ecosystem services are described in Table 1 but not exhaustively, for detail explanation about indicator and services description can refer to MEA (2005), De Groot et al., (2010) and TEEB (2011).

Wallace (2007, pp.241) advocates to distinguish the processes and services in valuation of ecosystem services because "ecosystem services are specifically related to human value while processes and assets do not". Similarly, Costanza et al., (2014) illustrate that ecosystem services do not generate human well-being directly through natural capital. It is through the interaction of natural capital with the social capital (communities), human capital (people) and built capital (man-made environment). In general, built and human capitals (the economy) are embedded in the society which is embedded in the rest of nature. When nature contributes significantly to human welfare, it is a major contributor to the de facto economy (Costanza et al., 1997, 2014) This signifies each and every decision makes about development, the concern should be given to society welfare rather merely looking at how best to proliferate the economy. For instance, are we going to cut down the forests to harvest its wood for the sake of economy gain while neglecting the benefits that forest ecosystem delivered such as carbon sequestration, air purification, clean water and continuously oxygen that nature is supplying? Veritably, natural capital that benefits human well-being should be given adequate weight as well in the decision-making process (Costanza et al., 1997). Essentially, the valuation of ecosystem services should be focused on how to balance all the other assets to achieve a sustainable outcome.

Table 1: *Categories of Ecosystem Services*

Type	Services Delivered
Provisioning services	Food, raw material, water, medical resources, ornamental species
Regulating services	Air quality regulation, climate quality regulation, natural hazard mitigation, wastewater treatment, erosion prevention, pollination, biological control
Supporting services	Nursery habitat, maintenance of genetic diversity
Cultural services	Recreation, mental and physical health, tourism, aesthetic appreciation and inspiration, spiritual, religious inspiration and cultural heritage

2.2 Trend and Pattern

The top-down approach was used to explore the trend and pattern of ecosystem services studies from 1990s to 2010s. Firstly, we identified the research field that still need emphasis. Then, we highlighted what dimensions that still need to explore further. For the last two decades, a plethora of research on urban ecosystem has witnessed a prominent rise of concern through the valuation of ecosystem services. Early 1990s and 2000s, many literatures have focused on the classification and concept of ecosystem functions, services and their economic value (e.g., Bolund and Hunhammar, 1999; Costanza et al., 1997; Folke et al., 1997; Daily, 2000; De Groot et al., 2002; MEA, 2003). Later on, year 2005 onward there was a great deal of literatures assess ecosystem service by monetization and commodification value which incorporated into markets and payment mechanisms (see Gómez-Baggethun et al., 2009, 2013; Leimona et al., 2015). Meanwhile, there were also studies related to ecosystem services but mainly focused on the practice of green infrastructure assessment, conceptualization, pricing (Netusil et al., 2014; Tzoulas et al., 2007; Weber et al., 2006) and management in agro-environment (Tscharntke et al., 2005). Until recently, little attention has been given to restoration and sustainable development in landscape and urban planning (Blignaut et al., 2014; De Groot et al., 2010; Foo and Hashim, 2014; Frank et al., 2012). Despite the uptrend of publications related to ecosystem goods and services in different fields, however, one domain still need more attention is the assessment and valuation of ecosystem services to ameliorate trade-offs and enhance synergy in landscape and urban planning that can contribute to future sustainable growth and development trajectories.

In landscape (land use) planning, landscape changes influence the functions of ecosystem properties and thus affecting the service supplies. Usually, the affection is not limited to particular service alone but multiple ecosystem services (bundle) provided by that ecosystem (De Groot et al., 2010). When the ecosystem services respond differently to landscape changes, this is where the trade-offs emerge. Foley et al. (2005) qualitatively illustrated three different patterns of the hypothetical landscapes to show the trade-offs of provision, regulating and habitat services. While, Raudsepp-Hearne et al. (2010) quantitatively measured the trade-offs of provision, cultural and regulating services in a diverse landscape. Both studies have shown the provision services (farming) has contributed to the diminution of other services. In this circumstance, we agree that intensive farming has degraded the environment and ecosystem. At the same time, other question arises. How about the increasing of unrestraint built capital particularly housing development affects the bundle of ecosystem services especially in developing country? Would it affect bundle of ecosystem services more profoundly?

2.3 Scale and Gradient

Ecosystems are categorized into two scales- ecological and institutional.

Ecosystem services are delivered at all ecological scales ranging from global, biome, landscape, ecosystem, and plot to individual plant. And it affects all institutional levels differently from international, national, state, municipal, and family to individual (Hein et al., 2006).

Many previous studies on ecosystem services focused in relatively broad context, for example from state to national levels (Bolund and Hunhammar, 1999; De Groot et al., 2002; Kroll et al., 2012; Larondelle and Haase., 2013; Troy and Wilson, 2006) and to international level (Costanza et al., 1997; Lavelle et al., 2006; Nelson et al., 2009; Seppelt et al., 2011; Tscharntke et al., 2005; Weber et al., 2006); despite it was qualitative or quantitative research. There are also a few studies emphasized on the municipal level (Grêt-Regamey et al., 2013; Neuenschwander et al., 2014). While, the assessment of ecosystem services on municipal level within urban –rural gradient boundary is still in lacunae, particularly at village spatial scale (see Malinga et al., 2014). So what is urban-rural gradient? Gradient implies spatial environmental patterns' variation in term of its structure and function in which usually is related to the degree of environmental changes in space due to urbanization (McDonnell and Pickett, 1990). Usually, the landscape pattern in urban-rural gradient consists of natural, semi-natural and built environments areas. Natural areas include river, forest and mountain while semi-natural areas are such as agriculture land, grazing land and mountain pasture. While, built environment includes buildings, housing, parks, recreational, commercial and industrial facilities or other constructed elements. According to Halfacree (1993), pioneer research about urban-rural continuum was deviated by Redfield as early as 1941 in which his study covered a wide range of spectrum from the remote area through the transitional areas and to the modern city. Then, modest research about urban-rural gradient continue to strive in different field of studies such as human and environment (Newby, 1986) ecosystem structure and functions (Albert, 2005; McDonnell and Pickett, 1990), and lately, there are few studies focused on ecosystem services (Kroll et al., 2012; Larondelle and Haase, 2013). Assess ecosystem services in local level offers better opportunity to reveal the richness of biodiversity which eventually can contribute to the global ecosystem (Seidl and Moraes, 2000). Lack of ecosystems assessment in urban-rural context may result to misinforming policy and poor mechanism that will affect global sustainability, particularly in social-ecological perspective (Haase et al., 2014). For instance, one of the developing countries, Ho Chi Minh City, Vietnam, transformed 660.2 km2 of cropland to built-up areas in 22 years period with the intention to attract more foreign investment. Economically, it sounds beneficial, but it may also lead to food crisis (Kontgis et al., 2014). Then, how do we determine that it is good for the human well-being? Hence, assessing ecosystem services in developing countries within village spatial scale at urban-rural areas is crucial to preclude that all the rural area riches in natural resources tardily converted to high density urban areas.

3 Problem and Policy

After identifying the trend and pattern of study, we further reviewed local (Peninsular Malaysia) literature and policy that explicated urbanization and unrestraint development problem including the case that induced harm to the environment and human. Besides, we also explained three environment related policies in Malaysia, including National Policy on the Environment (NPE), National Landscape Policy (NLP), and National Physical Plan (NPP). Many of the developed countries have recognized the importance of ecosystem services especially its value to the human well-being. To name a few, The Economics of Ecosystems and Biodiversity (TEEB- http://www.teebweb.org); Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES-http://www.ipbes.net); UK National Ecosystem Assessment (http://uknea.unep-wcmc.org); United Nations Environment Programme (UNEP- http://www.unep.org) and The Ecosystem Service Partnership (ESP- http://www.es-partnership.org/esp) are some of the organizations and initiative established to ameliorate, appraise, and safeguard Earth's ecosystem on all scale, be it at local, national or global level. Whereas, to date, in most of the developing countries, there is still no guideline and framework that directly deals with the provision of ecosystem services, especially Malaysia in the tropic region.

3.1 Problem in Landscape and Urban Planning

Urbanization in Peninsular Malaysia has been burgeoning from 54.3% to 65.4% between 1991 and 2000 and is expected will reach 75% by 2020 (JPBD, 2006). Besides, Peninsular Malaysia also has lost a substantial forest cover from 9.5 million hectares in 1954 to 6 million hectares in 2000 and slight dropped to about 5.9 million hectares in 2008 (JPBD, 2010). According to Lyytimäki and Sipilä (2009) environmental damages in developing countries are caused by the economic interests, and this phenomenon is reflected in Malaysia at the tropical region. Unrestrained development such as land conversion from forest to agriculture, infrastructures and housing has appeared to degrade the condition of ecosystem in sustaining life on Earth (Foo and Hashim, 2014). More critically, rapid development and urbanization has continually inducing changed in ecological functions and processes of natural capital (Shrestha et al., 2012). Thus, it influences the provisioning, regulating and cultural services supply. In Malaysia, one of the main concerns is the expansion of ungoverned built capitals resulting all the natural and semi-natural resources shrinking sporadically. For instance, recent evidence at Johor Bahru coastal area reclamation project, Danga Bay development that reclaimed 250 meters of land to create new waterfront developments that transforming all the mangroves and pre-existing residential areas to higher-density urban forms which have threatened the local ecosystem, traditional livelihood and cultural identity (Nasongkhla and Sintusingha, 2013). Malaysia has shown a gradual improvement in term of education, economic growth, environment quality, social and recreation opportunity, health and safety (EPU, 2012). But there are still growing evidences such as inappropriate planning of land-use and build environment has contributed to calamity such as flood and erosion (Foo and Hashim, 2014; Tan-Soo et al., 2014) and raises in energy consumption and CO2 emission (Bari et al., 2011; Hosseini et al., 2013; Safaai et al., 2010). This means, the imperativeness of natural capital in Malaysia is still inadequate, as the benefits of ecosystems services supplied still not being widely recognized. Therefore, raising awareness of stakeholder and decision makers are crucial. As strengthening the local policy in safeguarding and restoring the natural capital is also necessary.

3.2 Flaw of Policy

To strengthen the local policy and guidelines, we have reviewed NPP and two others environmental related sectorial policies there were NPE and NLP. NPE aims at "continue the economic, social, and cultural progress of Malaysia and enhancement of the quality of life of its people, through environmentally sound and sustainable development" (MOSTE, 2002; pp. 2). Similarly, NLP aims to enhance the quality living environment, conserve of natural resources, implement of planned development, as well as establish effective management system (NLD, 2011). Both NPE and NLP have established a good initiative to improve quality of life and living environment.

However, both policies did not accentuate the importance of natural capitals that benefits people in environmental, economic and social-cultural aspects. In contrast, NPP has emphasized the importance of "natural and rural landscapes should be conserved for the supply of oxygen, recreation, and enjoyment" (JPBD, 2010; pp. 2-12). And to achieve sustainable development, contemporary conceptualization was formulated (JPBD, 2010; pp. 2-3). At this point, we did not completely agree that society is dependent on the well-being of the economy as stated by the sustainable concept. The reason is, built and human capitals (the economy) are an integral part of society and embedded in the rest of the environment (Costanza et al., 2014; pp. 153). This indicated, the well-being of society is dependent on the well-being of environment instead of the economy. Perhaps, due to this reason, Malaysia's forest covers were declining and fragmenting since 1954 (JPBD, 2010). In this situation, we opine that a framework is necessitated especially in landscape and urban planning, biodiversity conservation and resource management to raise awareness among stakeholders the importance of ecosystem services. Subsequently, rectifying the sustainable concept and instilling ecosystem services studies into Malaysia's policies are rather crucial as well. We do not urge to promulgate the policy immediately. Instead, we provide a terminus a quo to think policy in a real sustainable way.

4 Conceptual Framework

Due to the sequent problem in landscape planning and inappropriate concept of policy explained in Sections 3.1 and 3.2, respectively. We proposed a conceptual framework to evaluate the trade-offs of ecosystem services in Peninsular Malaysia. To assess and value multiple ecosystem services, we integrated InVEST model and bundle of ecosystem services that demonstrate the landscape changes (transformation). The changes mean the decision of the stakeholder to conserve, develop or plan the existing landscape. And each decision they made can have future impacts, and this can be captured and analyzed through the use of simulation models (Nelson et al., 2009).

4.1 InVEST and Bundle of Ecosystem Services

In order to attain human well-being, natural capital needs to interact with social, built and human capitals (Costanza et al., 2014). For example, the transformation of rural area to urban housing area. How to estimate the value of ecosystem service that contributes to human well-being? Is it better to investigate on single factor or multi-factors? Often, it is inadequate to look merely on single perspective, for example the nature. Rather, it should also look into the communities, people and their man-made environment. In fact, concentrate on managing a particular habitat like treating the symptoms rather than provision for sustainable land management (Hostetler et al., 2011). Hence, to evaluate multiple ecosystem services within different landscape and capitals, we can adapt the concept of InVEST model. InVEST consists a suite of models that use land cover patterns to estimate ecological, social-cultural and economic values of ecosystem services provided by the natural capitals (Nelson et al., 2009). It aims at modeling multiple ecosystem services, biodiversity, and trade-offs, spatially (De Groot et al., 2010). The evaluation of InVEST model is profound, but the prognostic modeling presented single factor (service) only, such as water quality, carbon sequestration, market value of commodity production, soil conservation, storm peak management and biodiversity conservation due to landscape change (Nelson et al., 2009; pp. 8). In this circumstance, we suggest to integrate the InVEST model with the conceptual framework of Foley et al., (2005) looking at how the landscape changes affect bundle of ecosystem services as shown in Figure 1.

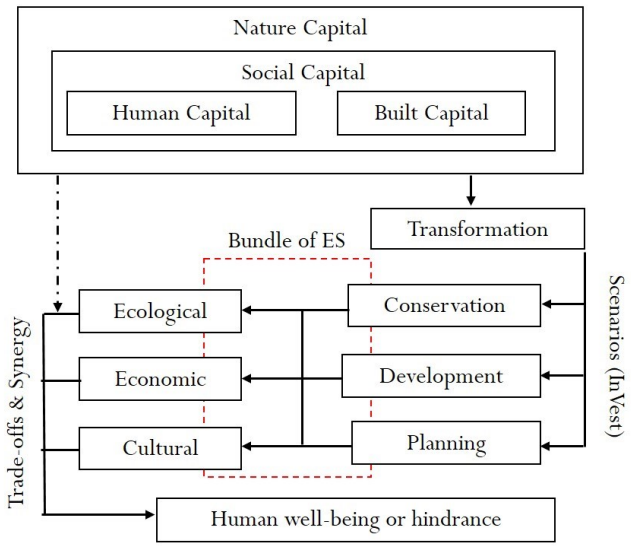

Figure 1: *Affection of landscape changes with three different scenarios toward the bundle of ecosystem services. Bundle of ecosystem services includes all the services shown in Table 1.0.*

(Source: Adapted and modified from Costanza et al., 2014; Nelson et al., 2009; Foley et al., 2005).

Foley et al., (2005) proposed three hypothetical landscape patterns: (i) natural ecosystem, (ii) intensive cropland, and (iii) crop land with restore ecosystem service to estimate the trade-offs of bundle ecosystem services. Firstly, conserving natural capitals can provide many benefits and support many ecosystem services such as regulate climate and air quality, preserve biodiversity, maintain forest production, regulate water flow and quality, carbon sequestration and mediate infectious disease. Secondly, intensively conversion of the natural ecosystem to agriculture can provide maximum crop production and high financial gain, at least in the short term. But this will hamper other services. Thirdly, the approaches to manage a cropland explicitly together with the natural ecosystems yield.

The conceptual framework proposed is suitable in any context and scale. The framework will be used to forecast the aftermath of urbanization and rapid development towards bundle of ecosystem services in Malaysia. For example, it can be used to evaluate the trade-offs between provision service (food), regulating service (temperature) and cultural service (recreation) within three different trends: conservation, development and planning. Each trend will infer bundle of ecosystem services differently. This allows, stakeholders to have an insight the pros and cons of each decision they make, be it in ecological, economic or social-cultural perspectives. Therefore, it is easier to identify whether the transformation of land can lead to human well-being or perhaps, a hindrance. Our further intention in this conceptual framework is to offer a pragmatic way to evaluate ecosystem service through spatial mapping (Frank et al., 2012) which include multi-criteria evaluation and analytical hierarchy process. But, the conceptualization of the methodological framework is not the main concern in this paper. Therefore, the methodological framework of spatial mapping techniques will not be elaborated.

5 Preliminary Review of Study Area

We selected Malaysia as our preliminary study area because it is one of the developing country, to-date. Malaysia is located in the equatorial zone separated by the South China Sea into two regions, Peninsular Malaysia and East Malaysia (Malaysian Borneo). Malaysia's ecology is diverse, riches in both flora and fauna. And it is categorized as one of the countries comprises the highest level of biodiversity (Caldecott et al., 1996). However, inappropriate landscape planning (see Section 3.1) and ineffective environment management and multiform policies (see Section 3.2) has continually contributed to the degradation of ecosystem and biodiversity. The conceptual framework established will be used to examine the ecosystem services delivered in small towns of Peninsular Malaysia. But, before that, we need to identify all the small towns in Peninsular Malaysia first. When we reviewed the potential study areas, four steps were being deliberated. Firstly, the site should be a small town. As asserted by previous literature and syntheses of ecosystem services, assess the ecosystem within local boundary offer better opportunity to reveal the richness of biodiversity and produce a more accurate mapping that will benefits policy maker in conservation practice and contributing to the global ecosystem (Foo and Hashim, 2014; Seidl and Moraes, 2000). Secondly, the landscape of the small towns should consist both urban and rural characteristics as suggested by Haase et al., (2014). Because the assessment of ecosystem services on urban-rural gradient's towns can be helpful to stakeholder to draw the right decision especially on selecting trade- offs. Thirdly, we extracted the information of small towns from the map of Peninsular Malaysia (see JPBD, 2006; pp. 38). Approximately 114 small towns have been identified across the Peninsular Malaysia that falls under different level of conurbation. For detail classification of conurbations can refer to NUP (JPBD, 2006; pp. 88-93). This paper specifically focuses on municipal level as discussed in Section 2.3 hence district growth conurbation with population ranging from one hundred thousand to three hundred thousand (JPBD, 2006, 2010) is more suitable to be the potential study areas. Lastly, Muar, Batu Pahat, Kluang, Manjung and Temerloh are the selected potential study areas as shown in Figure 2. While pertaining the landscape characters such as forest cover, water body, agriculture, and housing area, Muar and Manjung districts have shown more diverse landscape pattern compared to others. Therefore, we recommended to explore and assess ecosystem services within this two areas. Both towns

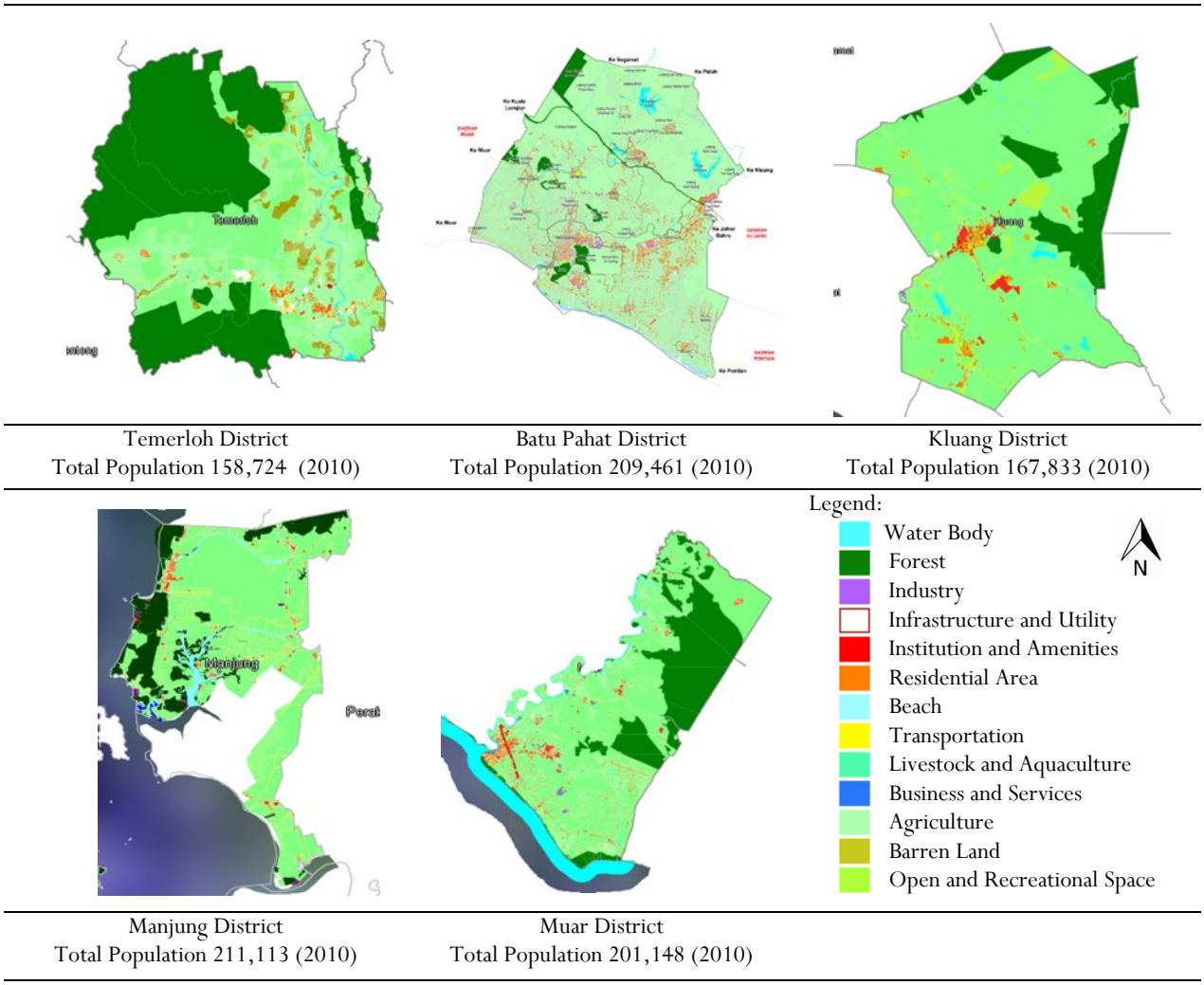

Figure 2: *Spatial land use maps of district growth conurbations*

are still covered with substantial natural resources and therefore it is important to cue the stakeholders the significant to conserve and manage it in good order. Nevertheless, this does not mean other towns are a notch below. In fact, those highly urbanized towns should concern on how to restore the natural resources to balance all other assets for the long run.

6 Conclusion

We have accentuated the importance to assess and value ecosystem services in small towns in developing countries within urban-rural gradient to preclude further detriment of biodiversity. Developing countries often favored to the immediate economic interest. For example, rampant development to attract domestic and foreign investments. We are at a critical point where biodiversity loss is occurring daily due to increasingly human needs, unrestraint development and unsystematic policy.

This paper answered the research question of the established conceptual framework to assist in ameliorating trade-offs. The conceptual framework (Figure 1) laid out here provide a platform to evaluate the changes of land pattern affects the bundle of ecosystem services. It also uses to facilitate the development strategies in landscape planning through projecting future impact in visualization form through the use of mapping. In this way, it assists stakeholder to identify trade-offs and synergies, subsequently provides alternate choices to maximize synergies and reduce trade-offs. Stakeholder's decision and public needs play an important role to determine the weightage given to different scenarios in landscape planning. If the towns are looking to achieve high biodiversity, riches both in flora and fauna, then the built environment will follow conservation trend. In contrast, if the towns are seeking to generate high economic profit, then development trend will be adapted. However, this trend will result to neglect other ecosystem services significantly. Due to this reason, the ultimate goal of ecosystem services concept is to protect people welfare, safeguard ecosystem and biodiversity and simultaneously to generate long term economic profit. And this can be achieved through planning trend. One of the constraints in this framework is it includes too many factors and therefore requiring a large amount of real world land use/ cover and socio- economy data. Because of that, the framework is not final yet and need to adjust and upgrade from time to time. Anyhow, the output of the framework can use to assist and guide stakeholders to attain better decision and eventually produce a more coordinated environmental policy in landscape and urban planning. Therefore, architect, engineer, landscape architect, urban planner, developer and other practitioners have a uniform standard to follow. Besides, it also aids designers to develop a more livable built environment and community with multiple functional ecosystem services that provide health and well-being benefits to society. Meanwhile, calamity such as flood and erosion, energy consumption and greenhouse effect can also be mitigated indirectly.

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Formal Housing Sector Reform in Neoliberal Nigeria

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ABSTRACT

In the past two decades, Nigeria has deployed neoliberal principles in the provision of formal housing. This approach was adopted on the assumption that the implementation of enabling reforms would enhance the role of the private sector and equally promote the development of a formal housing system in Nigeria. This has not occurred; the neoliberal housing approach has brought fewer results than the reform promised. The study therefore aims to explore the agency and actions of Nigerian authorities in response to this neoliberal agenda. To achieve this aim, the following objectives are pursued: The first objective analyses why neoliberalism failed to effectively change the housing market in Nigeria; the second examines the impact of neoliberal restructuring process on housing provision in Nigeria; and the last analyses the success of legislative reform that were carried to support housing provision under Nigeria's neoliberalism. To achieve these objectives, the paper adopts a documentary method and in accordance with this, a wide range of documentary evidence was collected for a content analysis. The findings of the analysis suggest that economic recession, political instability and changing ideological stances of successive governments affected the consistency of neoliberal reforms. Furthermore, the reforms implemented were seen to be progressive but the events occurred rather slowly, haphazardly and uncoordinated. A time lag is also observed in the reform processes and the sequence of events shows a lack of consideration of the interdependency of legislation and action. This policy review concludes that the neoliberal approach has the potential to improve the delivery of formal housing; however the authorities need to be consistent with the reforms while at the same time aligning legislation and action.

1. Introduction

Over the last two decades, the government of Nigeria introduced reforms that are hinged on neoliberal assumptions and in accordance with this the federal authorities have intensified the program of deregulation, privatization and liberalization. For example, the telecommunication sector was restructured in 2000, the financial sector had its privatization, recapitalization and consolidation program between 2001 and 2004, and a considerable restructuring took place between 2000 and 2006. This affected a multitude of state-owned enterprises including cement manufacturing companies, iron and steel companies, clay and brick companies, national oil and marketing companies, agro-allied industry, motor vehicles and truck assembly companies, hotels, public housing, pipelines and marketing companies, airports, port terminals, coal companies and electricity enterprises (FRN, 2006c, p. 28 -31, 34-38).

In the housing sector, the neoliberal reform program sought to roll back from the direct provision of housing by the state. As the state withdraws from direct provision of housing it was expected that the private sector would step forward to provide housing in partnership with the government. The partnerships fostered between the government and the private sector were expected to tackle issues such as: the provision of housing finance, the supply of land for housing, the supply of building materials, and the creation of an effective organizational arrangement for housing supply (FRN, 2010, p. 36). In pursuance of this, the National Housing Policy (NHP) statement was revised (FRN, 2012, p. 28, 29; FRN, 2006a).

Despite the reforms implemented, the supply of formal housing has continued to fall short of its demand. Even when the supply exists, those households who fall below the poverty line are unable to afford the cost. To illustrate this clearly, the population of Nigeria was estimated at 166.2 million in 2012 and 84.59% of people were earning below US$60 a month, which is below the international poverty line. It takes a monthly income of US$200 to service a loan of US$30,000 and this is far too high for poor households. More worrisome is the cost of new housing, which is a prohibitive factor to accessing formal housing. In 2012, for example, the cost of a newly constructed 72m2 house in Lagos, the commercial center of Nigeria was US$31,250 and that of a 62m2 house outside of Lagos was US$ 15,600 (Centre for Affordable Housing, 2012).

Other studies that examined the challenges of housing provision in Nigeria's neoliberal era have raised multiple concerns. For instance, the role of government agencies in public-private partnership (PPP) for housing delivery in some selected cities of Nigeria was assessed in a study by Ibem (2010). The findings suggest that PPP arrangements have attracted financial resources, managerial competence and technical know -how of the private sector in providing housing. However, the PPP approach has only produced a relatively low quantity of affordable housing for low-income people in Nigeria. As a consequence, access to affordable housing by low income groups remains an issue of concern in the neoliberal era as confirmed by Adedeji and Olotua (2012). Ayedun and Oluwatobi (2011) were interested in uncovering the constraints and challenges militating against housing provision in Nigeria. The issues identified were connected to the unstable economic and political environment in Nigeria, which in turn is leading to a rise in the cost of building construction inputs including land and finance.

In a study that was focused on assessing the threats and opportunities presented by globalization on the house building industry in Nigeria, Mbamali and Okotie (2012) concluded that there has been a dominance of foreign construction companies over indigenous ones. In addition, the opportunity for deployment of indigenous technology and local materials in housing provision has diminished considerably in Nigeria. Ibem, Opoko, and Aduwo (2013) were concerned with the implementation of a mass housing scheme by the federal government of Nigeria. The findings suggest that the housing scheme suffered poor program conception, planning and funding. Ibem et al. (2013) concluded that despite the deployment of a neoliberal approach and the subsequent adoption of new housing and urban development policies, low organizational capacity of public housing agencies, the lack of collaborations between relevant agencies and the non- application of local building materials have continued to impede the implementation of public housing programs in Nigeria.

The spread of neoliberalism to Nigeria did change the course of development but did not lead to material progress in formal housing provision as confirmed in the preceding discussions. In fact, several studies including Dolowitz & Marsh (1996), Daly (2001), Held (2004), Davis (2004; 2006), Easterly (2002; 2003), Evans (2009), Fasenfest (2012), Stiglitz (2003) and Smith (2014) have already establish that the neoliberal agenda was coercively transferred to the developing countries, and as a result, it interfered with economic development and social services systems. The aim of this policy review is not to oppose this position; rather it seeks to explore the agency and actions of Nigerian authorities in response to this neoliberal agenda. To achieve this aim, the paper will first of all set the Nigerian case study in a wider African context by offering a short review of neoliberalism in sub-Saharan Africa. After this, the study will then narrow down to Nigeria to address a number of issues: one, the study will analyze why neoliberalism failed to effectively change the housing market in Nigeria. Secondly, the paper will examine the impact of neoliberal restructuring process on housing provision in Nigeria. Thirdly, the paper will analyze the legislative reform that were carried to support housing provision under Nigeria's neoliberalism. Lastly, the study's conclusion will be presented.

2. Neoliberalism in sub-Sahara Africa

The neoliberal reforms that have been ongoing in the sub-Saharan Africa region can better be understood in reference to the contemporary neoliberal agenda, which was born out of the Washington Consensus in 1989. The Washington Consensus was a policy proposal made by the International Monetary Fund (IMF) in collaboration with the World Bank, for countries affected by the debt crisis of 1980s. In the 'Consensus', the IMF and the World Bank advised countries that were ravaged by the debt crisis to introduce the following measures as a solution: undertake tax reform; introduce fiscal discipline, reorder public expenditure priorities; liberalize trade, interest rate and inward foreign direct investment; pursue competitive exchange rates; privatize public enterprises; deregulate economic activities; and strengthen property rights (Williamson, 2003). The IMF and the World Bank felt that this set of principles were appropriate and capable of restoring stability while at the same time promoting development among the developing countries (Stiglitz, 2003).

Between 1991 and 2002, about 38 sub-Saharan African countries that needed loans from the World Bank to cushion the effect of their debts had to undertake neoliberal reforms as a precondition. The neoliberal reforms implemented among the sub-Saharan Africa countries were shrouded in multiple implementation challenges (Buchs, 2003, p. 5). As a result the rates of poverty from 1990 to 1998 were found to increase in countries like Burundi, Central African Republic, Gabon, Guinea-Bissau, Madagascar, Niger, Nigeria, Rwanda, Senegal, South Africa, Tanzania, Zambia and the Gambia. In Ghana, there was no change in poverty rates during the period. However, the poverty rates were found to decline in Burkina Faso, Cote d'Ivoire, Ethiopia, Guinea, Kenya, Mali, Uganda and Zimbabwe (Buchs, 2003, p.39).

In a global context, the neoliberal agenda has proved very controversial for a number of reasons: firstly, it has been argued that instead of restoring stability in countries affected by the debt crisis, the IMF and the World Bank were more interested in promoting the neoliberal agenda and creating free markets (Smith, 2014). Secondly, those countries that needed loans from the World Bank were made to implement neoliberal reforms through conditionality that led to crippling effects on their economies. Some of the conditionality that produced the worst effects among sub-Sahara African countries includes the devaluation of domestic currency and the cutting of public expenditure for social services like education, healthcare, housing and welfare (Stiglitz, 2003).

Thirdly, Stiglitz (2003) documents that the privatization programs and the austerity measures implemented by countries who accepted Structural Adjustment Program (SAP) were pushed too far. In sub-Saharan Africa the austerity led to a rise in interest rates thereby impeding the growth of businesses; rapid privatization as prescribed by the IMF and the World Bank led to job losses; and further, the proceeds of privatization were lost to corrupt government officials in most cases (Stiglitz, 2003). Lastly, Brenner and Theodore (2005) have argued that neoliberalism exacerbates regulatory failure in many countries. This is so because neoliberalism has not established a framework for stable economic development, political regulation or social cohesion. It has rather resulted in contradictions that tend to undermine many of the economic, institutional and geographical preconditions for economic and social revitalization.

3. Study approach and methods

The study employs documentary analysis in examining the research question. This approach is adopted within this study for two primary reasons: first, documents are particularly useful for tracking change over time and they enable an analysis of a larger sample size than might be collected from other methods (Mogalakwe, 2006). Second,

documentary evidence is employed in order to overcome the difficulty of accessing participants who can give a relatively accurate account of housing under Nigeria's neoliberalism.

This study draws on public–policy statements, reports, bulletins, speeches and private documents including textbooks, peer review articles, position papers, annual reports, consultancy reports, periodicals and newspapers. The public documents were collected from University libraries, government agencies such as the Federal Housing Authority, the Federal Ministry of Lands, Housing and Urban Development, the Federal Mortgage Bank of Nigeria (FMBN), the National Planning Commission, the Nigerian Building and Road Research Institutions (NIBRRI) and the State Ministries of Lands, Housing and Urban Development. The private documents were collected from Primary Mortgage Institutions (PMIs), the Mortgage Banking Association of Nigeria (MBAN), the Real Estate Developers Association of Nigeria (REDAN), and the Centre for Affordable Housing Finance in Africa (CAHF) – a division of FinMark Trust. Most of the documents were retrieved from the websites of the relevant organizations while others were obtained directly during a visit to the relevant organizations in Nigeria. The analysis was conducted through content analysis of the documents collected for the study. In brief, analytical reading involves the breaking of textual information into its components parts, in order to understand its meaning and relationship to other text (Helm, 2000).

4. Neoliberalism under economic recession and political instability: a failure to change the housing market

The anticipation that Nigeria's housing market would improve under neoliberalism failed to materialize and the examination of documents reveals two interactive factors that caused this failure. First, the shift from a state-led housing system to the neoliberal approach in 1991 was necessitated by a recession period which began in 1982 and culminated in a Structural Adjustment Program (SAP) from 1986 to 1993 (Metz, 1992). As a product of recession and the SAP, the market friendly proposals which were outlined in the neoliberal housing policy were not given priority by successive military administrations until after the return to civil rule in 1999. Theoretically, a neoliberal housing system should thrive on liberalism and a market friendly business environment (Pugh, 1994a&b; Helmsing, 2001) but this was found not to be the case in Nigeria due to economic recession.

The second factor is the political context of Nigeria. During the period of the implementation of neoliberal reform there was instability in governance as a result of military coups and changes in administrations that held opposing ideological stances (Metz, 1992; FRN, 2006b). For instance, in 1982 the civilian government which was later dislodged by the military in December of 1983, had initiated IMF and World Bank inspired austerity measures which were conditioned on the removal of subsidies on services, deregulation and the promotion of market friendly policies (Metz, 1992). When the military government took over in 1983 and ruled for only 20 months, they were opposed to the IMF and World Bank inspired austerity measures. They rebuffed all entreaties by the IMF and World Bank to deregulate, devalue domestic currency, remove subsidies on services and increase the pump price on fuel (Metz, 1992). This very administration was inclined to socialist ideology and even set up a committee to design a social housing policy (Aluko, 2011).This policy never saw the light of day because the government was overthrown in August of 1985 by another military government that was opposed to this ideology (Metz, 1992). The Socialist ideas were immediately jettisoned in favor of liberalism and market friendly policies (Falola, 2013). The new government introduced a national housing policy that was consistent with neoliberal thinking in 1991 and handed over power to a transition government in June 1993. The transition government was overthrown three months later in August of 1993 by another military government that was opposed to market friendly policies and public housing projects were again reinitiated (Ikejiofor, 1999). By June 1998, yet another military government took over following the demise of the military Head of State and returned the country to civil rule in May 1999 (Falola, 2013). This instability, along with the weak economy, negatively influenced the deployment of neoliberal principles in the provision of housing.

Developing countries that have experienced appreciable success in housing provision on the basis of neoliberalism were found to introduce this system at a period when macro-economic imbalances were largely eliminated. Typical examples are Indonesia (Pill and Pradhan, 1995; Park and Bae, 2002), Korea, Malaysia and Thailand (Park and Bae, 2002; Zagha and Nankin, 2005). Nigeria's liberalization program was introduced in a period of economic recession, the economy was depressed, the inflation rates were high, and there was a huge foreign debt overhang. This experience was similar to that of Ghana, Kenya, Gambia, Cameroon, Côte d'Ivoire, Uganda, and Senegal among others (Zagha and Nankin, 2005; Pill and Pradhan, 1995). Further, Nigeria's SAP induced inflation was extremely serious, rising from 5.4 percent in 1986 to 40.9 percent in 1989 (Anyanwu, 1992, p. 5). Housing provision on the basis of neoliberalism was at a higher risk of failure in Nigeria because the weak economic situation was worsened by political instability. These factors contributed to the failure of housing provision. Indeed, as it will be seen in subsequent discussions, much of the positive developments that have occurred from the neoliberal approach for housing began after the country's return to democratic rule in 1999.

5. Neoliberal Restructuring Process and its Impact on Housing Provision in Nigeria

This section examines the outcome of neoliberal restructuring processes in relation to housing legislation, housing finance, housing development and home ownership. Nigeria's liberalization process began as far back as 1982 but the actual restructuring of public enterprises only commenced in 1999. This irregularity affected housing development under Nigeria's neoliberalism. For instance, when the neoliberal housing system was said to have been launched in 1991, with expectations that public-private partnerships in financing and supplying housing should begin, the formal housing market was still dominated by public bureaucracies with limited participation of private institutes. The dominance of the national and local housing markets by public bureaucracies made the business environment unattractive to private institutions. To illustrate, in the early 90s, attempts were made to set up private Primary Mortgage Institutions (PMIs) to operate alongside those created by the government. About 300 PMIs were in operation in the 90s of which over 70 percent were private. However, by 2004 many had vanished, leaving only 83 surviving (FRN, 2006a). A hostile business environment, defective capital structures, lack of professional capacity, and poor patronage of private PMIs by public sector workers were some of the factors that led to their demise (FRN, 2006c).

The market restructuring process has been slow and was still on-going at the time of the research. This is not unconnected to the economic and political circumstance explained above. From Table 1, it is clear that since the commencement of the deregulation program in 1999, some

Federal Government enterprises concerned with finance (commercial banks, insurance companies and PMIs) and the supply of building materials (cement companies, bricks and clay factories, steel rolling mills, and stone quarries) were fully or partially privatized or even liquidated as in the case of the Federal Mortgage Finance Limited. However, the two development finance institutions whose roles are critical to the provision of low interest mortgages and the finance of urban infrastructure were turned into Government Sponsored Enterprises, which permitted the Federal Government to maintain their full ownership (Yari, 2010, p.20). At the time of this study the federal government was still in full ownership of a Housing Corporation (FHA), and this institution along with the FMBN were still being run as public bureaucracies (FRN, 2010). The ongoing heavy government involvement in the FHA and the FMBN does not allow them to operate free from the interference of government officials. This interference has been found to result in lack of transparency and poor performance in the institutions (Mabogunje, 2011).

The most progressive development that followed the restructuring process was the stabilization of finance institutions. This began in 2004 after the Central Bank of Nigeria (CBN) introduced a new minimum capital requirement for commercial banks, insurance companies, PMIs, the FMBN and other finance institutions. The CBN reports (CBN, 2007, 2008, 2010) confirm that the restructuring process led to increased mergers and acquisitions among private financial institutions. This development gave rise to capital appreciation in deposit taking banks from N0.662billion in 2004 to N6.432 billion in 2007. For insurance companies, there was a rise from N25.1million in 2004 to N419million in 2007 and PMIs appreciated from N45.25million in 2007 to N52.202 in 2008. Similarly, the loan and advances portfolio of deposit taking banks rose to N8.45billion in 2009 from N1.29billion in 2004. Loans made from PMIs went up to N188.5billion in 2007 from N94.34billion in 2006 and loans disbursed from the FMBN appreciated by 42.7 percent from 5.8 percent in 2006.

Despite stabilization of finance institutions the study also found that commercial banks and primary mortgage institutions could not sustain

Table 1: *Summary of Policy Proposals and Institutional Reforms*

Year	Policy proposals and Reforms	Remark
1988	The Technical Committee on Privatization and Commercialisation (TCPC)	Between 1988 and 1993, the TCPC Committee was involved with the privatization of 110 public enterprises, of which about 70 were fully divested (Drum, 1993)
1991	The National Housing Policy was launched	A neoliberalism system for subsidizing low-income housing was introduced. The idea of enabling was introduced.
2002	Liquidation of the Federal Mortgage Finance Limited	The federal government withdrew from primary mortgage operation and liquidated its primary mortgage institution in 1993; however, the state government continue to maintain ownership of theirs. The withdrawal of federal government led to the emergence of privately owned PMIs. As at 2011, there were over 80 PMIs in operation (Mabogunje, 2011)
	Reforms at the Federal Mortgage Bank of Nigeria	A new Board was constituted; retrenchment of incompetent staff and the employment of professionals were achieved (Mabogunje, 2011 p. 579). In addition, an arrangement was put in place for private developers to access Estate Development Loans (EDL) from the mortgage bank to build houses for the benefit of subscribers (Mabogunje, 2011 p.584)
2003	New Guidelines for Primary Mortgage Institutions (PMIs) introduced	The Central Bank of Nigeria introduced new guidelines for the Primary Mortgage Institutions with effect from August 2003 (CBN, 2003)
	Monetization policy	This policy directed government agencies to sell off public residential houses
2004	The recapitalization and stabilization of financial institutions started	The capital base of all licensed financial institutions was reviewed upward. This program led to the merger and acquisition of financial institutions (CBN, 2012).
2005	Privatization program	By 2005, 6 cement companies, 5 bricks and clay making companies, 3 steel rolling mills and 2 stone quarries were privatised (FRN, 2006c)
		By 2005, 5 public commercial banks were privatised (FRN, 2006c)
		By 2005, the Federal Government divested in three public owned insurance companies through management buy-out and core sales
		By 2005, the Federal Mortgage Bank of Nigeria and the Urban Development Bank of Nigeria were turned into a Government Sponsored Enterprises (FRN, 2006c,Yari, 2010 p. 20)
2006	The Nigeria Deposit Insurance Corporation Decree No. 22 of 1988 was amended	The amendment of this law became necessary to ensure that deposits collected by financial institutions are insured to prevent the wide-spread distress and failure of financial institutions witnessed in the past
2007	Procurement guidelines	Guidelines for procuring consultancy services, goods and works were circulated (FRN, 2007)
	Some banks undertook self-induced consolidation	Some banks went on to enhance their capital base through a combination of rights issue and public offers in pursuit of their domestic and regional expansion programs
2011	Public procurement	A Public Procurement Manual was prepared, drawing from the relevant sections of the principal Act and circulated to government departments (FRN, 2011a)
	Housing supply agencies	By December, 2011, there were 102 private house building companies which were in partnership with the Federal Mortgage Bank of Nigeria (FMBN) for the purpose of building low-income housing. The partnership between housing building companies and the FMBN is an indication that the introduction of Estate Development Loan was a step forward in Nigeria's neoliberal housing (FRN 2011b).

their growth after consolidation. Specifically, the deterioration of balance sheets began to occur in records of PMIs from 2009 and deposit taking banks from 2010 (CBN, 2010). The reports of the Central Bank of Nigeria (CBN, 2007, 2008, and 2010) gave some explanation to this: that much of the money that led to the growth of the financial institutions was realized mainly from the sale of shares and mergers rather than savings. In addition, long term sources of finance were not available to the financial institutions and as a consequence, those institutions that were involved in mortgage operation could not lend to customers on long term basis (World Bank, 2009).

As indicated in Table 1, there are two landmark developments that resulted from Nigeria's neoliberal reform: one of these development occurred in 2002 when the FMBN introduced the Estate Development Loan (EDL) arrangement. The EDL arrangement is a window that allows private small and medium Estate Development Companies to have access to subsidized credit to build houses for sale to subscribers. This innovation brought in 102 companies into partnership with the FMBN (FRN, 2011a&b). As result of this partnership 7106 housing units were developed across 19 cities of Nigeria between 2004 and 2006 (FRN, 2006a). The second development that is worthy of note is the policy on the privatization of public housing stock which came into operation in 2003 (See Table 1). This policy directed federal, state and local government authorities to privatize their public housing. The federal

Table 2: *Summary of Legislative Reforms and Outcomes*

Year	Legislative Reforms	Outcomes
1988	Privatisation and Commercialization Decree	The Technical Committee on Privatization and Commercialization (TCPC) was constituted and given the mandate to privatize and commercialize public enterprises owned by the federal government (Drum, 1993)
1989	The Primary Mortgage Institutions Act	This set the ground for the creation of PMIs by government and the private sectors (FRN, 2006c p. 10)
1991	Banks and other Financial Institutions Act	A legal framework for regulating the activities of banks and financial institutions was created without an enforcement agency
1992	The National Housing Fund Act	This act introduced the National Housing Fund (NHF)
1993	The FMBN Act 82	The FMBN that existed prior to introduction of the NHF in 1992 was empowered to administer the scheme
	The UDBN Act 88	The UDBN was incorporated as a Public Liability Company (PLC) to finance the provision of urban infrastructure
	The Nigerian Social Insurance Trust Fund Act 73	This Act created the Nigerian Social Insurance Trust Fund (NSITF) for the purpose of providing Social Security to all Nigerians
1994	The Failed Banks and Financial Malpractices in Banks Act	Banks were beginning to fail as a result of non-performing loans and financial malpractices were prevalent. The Act was enacted to help failed banks recover debts and to checkmate financial malpractices
1995	The Advance Fee Fraud and other Fraud Related Offences Act	Fraudulent activities were on the increase in Nigeria and this law was enacted to curtail fraudulent activities
	The Money Laundering Act	Money laundry was now a common crime among corrupt government officials and this law was enacted to control it
1999	The Public Enterprise (Privatization and Commercialization) Act	The Bureau of Public Enterprises (BPE) was empowered to take responsibility of implementing the Nigeria's policy on privatization and commercialization (FRN, 2006c)
	The National Insurance Commission (NAICOM) was created	The Insurance Act of 2003 empowered the NAICOM to address problems facing insurance companies in Nigeria (FRN, 2011a)
2000	The Corrupt Practices and Other Related Offences Act	The Independent Corrupt Practices and Other Related Offences Commission (ICPC) was created and vested with the responsibility of investigating and prosecuting corrupt related offences
2003	The Insurance Act 37 Volume 90	This law was made to provide regulations for insurance companies (World Bank, 2009, p. 89)
2004	The Pension Reform Act	A contributory pension scheme involving workers and employers was introduced
	Money Laundering (Prohibition) Act	An enabling law for the prohibition of money laundry was created
	The Economic and Financial Crimes Act	The Economic and Financial Crimes Commission (EFCC) was created. This law harmonised statutes that existed prior to this time but were ineffective due to a lack of an enforcement agency
2007	The Public Procurement Act	The Bureau of Public Procurement (BPP) and the National Council on Public Procurement (NCPP) were created
2011	The Pension Reform Amendment Act	This Act was amended to exempt members of the Armed Forces and members of the Intelligence and Secret Services from a contributory pension in line with international conventions (FRN, 2011a).
	Personal Income Tax Amendment Act	Personal Income Tax Law was amended to regards deductions from gross income in relation to the National Housing Fund contributions as non-taxable (FRN, 2011c)

government showed a high degree of compliance by selling its housing across the country but states and local government authorities did not fully comply. This form of privatization has not fulfilled the government's aspiration to increase supply of new housing because it does not contribute to the commissioning of new homes. Unlike other forms of privatization, this policy sought to transfer the responsibility for public assets not to private companies but directly to individual members of the public. Sprigings and Smith (2012) observed that public housing transfer in this manner may have unintended consequences as experienced in the UK and Eastern Europe where the initial privatization of public housing led to subsequent commodification and re-commodification (Sprigings and Smith, 2012). There is no evidence about these consequences in Nigeria.

6. Legislative reforms and the restructuring process: disharmony between policy and law

Over the past two and half decades national legislation (see Table 2) was continually being made for the purpose of improving the legal and regulatory framework for housing finance and provision. Despite widespread legislative reforms, housing supply did not improve substantially. Furthermore, the reforms that have occurred in Nigeria appear to be tardy, haphazard and uncoordinated. Most notably, there has been disharmony between legislation and the action that followed. For example, the revised national housing policy in 2006 directed the Federal Mortgage Bank of Nigeria to commence trading of securitized mortgages when securitization law was missing. This law was yet to be passed at the time of the study and its absence is limiting the ability of mortgage supplying institutions to transact securitized mortgages so as to generate long term capital. A study by the World Bank (2009) reported that arrears on mortgage lending that have taken place in Nigeria's mortgage institutions were very low. The World Bank did not substantiate this broad claim with quantitative evidence but it gave a further explanation: that the suppliers of housing finance at the open market mortgage sector (which include PMIs, deposit taking banks, Insurance companies, Pension Fund Administrators and Housing Cooperatives) and the subsidized mortgage sector (FMBN) were unable to tap into long term funding from the capital market in order to finance long term loans.

The annual report of the Central Bank of Nigeria (CBN 2010) corroborates this evidence. In the CBN report, an analysis of the maturity structure of loans and advances made by Deposit Money Banks indicates that short-term loan maturity remains dominant in the credit market. Outstanding loans and advances maturing in one year and below accounted for 65.3 percent while the medium-term (1-3 years) and long-term (3 years and above) accounted for 14.6 and 20.1 percent respectively (CBN, 2010 p. 68). Deposit Money Banks are the key players in the open market mortgage sector but their credit supply is substantially on a short-term basis. Also corroborating this evidence, the EFInA and FinMark studies (2010 p. 33) found that private mortgage institutions were advancing mortgages at a maximum tenure of 10 years as a result of a dearth of long term funds. This tenure is incompatible with housing finance, which requires long-term finance with tenures of up to 25 years or greater.

The documents examined confirm a considerable time lag in the neoliberal reform process. For instance, the actual privatisation process commenced in 1999, almost eight years after the government decided to roll back from the direct provision of housing in 1991. Furthermore, until 2002 only Housing Corporations could have access to loans from the FMBN. Private developers only came into the circle after the FMBN introduced a platform for the disbursing of loans to them in 2002. However, this development did not immediately result in the provision of housing by private developers. This study also found that the national and local housing markets are constrained by weak property rights. The critical legislation required for the improvement of property rights (foreclosure law) was yet to be passed at the time of study. The absence of foreclosure law creates risk for Nigerian mortgage lenders. In the event of default, lenders often experience difficulty and delay in foreclosing property (World Bank, 2009).

The absence of foreclosure law has resulted to the use of arbitrary measures to mitigate risk by mortgage lenders. For instance, the World Bank (2009 p. 123) found that "open market mortgage lenders in Nigeria often adopt measures such as requiring lenders to provide collateral security in the form of land that has a registered title (C of O) and located in a good location. In Nigeria, obtaining C of O is synonymous to registering property and the process of land registration is cumbersome and difficult to achieve at reasonable time and cost". The World Bank (ibid) study also reveals that some lenders have adopted the practice of charging high interests that are typically tied to prime lending rates in the range of 15 - 20 percent. High mortgage rates act as a deterrent to some potential low-income borrowers and put a heavy repayment burden on those who do borrow. In addition, there is a practice of using equitable mortgage, which requires borrowers to make an initial down payment of 30 percent prior to taking possession of the mortgaged property (EFInA and FINMARK Trust, 2010 p. 17). In some instances the lenders prefer to deal with borrowers only from certain specified employers, typically the public sector and large corporations (World Bank, 2009 p. 125). Instances also exist where lenders would prefer to recover mortgage loans through deductions from monthly wages, and this usually requires some informal support from the employer, perhaps allowing lenders to move salary accounts to the lending institution (World Bank, 2009 p. 125). All these measures are capable of depriving and excluding prospective home owners from acquiring houses through the formal mortgage system.

7. Conclusion

This policy review was set out to examine neoliberalism and housing reform in Nigeria. The study was focused on scrutinizing the underlying assumptions that informed the adoption of neoliberal housing approach in Nigeria and why this approach failed to produce desired results. The examination of the data collected for this study agrees with previous studies in confirming that Nigerian authorities were compelled to adopt neoliberalism following the economic recession that affected developing economies over the decades of 1980s and 1990s. In Nigeria, the deployment of neoliberal principle was found to change the course of economic development and the arrangement for the delivery of social services including formal housing. Regarding the delivery of formal housing, the Nigerian authorities adopted the neoliberal approach on the assumption that the implementation of enabling reforms would enhance the role of the private sector, thereby promoting the development of formal housing. The analysis of the data indicates that the opposite was the case in practice. There are three factors that were found to explain this failure: firstly, the neoliberal housing approach in Nigeria was a product of economic recession which culminated into the Structural Adjustment Program (SAP). As such, the market friendly proposals which were outlined in the neoliberal housing policy of 1991 (and the

revised versions of 1994 and 1996) were made amidst a weak economy with dwindling revenues and huge debt overhung. This scenario was found to constrain government's financial capacity to implement the necessary reform to support housing delivery under Nigeria's neoliberalism.

Secondly, this policy review found out that political instability affected the process of neoliberal reforms to the extent that it caused a considerable delay in changing the housing market. The data examined confirms that the neoliberal proposals, which were made in Nigeria's housing policy, following the adoption of neoliberalism did not receive attention by the then military administrations until after the return to democracy in 1999. Theoretically, a neoliberal housing approach should thrive on liberalism and market friendly business environment but this was not found to be so during Nigeria's military era (1983 to 1998). During this period, there was instability in governance as a result of military coups and changes in governments that held opposition ideological stances. This level of instability created inconsistency in the implementation of enabling reforms; the analysis especially, reveals that the inconsistency of reform led to a partial privatization of relevant public enterprises in the housing sub-sector. As a result of this, the formal housing market was dominated by public bureaucracies with limited participation of private institutions such as housing financiers, house building companies and manufacturers of building materials among others.
Thirdly, the neoliberal reforms implemented were progressive but the events occurred rather slowly, haphazardly and uncoordinated. A time lag was also observed in the reform processes. Furthermore, inconsistency is observed on the part of the Federal Government to review or make new legislation. Some typical examples are the land tenure system, the foreclosure law, the securitization law, and a law to support the decision to provide capital subsidies for housing development. Finally, since the return to democratic rule in 1999, housing under neoliberalism began to receive a boost in Nigeria through the involvement of private financiers and house builders. The private actors are now complementing the role of government in the provision of formal housing. Overall, therefore, this study has added our understanding of the impacts of neoliberalism on housing – particularly the challenges of implementing a neoliberal approach.

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Construction Failures in Lagos Metropolis: An insight of non-technical issues

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ABSTRACT

The common causes of construction collapse are mainly design, materials, accidents, the elements, workmanship and supervision. Regarding the increasingly frequent incidents in the Lagos Metropolis, published findings of researchers have not been markedly different. This paper argues that beyond the technical issues already raised, there are important factors yet to be investigated, which may be classified as being non-technical in nature, but constitute hindrances not only to the capacity of the supervising agency, the Lagos State Building Control Agency to perform its functions, but more importantly, to the effective execution of building control generally. The study reviews earlier findings, the practice and challenges of building control in the Lagos Metropolis before identifying and discussing these other factors. The findings are that the building control function is inappropriately assigned to the state government, rather than the local governments, and that the state bureaucracy cannot effectively execute building control because of poor capacity and practices. The most important implication of this research is that, by drawing attention to issues which have hitherto been unconsidered, it brings to notice the need to ascertain pragmatically which tier of government is better suited to execute building control and offer the required capacity and organizational effectiveness.

1. Introduction

Collapse during construction is just one aspect of building failure. Others occur during renovations, alterations and demolitions, in construction and demolition accidents, crane and scaffold collapses. Included also are demolition mistakes, errors of design, detailing, construction and procedure, expansion and movement, and natural disasters such as earthquake, high wind and tornado amongst others. These occurrences are interchangeably referred to as building failure, building collapse, construction failure and construction collapse. Collapse during construction occurs all over the world, even in the most advanced societies. Examples include the FC Twente Stadium Roof Collapse (MacDonald, 2011) and the San Antonio Parking Garage Collapse (Jiang, 2012). Janney (1986) defines construction failure as "failures that occur during construction and they are considered to be either a collapse or distress of a system to such a degree that it cannot safely serve its intended purpose''. Thornton (1985) states that the causes of failure can be grouped into five general areas comprising design, construction, material, maintenance and administrative deficiencies. A structural failure is a construction failure which occurs when a structural system becomes incapable of achieving its purpose.

Building failure in the Lagos Metropolis dates back to 1982, but this study is limited to construction stage failures which have occurred since 2000 which approximately coincides with the restoration of democratic governance in 1999. The major incidents of construction stage collapses in Lagos between 2000 and 2015 are presented in Table 1.

Statistics show that since 2000 there have been collapses every year except for 2008 and 2009, the highest frequency of 13 having occurred in 2006 followed by 10 in 2000.Oni (2011) reports nearly 30% of the incidents as having occurred in Lagos Island. This should be ascribable to its being a highly populated business and residential district where the pressure of development is great, with a density of 92,856 persons/km2, the second highest among the local governments (Resourcedat, 2016). Building control laws exist in Lagos, but in spite of them, construction stage collapses have continued and their frequency is growing. With each incident of failure, there follow calls for the state government to investigate the causes, prevent further occurrences by improving monitoring and prosecute offenders against the law. The government response has been through a 2010 reorganization of its administration of building control by creating a separate agency for that purpose. Yet, the frequency of collapses has been rising. There is also a discernible acceptance by stakeholders that only some now well-advertised technical factors could be responsible for collapses and this has created a kind of complacency all round. It is against this background that this paper looks further into the practice of building control in the Lagos Metropolis with a view to highlighting other issues which have a bearing on the capacity and capabilities of the existing system to function effectively and purposively.

As a preamble to this chapter, the reasons for the importance of this study have to be stated. First, the spate of collapses and the significant level of fatalities suggest that the construction industry has a poor safety record. This situation needs to be improved. According to Yates and Lockley (2002), "It is impossible to totally eliminate structural failures,

Table 1: *Major incidents of construction collapse in Lagos metropolis (2000-2015)*

No.	Year	Location	No. of story	Local Government Authority	No. of Casualties
1	2000	Oluwanisola Estate, Ikota, Lekki	Multi-storied	Victoria Island-Iru LCDA	2
2	2002	Mosadolohun St,Iba	3-storied	Ojo LGA	15
3	2003	Tapa Street,Orile	3-storied	Aguda-Coker LCDA	9
4	2004	Elias Street, Lagos Island	3-storied	Lagos Island LGC	8
5	2006	Ebute Metta	4-storied	Lagos Mainland LGC	37
6	2009	Ojerinde Street, Idiaraba	3-storied	Itire LCDA	9
7	2010	Odowu Street,Oshodi	2-storied	Oshodi-Isolo LCDA	4
8	2010	24 Alli Street, Victoria Island	2-storied	Victoria Island-Iru LCDA	3
9	2014	Synagogue Guest House, Ikotun	5-storied	Ejigbo LCDA	116
10	2015	Odunfa Street, Lagos Island	3-storied	Lagos Island LGC	Many trapped, rescued with injuries

Note: These major incidents of were chosen on the basis of the magnitude of loss of life and serious injuries. Between 2000 and 2015 there were over 50 incidents of construction stage collapse in the Lagos Metropolis. Ayedun, Durodola et al (2012: 316-318) list 56 such incidents up to 2010.The fatalities and injuries involved construction workers, passersby, people sheltering from rain and people inhabiting the unfinished structures.

but the safety record of the construction industry can be improved by reducing the overall number of structural failures". Second, when collapses occur, the stakeholders come into disrepute: regulators are accused of dereliction of duty and the regulated (developers, their workforce and engaged professionals) face opprobrium and official sanctions. In actuality, these situations lead to stakeholders playing the blame game. Ayedun, Durodola and Akinjare(2012) report that data gathered from a study of stakeholders: professionals in the building industry, landlords, developers and contractors, shows a difference of opinion as to the causes of failure, with each group exonerating itself and putting the blame elsewhere. The authors consider this finding as being indicative of a failure to appreciate the consequences of building failure. Third, collapses come with costs in the form of the loss of resources: money, property, life and time, all of which are irreplaceable. Fourth, in the matter of putting up structures which stand the test of time, the stakeholders constitute not only the regulators and the regulated, but indeed all who make use of constructed facilities. In some of the Lagos incidents, fatalities were recorded amongst non-construction workers and often when no activity was taking place on the site. It is, therefore, in the interest of all that buildings stay up as they are designed to be, rather than come down even before completion.

Regarding justification, in the aftermath of recent collapses, stakeholders have offered explanations and researchers given findings for the causes of failure, but these findings have been technical in nature such as poor design, poor supervision, incompetent builders, sub-standard materials and the like (Olagunju, Aremu, et al.,2013) and Alamu and Gana (2014). There have also been stakeholder assessments with similar findings (Ayedun, Durodola and Akinjare: 2012). However, further research is recommended by Oni as well as Olagunju, Aremu and Ogundele). Alamu and Gana, in doing the same, also call for local involvement in the execution of the building control function. They do not expatiate on their reasons for this particular recommendation, but it may be inferred that the present system lacks local input which they believe would be beneficial to the process. Given that further research is always necessary for phenomena to be better understood such research need not be in one direction only, which in the case of collapses, has tended to be only in the technical direction. It is equally germane to look in the non-technical direction if it can shed light on the matter. Building on earlier work which has identified the technical issues, this paper seeks to enquire further in other directions.

Further research is made necessary also by certain disturbing facts which are associated with recent collapses in the Lagos Metropolis. First, the casualty rate tends to be high. Second, the casualty rate tends to be higher among non-construction workers as seen in the Synagogue Church Guest House collapse in which all 116 fatalities were non-construction workers, and in the 2016 Lekki Gardens collapse where none of the 34 casualties was carrying out construction activities at the time of the incident. This is contrary to what should be expected in a building under construction. Third, in both the Synagogue and Lekki Gardens incidents, the building control administration claimed to have served contravention notices which were disregarded by the builders/ developers and, curiously, without any official follow-ups being made or sanctions applied until the collapses occurred. Fourth, both structures were very visible multi-story structures and in locations which could be easily monitored by officials.

This paper looks beyond findings on the causes of failure as contained in existing literature. It evaluates certain non-technical, structural and cultural factors which are relevant and complementary to explaining the rising trend with a view to proposing solving measures which can significantly bring down the level of failures. To achieve this aim, this study first reviews the technical findings on construction stage collapses since 2000;second,it evaluates the structural administration of building control in present day Lagos compared to earlier times and practice in external jurisdictions; third, assesses the activities and challenges of the government agency in charge of building control together with associated socio-cultural practices which, because they affect the conduct of the stakeholders (the regulators and the regulated) can help to shed light on the overall effectiveness of the building control function; fourth, offers an insight into the non-technical issues which have a bearing on the performance and effectiveness of building control; and fifth, makes recommendations on how the identified hindrances can be overcome.

2. Theoretical Backgrounds

2.1 Building Control in the Lagos Metropolis

The Lagos State Building Control Agency (LASBCA) was set up as an agency of the Lagos State Government under the Lagos State Urban and Regional Planning and Development Law of 2010.Before 2010, the Development Control Department of the Ministry of Physical Planning took charge of building issues. In addition to this enabling law, its activities are governed by the LASBCA regulations and the National Building Code.

According to Section 47 of its enabling law, the responsibilities of the LASBCA are: (a) enforcement of building control regulations, (b) regulation and inspection of building works and, certification of various stages of building construction and keeping of such records, (c) removal of all illegal and non-conforming buildings, (d) identification and removal of distressed buildings to prevent collapse, (e) issuance of certificates of completion and fitness for habitation, (f) provision of building services such as material evaluation and testing, fire and public health control, (g) establishing Local Building Control Offices in co-operation with the local governments and local council development areas, for the discharge of its functions at the local government level with the approval of the Governor, on the recommendation of the Commissioner.

2.2 Effectiveness of the Agency

Under its present name and operating system, the agency is relatively young, but it has had the opportunity of building capacity and developing expertise under the old administrative arrangement. The areas in which the agency has been able to achieve a measure of success include: (a) Increased enforcement activity which has resulted not only in more awareness of the importance and necessity of seeking building approval, but also, leading the now better informed citizenry to seek approval before building in order to avoid sanctions, (b) The use of the services of professionals. Recognizing that its staff strength of lower than 300 as at 2015 is inadequate for its functions, the agency complements with the engagement of independent professionals to carry out its assignments, (c) Establishment of the Materials Testing Offices in various locations to provide comprehensive, one-stop services for builders, (d) The promotion of Building Insurance to protect building owners against loss, (e) The registration of artisans so as to afford an avenue for monitoring their on-site activities at construction projects. However, the agency has shortcomings which serve to hinder its overall effectiveness.

In the first place, there is the issue of perception by the public. Easily, the most enduring perception of the Lagos building control agency is as an entity which demolishes people's structures without allowing the removal of their moveable properties. This reputation was notoriously acquired 25 years ago by the Maroko demolition of 1990 which displaced over 300,000 citizens and appears to have set a poor public policy standard which is difficult to depart from. The early January 2016 holiday-time demolition of the Oshodi market and the destruction of the traders' goods in the process is the latest example of this now entrenched practice. Also, an aspect of citizen-unfriendly behavior is the cost of seeking building approval which appears to be geared towards the maximization of state revenue earnings rather than encourage compliance through affordability of the charges. The agency has an unfriendly image. Its effectiveness can be improved only with a re-orientation not only of its staff, but also, of the Lagos State Government which supervises it.

Second, there is the issue of capacity and professionalism. Ogundimu (2013) identifies the poor knowledge, experience and exposure of the agency's staff as severe limiting factors, stating that: "Their academic qualifications and experience are questionable…"and they "do not have the necessary experience or expertise to deal with the numerous housing issues in the state. Most of the top officials lack the necessary exposure and very few have travelled out of the country, which is extremely important in terms of exposure these days". Udo-Udoma (2014a) agrees in commenting that: "The frequency of collapsed buildings in Lagos cannot solely be attributed to developers cutting corners or inadequate materials, the Lagos State Government needs to build capacity of the authority and its staff members who police, manage, administer building regulations and planning permission".

Third, there is the national bugbear of official corruption and compromise, from which the agency suffers also, as part of the scheme of things. According to Ogundimu (2013) corruption within and outside the Lagos State Building Control Agency is another reason why building regulation is impossible to enforce in the state. The issue of corruption is remarkably not mentioned in the findings of (Alamu and Gana, 2014), (Olagunju et al., 2013).Also, Ayedun et al. (2012) whose study involves a survey of the key stakeholders namely, professionals, landlords and developers, do not in their findings specifically mention corruption as the issue was not featured in their structured questionnaire which focuses on issues of materials, design, defects, workmanship, supervision and the elements. Oloyede et al. (2010) conclude from their survey that bribery and corruption were considered as insignificant, but this position conflicts with their finding that the remote causes include non-enforcement of the existing laws. The non-enforcement of the laws can constitute not only a dereliction of duty, but may also be construed as an act of corruption which confers advantage on the owner of the property which is deliberately not subjected to the laws of building control. Corruption is usually assessed by perception in view of the difficulty of gathering actual evidence and it is not restricted to the demand for, and receipt of, inducement but can be the deliberate overlooking of breaches of the law for preferential reasons.

Fourth, a lack of infrastructure and resources to tackle the great challenge of monitoring development springing up in all nooks and crannies of the state is identified also by Ogundimu (2013) as a problem to which no solution has been found. The rapid urbanization and expansion of the built up areas of the state coupled with inadequate agency staffing and modern monitoring resources has meant that the agency becomes aware of the opening up of new areas after individuals, acting in their own best interest, have taken actions which do not sit well with official regulations. An official response with sanctions creates an image problem whilst condonation would be ill-advised where the structures are unsound.

There are constraints and challenges to building control which come in the form of (a) physical attacks upon, and the unlawful detention of, LASBCA staff in the course of their enforcement duties by irate and unco-operative members of the public, (b) low public appreciation of LASBCA functions, except perhaps as a building demolition agency, (c) low public perception of LASBCA staff arising from the issue of official gratification, (d) removal of official notices served upon building owners and developers, (e) delays in the prosecution of building law offenders whose conviction should have a deterrent effect on would-be

offenders, (f) difficulty in obtaining building ownership data from multi -tenanted dwellings whose occupants usually remove official information-gathering notices pasted on such buildings, (g) inadequate staff strength-its staff number of below 300 as at 2015 cannot serve a metropolis of 21 million with an average density of population of not less than 13,400 per square kilometer, (h) inadequate operational equipment, (i) Building standards are unclear to the public, (j) the regulatory requirements of the environment are difficult to handle.

The common thread in the collapses is that they involve storied buildings requiring appropriate substructure designs and reinforcement for the superstructure in a terrain which is some 40% made up of wetlands. Other environmental monitoring challenges include pressure of rapid development arising from a population growth rate of 3.5% per annum. As Udo-Udoma (2014 b) observes: "The collapses stem mainly from hasty illegal construction as buildings are tossed up virtually overnight to accommodate the city's mushrooming populations. In the rush to solve these worsening housing deficits, corners are cut, palms are greased, low-quality materials are used and, in general, shoddy work is performed".

2.3 Construction Failure in Lagos Metropolis

The approach adopted in presenting a review of existing literature is to summarize in tabular form the main findings and recommendations of some authors who have researched into the problem of collapses in the Lagos Metropolis. Table 2 summarizes the findings/recommendations of five such authors.

There is a congruence in the findings of the various authors. The findings are basically technical in nature as they relate to the process of the production of building structures. Regarding recommendations, all authors are agreed as to the need for the involvement of the public in the monitoring of development. The implication is that agency officials alone cannot handle the task. There is also agreement as to the strict application of the laws and sanctions. This, again, is to ensure that the technical processes are strictly followed. Alamu and Gana's recommendation that a "Systematic inspection of building works should be enforced at the Local Government level" is instructive as it implies that the problem of building control could be better handled if there was meaningful involvement at local level which is currently not the case. Oni, as well as Olagunju et al. (2013) concur that there is a need for further research into the causes of building collapse in Nigeria in general and the Lagos Metropolis in particular. This recommendation is important because construction failure, even though preventable, cannot be eliminated as failure can result from factors which cannot be controlled or predicted.

3. Methodology

This paper is designed as a review of the system of building control in the Lagos Metropolis. Since the study is a review, it relies on data obtained from secondary sources, mainly the studies and findings of researchers into the phenomenon. Construction collapse data used in this study were derived from these previous studies. Reference is also made to extant legislation on building control in the study area and to studies on capacity and culture in the Nigerian bureaucracy of which that of Lagos State is a part, and the implications for public sector service delivery of the structural organization of the Nigerian State and its constituent units.

4. The Study Area

The Lagos Metropolis is the business and industrial capital of Nigeria. Its population is put at 21 million (Lagos State Bureau of Statistics, 2015) and it is administratively divided into 57 local authorities spread over a land area of 3,577 square kilometers (Learn About Lagos, 2016). The population density per square kilometer is given at 13,405 persons by Wikipedia (2016). 2016).The considerable geographical size and population density of the study area underscores the responsibility and the volume of work involved in the effective monitoring of development. Administratively, the area is structured into 20 local government councils as provided for under the constitution of the Federal Republic of Nigeria but in 2003 the government of the state unilaterally created 37 more administrations which, following the disapproval of the federal authorities, it was forced to re-designate as *local council development areas,* but with all the characteristics and functions of the constitutionally approved local government councils.

Table 2: *Summary of literature on causes of construction/building collapse in the Lagos metropolis*

Authors	Findings	Summary of Recommendations
Oni(2010)	Poor workmanship/materials, Design defects.	Public involvement in monitoring, .strict enforcement for compliance with laws, further research into failure
Oloyede, Omoogun and Akinjare(2010)	Poor materials/specifications/workmanship; non -enforcement of existing laws	Public education, Involvement of citizens, Non-interference by government, prompt sanctions.
Ayedun,Durodola and Akinjare(2012)	Poor materials/workmanship/specifications, Design defect/alteration	Involvement of citizens/professional bodies in monitoring, strict enforcement.
Olagunju, Aremu and Ogundele(2013)	Poor materials/workmanship, design defect (foundation), the elements.	Strict adherence to laws /standards, public enlightenment, further research into failure
Alamu and Gana(2014)	Poor materials (concrete mix ratio)/poor materials/workmanship; (walling)/specification/ supervision; Design defect (foundation), the elements.	Pre-test of materials; strict enforcement; ensure use of professionals on site; Local involvement

5. Discussion

5.1 Purpose of Building Control

Building control is aimed at delivering safe and sound structures which will not fail either during construction or when subjected to normal use thereafter. The rationale for control is that the production of built structures is achieved through a technical process which, for the right outcomes to be obtained, needs to be meticulously followed from substructure to superstructure Building control is the process by which building regulations or standards as to design and modification are administered or enforced by a building authority. The process applies to the design and construction of new buildings and improvements to existing ones. This activity occurs only after the planning agency has approved relevant issues as to appropriateness of the development.

5.2 Historical Background of Building Control in Lagos

The British, who created the Nigerian state, were responsible for introducing modern governance, creating townships and the framework for their administration which was patterned after what obtained in their home country. An important aspect of Township administration was the establishment of Town Councils as seen in the Lagos City Council, the Benin City Council and Enugu City Council among others, as authorities responsible for carrying out municipal functions such as the registration of births and deaths, sanitation, the naming of streets, promotion of public hygiene and the approval and control of development. Municipal authorities in Nigeria issued ordinances in carrying out their functions. Ordinances could not contravene or exceed statutory provisions from which their powers were derived .The provision for municipal governance through ordinances serve as proof that the colonial authorities believed in, and permitted, local administration of local issues by local officials just as in their home country. In this way locally elected councilors can make meaning of their local mandate.

The system of municipal responsibility for the zoning of development, its approval and control started in the colonial era and continued in the post-independence period. The laws issued by municipalities have over these periods been variously tagged as ordinances, laws, bye-laws and edicts. These were incidentally times in which Nigeria was under civilian governance. The crises of 1966-67 which saw the introduction of military rule in Nigeria led to an unforeseen and far-reaching structural reorganization of the country from four regions to 12 states by virtue of the State (Creation and Transitional Provisions) Decree No. 14 of 1967.These structural changes gave rise to cultural changes.

As a consequence, the organization of the Nigerian state, its constituent units and their agencies, their work ethics and organizational culture have been affected in ways which today reflect in the conduct and discharge of public responsibilities. These are the factors categorized in this paper as the non-technical issues implicated in the frequency of construction stage collapse of buildings in Lagos.

6. The Non-technical Issues

6.1 Appropriateness of Functional Responsibility for Building Control in Lagos State

There are two very important issues regarding the LASBCA, which give an insight into the recurrent building control challenges in the Lagos Metropolis. First, the agency is a public service organization and its staff constitute part of the Lagos State public service and also the wider

Figure 1: *Map of the Lagos metropolis*
(Source: Bohr, 2006)

Nigerian public service, with which is associated poor service delivery and considered to be in need of a comprehensive reform which will make it efficient, effective, transparent and responsive (Igbuzor, 2015). Second, it is a state-level organization set up to perform the functions of local organizations i.e. municipal organizations or local governments.

6.2 The Established Order of Functional Responsibility for Building Control

Building control is a local function which, in other jurisdictions across the world, is performed by the local authority in which a development project is to take place or takes place. This was the system established by the colonial authorities in Nigeria before independence and which was in place until the 1970s. Local supervision of development still obtains in the UK and it works very well there as a symbol of local democracy and the control which the residents of an area have over their affairs. However, local supervision and control over local development is no longer the norm in Nigeria in general and Lagos in particular.

6.3 The benefits of local administration of building control

The benefits of this arrangement are as follows: (a) **t**he local environment is best understood and also best monitored by those who reside within it. The current arrangement under which the LASBCA has only zonal representation in the councils cannot be regarded as being effective because the local officials have a greater familiarity with their territory and a shorter distance to cover in monitoring it than do officials located at headquarters. Looking at the Synagogue Guest House issue, the Ejigbo Local Council in whose territory it was located would have been better suited for a day-by-day monitoring of the site than head quarter officials. (b) **a** devolution of building control (and development control as well) would be in accordance with best practice. This is important for a city which prides itself as a "center of excellence" and aspires to the status of a "mega city". Without a strong and purposive local administration, the quality of urban governance in the state cannot improve. As matters stand, the Lagos State government executes the functions of a state government and, as it appears, those of the local governments as well.

According to the UNDP (2013) good governance is among other things participatory, transparent and accountable. Good governance occurs when societal norms and practices empower and encourage people to take increasingly greater control over their own development in a manner that does not impinge upon the accepted rights of others. Apart from being a tier of government, the local government is an institution of state which state governments in Nigeria, including Lagos State, must respect if indeed good governance is to be pursued. The people who administer the state governments, being elected just like those in the local governments, cannot decide what is suitable for the latter whose mandate is directly and more firmly rooted in the local environment than that of state officials. It is unacceptable and unduly paternalistic for elected officials at the state level to decide what is good for elected officials at the local level in spite of what the constitution says and what voters have decided. (c) **t**he devolution of power to the constituent local governments would enable them develop capacity not only in the discharge of the building control function, but also, in their other areas of responsibility in which they have so far failed to perform. Any argument that the local governments are unreliable and would make matters worse can be countered by the argument that the state agency has also demonstrated its unreliability as regards effective monitoring of development. Indeed, if these incessant building collapses had been occurring under local government administration of building control as is being proposed in this paper, there would likely by now have been attempts made by the state to take over the responsibilities basically in order to benefit from the revenue realizable from building permit charges. But who now takes over from the state when it is unable to perform? Doing the right thing cannot make matters worse especially when it comes with other advantages which effective local administration offers. Besides, the fact of local governments having problems of leadership is the making of state authorities who interfere in their activities.

6.4 Structural Impact of Centralization of administration and Restructuring

The capacity of the public service to perform has been, and is still being, affected by structural and cultural changes which were introduced by military *rulership* of Nigeria between 1966-1979 and 1984-1998. The coming and consolidation of undemocratic governance in 1966-67 not only usurped the powers of the democratically-chosen assemblies of Nigeria's four regions, but also, centralized all the powers of the state in the capital, Lagos. This was a destabilizing factor, but it was then not so recognized. When, in addition to the centralization of powers, the country was arbitrarily restructured into 12 states, another far-reaching step with unforeseen implications was taken. These two steps were to have serious effects which have lasted to this day.

Kukah (2012) states that **t**he nature of the military legacy and its cumulative impact on our polity has never really been studied and adds that there has been a negative cumulative impact and the rut has persisted. The fact of the matter is that we have never really exited the stranglehold of the military state that displaced our post-independence experiment with democracy. The reason why is that today, post-military Nigeria is paying a high price for the over-centralization of the threads of power in the hands of the military dictator**.**

The centralization of power introduced by the military still affects the democratic system or the semblance of it which Nigeria is operating. Stripped of all niceties, the Nigerian system can be characterized as follows: the federal government lords it over the constituent states, whilst the states lord it over the local governments; the presidency tries unduly to influence the federal legislature while the state governors emasculate their various legislatures. In this display of power and preference, the local administration is seriously handicapped. Inefficiency and corruption in local government is systemic, embedded in Nigeria's Constitution by an unwieldy, lopsided arrangement in which local community finances are held in the suffocating grip of the states, which are in turn controlled by the federal government (Maja-Pearce, 2014). The local government should be the bedrock of development as it is the closest to the people and every part of the country belongs under a local administration, but those who operate the constitution disregard these facts. Maja-Pearce (2014) adds that **t**o make matters worse, local representatives are themselves imposed by the parties at the center because, in the words of Chief Bisi Akande, National Chairman of newly unified opposition, the All Progressives Congress. IIt is the leadership of the party that understands the manifestos of the party and know**s** what the people really want. Agbodike et al**.** (2014) add that **l**ocal government administration in the country is confronted with issues and challenges such as federal and state government's interventions in the constitutional responsibilities of local

government. It is seen as avenue for dispensing politica**l** patronage to party loyalists. That the states have no intention of allowing autonomy at the local level was borne out in 2014 when all 36 governors were unanimous in their opposition to a bill proposed in the National Assembly for local governments to receive their funding directly from the Federation Account.

From these observations it may be inferred that the local government system is being deliberately made unworkable by the state administrations, but also complicit in this act are the federal authorities who have failed to intervene. In all, the impression created is that Nigeria's system of governance is centralized and not democratic. The conclusion of Maja-Pearce (2014) is that **i**f Nigerian democracy is to be cleaned up, if indeed, the country is to survive, then reform must start at the local level, with people demanding honest government and a fair share of the national wealth.

The weakening of local administration through the interference of the federal and state governments in its responsibilities, the use of its resources by state governments for political patronage has meant that this third tier of government has been unable to develop capacity, to attract and retain quality personnel who would see to the discharge of its constitutional responsibilities. This is true for each and every state in Nigeria. In the case of the Lagos, there was only the Lagos City Council in the 1960s when the territory and population were much smaller and this situation subsisted for part of the 1970s.Now,with a higher population, higher rate of building construction, greater built-up area and 57 local administrations, what still obtains is one building control authority being in charge of much wider responsibilities than was the case in the 1960s and 1970s.Working with the colonial template in which every town council had its own building authority and engineers fully in charge of development, the state authorities, having of their volition structured the territory into 57 local administrations, should establish that same number of building control agencies for effective coverage.

6.5 Cultural Impact of Centralization and Restructuring

The centralization of authority and restructuring of the country also produced some unintended consequences in the culture of the Nigerian public service (federal, state and local governments). First, the concentration of power at the center gradually weakened the federating units of the country and took government farther away from the people at the grassroots. Evidence that government is now further away from the people is seen in the demand for more states. From 4 regions, and without any referendum,12 states were formed, then increased to 19,then 36,with the final figure proposed in the 2014 constitutional conference put at 54.With the increase in the number of states came a dilution of the quality of capable personnel to manage their affairs. This was basically because the unclear criteria and hastiness of state creation did not take into account the need to have first in place capable personnel to man them. Thus, below the federal tier at which power is overly concentrated, there are weak states and even weaker local governments, resulting in poor governance. Second, military rule was neither transparent nor accountable to the people, and it did not encourage local participation in decision-taking. Human Rights Watch (2007) reports that at the state and local levels the people still have no way of holding their local officials accountable for their actions. Basic information about the use of public resources at the state and local level is kept a closely guarded secret, and state government 'oversight' of the local governments is often carried out in a manner that is **both** secretive and ineffective.

Third, the military politicized the public service and thereby negatively affected its culture. The federal civil service purge of 1975, involving over 10,000 personnel from the class of messenger to permanent secretary, was a destructive act. According to Asiodu (2015), "the destruction of the civil service meant that institutional memory was lost" because among "those swept away were role models imbued with the core values which enabled some checks and balances in the system". The inherited and now internalized culture is of unquestioning acquiescence to official directives. A situation in which public officers occupy positions which do not require critical appraisals, converts such offices to sinecures for the retention of which loyalty only, not performance, is necessary.

In the view of Ogunrotifa (2012), the service is known for a weak governance structure, red-tape, poor accountability, low professional standards, waste and corruption, poor productivity, and lack of control, redundancy and over-bloated staff structure and **s**trong institutions cannot emerge from the present day Nigerian Civil service where the top echelon is picked on the basis of ethnicity, religion and class. Abdullahi (2013) essentially concurs that **r**cruitments into the civil service have been influenced by patronage and politics. Nepotism and tribalism are the order of the day. Because of the political under tones entrenched in the public service, people are recruited based on tribe and connections. Unprofessional and incompetent hands are now recruited into the public service. This malaise affects all tiers of government across the country. Fourth, with politicization it became difficult for professionals to have career security. According to Asiodu (2015), the situation has long changed from the pre-1975 period when promotion was based upon the organizational chart and there was career planning. Today, public service is no longer the destination of high-fliers. **Fi**fth, the public services of today, in structure and culture, are the legacy of military rule and it is a problematic legacy. In the past, attempts at reform have been made, but these failed due to factors including a lack of political will, poor management, faulty diagnosis, poor recruitment policies, lack of human resource capacity building, political patronage, quota system and lack of democratic practices in the management of the public service (Igbuzor, 2015).These factors are coincidentally much the same which make the public service unable to perform.

Furthermore, recent research by Igbuzor (2015) has found that **t**here is no doubt that the Nigerian public sector performance is weak despite increased public expenditure. It has been shown that increased expenditure has not translated into service quality and performance. The missing link is a poor public service delivery process. This is why the way out of the problem is a comprehensive Public Administration Reform to produce a public service that is efficient, effective, transparent and responsive. The public service processes that need reform are planning, policy making, budgeting, human resource management and performance management. It is important to point out that the pattern of increasing expenditure and declining quality of service is probably worse at the sub-national levels (state and local government). This is why the Public Administration Reform needed in Nigeria must be comprehensive covering all levels and tiers of government.

The cumulative impacts of these cultural influences have been to handicap our various public services and render them incapable of delivering quality. The 2014 Synagogue Church Guest House collapse, in spite of the explanatory technical analyses proffered, smacks of official

neglect, failure, refusal to act on a supposed building contravention for reasons undisclosed to date. Failure to act on such a technical contravention is in actuality not a technical but rather a cultural issue founded in organizational structure and culture.

6.6 The Indigeneity Culture in a Cosmopolitan Environment

The leadership and staffing of the LASBCA, despite the cosmopolitan nature of Lagos State, has always been drawn from the indigenous population. Its status as a cosmopolitan city, an industrial and commercial center and the most prosperous in the country confers upon it many advantages which can help its transformation into a better place. As its government energetically pursues its mega-city project, it would do well to look into how it can exploit the advantages of state's financial resources and the available pool of human resources in the entirety of Lagos, not just among its indigenes, to tackle the deficiencies in its public service. In the very week of the Lekki Gardens construction collapse in early March 2016, it was announced (Nigerian Eye,2016) that the monthly internal revenue generation of Lagos State had attained a record height of N24.5 billion (US$ 122.5million) ,with most of it coming from land transactions, including fees for building approvals. The non-indigenous residents, who account for most of the productive investments in the state, contribute substantially to this rising revenue profile, but have no voice in the administration of the city.

The state ought to tackle the building control problem by recruiting the best available skilled personnel from the pool of labor engaged in the private sector organizations in the city, many of which are construction companies with engineers of repute. The seriousness of incidents of collapse, news of which travel around the world, should be seen as negative publicity which detracts from the efforts of the Lagos government and, indeed Nigeria also, to attract international investors. The bugbear of recurrent construction collapses indicates that the required technical expertise, experience, commitment or administrative skills are not available in the LASBCA and that the administrative arrangement is not appropriate. In the circumstances, treating the building control job as a position for political patronage which is reserved for Lagos State indigenes is contrary to best practice and good governance. The international dimension of the Synagogue collapse indicates that the responsibility transcends primordial and parochial considerations. Lagos state cannot do it all alone in a globalized world.

6.7. The Culture of Inhabitation of Buildings under Construction

Unlike collapses in better supervised jurisdictions where casualties tend to be fewer and are usually restricted to construction workers, in Lagos, casualty rates are not only relatively high, but predominantly consist of non-workers. A reason for this is the widespread practice of workers as well as their dependants (as it turned out in the Lekki Gardens case) sheltering and sleeping over in buildings still under construction. In two of the recent collapses, the Synagogue Church Guest House in 2014 and the Lekki Gardens in 2016, the casualty rates were respectively 116 and 34.Construction was not going on at the time of these incidents. The Synagogue incident is also curious in that the structure was a two-story guest house apparently completed and already in use which accounts for the 86 South African casualties who were guests living in the facility, yet this occupied structure was allowed to become once again a project site as the owners attempted to add three more floors. There are questions as to whether a completion certificate was issued by LASBCA for the two-**story** in confirmation of its proper completion before it came into use or whether none was issued probably because the project was yet to attain its 5-floor target.

Researchers, as well as officials, have not given consideration to the potential consequences of the occupation of buildings before the completion of construction, which practice has in these last two major construction failures led to heavy fatalities. The practice of construction workers sheltering inside structures under construction is explained by the reason that they generally reside in the low-rent city outskirts which are usually distant from project sites mainly in up market areas, making it difficult for them to get public transportation home after work and to arrive on site early each working day. This is a peculiar problem of Lagos due to traffic congestion and the absence of a mass transit system. LASBCA field officials who visit project sites cannot claim to be unaware of the fact that workers live in project structures and that this practice increases the risk of fatalities where a structure collapses even whilst work is not going on. The agency should long have stopped the practice and directed developers who need to accommodate workers on site to put up temporary structures in a safe area nearby for that purpose.

6.8. Absence of a Culture of Self-Appraisal and Public Accountability

It is not the norm for public sector bodies, Ministries, Department and Agencies, to undertake performance assessments of the quality of the services they provide to the public. This is a reflection of the poor accountability in the entire Nigerian system, federal, state and local government administrative levels, as referred to by Human Rights Watch (2007).

As a public service organ, neither the LASBCA or its predecessor agency has ever sought (and publicly presented as would be expected in a democratic setting) stakeholder assessments from developers, real estate professionals, artisans and the general public as to how effectively it has been carrying out its activities. All the agency has cared about it seems, is the substantial revenue which it has been raising from its activities. This may be a problem of leadership capacity.

Leadership determines the pace and direction of an organization. It is important for result-oriented leadership that those who are appointed to head government agencies interrogate the philosophy of the organization and its operational culture and practices. Where leadership is properly selected, and therefore, is not installed by patronage and fettered by politics, there is a greater chance that it will be knowledge-driven, target-driven, professional and pro-active and equipped to establish a culture whereby periodic introspections and self-analyses are carried out.

6.9 Failure to Enforce the Laws

The state authorities have demonstrated an unwillingness or incapacity to see things through regarding the enforcement of the laws of building control. According to Alao (2015),the Lagos State Tribunal of Inquiry into the building collapses which occurred between 2007 and 2013 indicted the state government for being complicit because it "has not done enough in the implementation of laws that prescribe the operations of all stakeholders in the construction industry in the state" adding that, "the preponderance of illegal developments in the state could be traceable to cumbersome planning permit process, absence of physical

development plans and operative development guides, as well as title documents as prerequisite for granting planning". Udo-Udoma (2014b) reports the Chairman of the Lagos State Tribunal of Enquiry as saying also that: "There is no record of persons prosecuted or sanctioned for incidents of building collapse by the Ministry of Justice, the Nigeria Police and any other law organ because of political, cultural, administrative and other interventions."

7. Conclusion and Way Forward

This paper was aimed at giving an insight into the non-technical issues lying at the background of the recurrent incidents of construction stage collapse in the Lagos Metropolis since 2000. A review was made of earlier findings on construction failure in Lagos, the functions and challenges of the state building control agency and the structural anomaly in having a state agency carry out the functions of local agencies. The structural and cultural factors which constitute handicaps to the state agency in the execution of its functions were identified as the non-technical issues which are contributory to incessant construction stage collapses. Further investigation is still necessary into these factors as well as to ascertain under which tier of government, state or local government, the building control function would be better executed in the Lagos Metropolis and the necessary conditions for this to be effective. A clarification of these issues would constitute that important first step towards a total reorganization of the present system for better building control performance.

The way forward which arises from this paper is simply that the present system of building control administration in Lagos State is deficient and should be dismantled and reorganized for the following reasons: (a) building control is a local activity which is best administered at the local level. A city which aspires to mega-status ought to apply best practice as seen across the world. Concentration of powers at the state level needs to be reconsidered in view of its inefficiency, (b) capacity at the local level is crucial to good governance and must be actively developed and nurtured so that local communities and administrators can take ownership of their own affairs. The use of elective local offices and resources for political patronage must be discontinued, (c) the inadequacies of the present LASBCA, as part of an incapacitated national bureaucracy, ought to be tackled innovatively by seeking expertise wherever it may be found. Such expertise is to be deployed under a decentralized and democratized administrative structure with each local administrative unit having its own building control agency, (d) in reorganizing the local administration of building control, only 20 and not 57 building control departments are recommended because the 1999 constitution of the Federal Republic of Nigeria (as amended) granted Lagos State only that number of Local Government Councils.

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Health Risk Assessment for Transport Corridors in Delhi through Vehicular Air Polluting Mapping

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ABSTRACT

Vehicles are recognized as one of the major sources of air pollution. Delhi having a very large number of vehicles produces a lot of air pollution. There is an utter need to ascertain the concentration of the pollutants and their impact on the health of the people of the concerned region. This paper makes an attempt towards such an examination. The method employed here is based on Epidemiology. The assessment of health risks due to increased levels of various pollutants on people represented in this paper is based on the spreadsheet model, Risk of Mortality/Morbidity due to Air Pollution (Ri–MAP). This paper presents the findings of the study that evaluates the Impact of increasing air pollution on human health, especially vehicular pollution, in the monitored region, i.e., National Capital Territory of Delhi (NCT Delhi) during the year 2015 by choosing fifteen study sites from different parts of the capital city. The findings are in terms of excess number of cases of cardiovascular and respiratory mortality, and cardiovascular and respiratory morbidity for all fifteen transport corridors. Among others, Noida link road recorded highest excess number of cases of cardiovascular mortality and morbidity and respiratory Morbidity. In case of respiratory mortality, Wazirabad road recorded maximum excess number of cases. With respect to least excess number of cases, it was Connaught Place (Outer circle). The excess number of cases are directly proportional to the population density of the respective region. Also, the regions showing smaller excess number of cases are the planned, less crowded and posh regions of the national capital territory of Delhi.

1. Introduction

The National Capital Territory of Delhi (NCT) covers an area of approximately 1500 km2 including parts of the neighbouring states of Haryana, Uttar Pradesh, and Rajasthan and is counted among the most densely populated cities of the country as well as of the world. The region has grown rapidly over past 20 years. Delhi shows huge growth in its population every year which is estimated to cross approximately 20 million in 2020. The rapid urbanization and industrialization have resulted in the tremendous rise in population of Delhi, the capital city of India and its surrounding areas. Along with the large size population, Delhi is a prime centre for trade and commerce. It is heavily used for various socio-economic, cultural, political and major tourism activities. The national highways and other major road networks of the city carries intra and inter-city traffic traversing to and from the different parts of the country. As a result of these factors, the number of vehicles roaming on the roads of Delhi has rapidly increased over the past two decades and is still rising. In last two decades, the vehicle numbers have increased by more than five folds (i.e., 21 million in 1991 to 114 million in 2009) (MoRTH, 2011). With rising transport demand, India became 7th largest vehicle producing country in the world (OICA, 2010). Around 80% of passenger and 60% of freight movement depend on road transport (MoEF, 2000). It has been reported that steep rise in vehicle number and poor emission control practices results in serious air pollution problem (Guo et al., 2007a). On-road vehicles were believed to be the single largest source of major atmospheric pollutants till 1998 (USEPA, 2000; Pokharel, 2002) and according to some reports Emission of airborne pollutants from transport sector accounts for more than 50% of gross emission in urban as well as semi-urban areas (Gujar et al., 2004; Fu, 2004; Wang et al., 2005; Zhang et al., 2008; Ramachnadran and Shwetamala, 2009; Sahu et al., 2011). According to Nagpure et al., 2013 traffic is one of the major sources of pollution in all big cities and most of the urban regions.

Air pollution has various impacts on public health, causes urban and regional haze, and can contribute significantly to climate change (Molina and Molina, 2004). Proximity to major roadways and exposure to traffic related atmospheric pollutants may be associated with a number of respiratory and cardiovascular issues including asthma, reduced lung function, adverse birth outcomes, cardiac effects, respiratory symptoms, premature mortality, and lung cancer (HEI, 2010). Recently, diesel exhaust was officially classified as carcinogenic by the International Agency for Research on Cancer (IARC) of the World Health Organization (Straif et al., 2013). Gauderman et al., 2007 found that children who lived within 500 m of a freeway had substantial deficits in lung function, when compared to children who lived 1500 m or more from a freeway.

The emission of criteria pollutants namely Carbon Monoxide (CO), Nitrogen Oxide (NOx) and Particulate Matter (PM) due to vehicles is estimated through the International Vehicle Emission (IVE) model, which includes the different driving modes of vehicles and meteorological parameters. Many studies have tried to evaluate the impact of pollutants on human health in past. Epidemiologic studies are very useful in providing a lot of information on impact assessment of the common exposures and are considered good basis for impact assessment (WHO, 2000; Lawrence et al., 2007). This kind of study helps in giving a fair idea of how the pollution due to vehicles can lead to increased number of mortality and morbidity due to various diseases in the concerned area (Dockery et al., 1993; Poloniecki et al., 1997; Woodruff et al., 1997). The mortalities assessment in Ri–MAP model which is used in this paper is based on long term exposure (1 year) to the air pollutants like PM2.5, and NOx whereas the assessment of morbidity is on the bases of short term exposure (24 hours) (WHO, 1999; Abbey et al., 1999; WHO, 2003). This paper gives an estimate the conditions of NCT Delhi for the year 2015 in terms of a few problems associated with air pollution and its impact on residing population. This study focus on the transport corridors selected from all across Delhi and attempts to evaluate the health impact for the people of respected regions of Delhi.

2. Description of the Study Area

The National Capital Territory (NCT) of Delhi is located at 28°36'50"N 77°12'32"E with pollution of 1,6753,235 persons, according to the census of India 2011 (Figure 1). As representative of the conditions of the transport corridors of the city, 15 different transport corridors were selected for monitoring. These transport corridors are counted among the biggest and busiest transport corridors of the city connecting it to the neighbouring states and other major cities of the country. Some of these corridors pass through the most significant/important regions of the capital and others pass through some of the densely populated towns of the capital city. Along with this, the selected fifteen corridors lie in different sub-districts across the capital city, representing the variety of population and living standard sceneries present throughout the city.

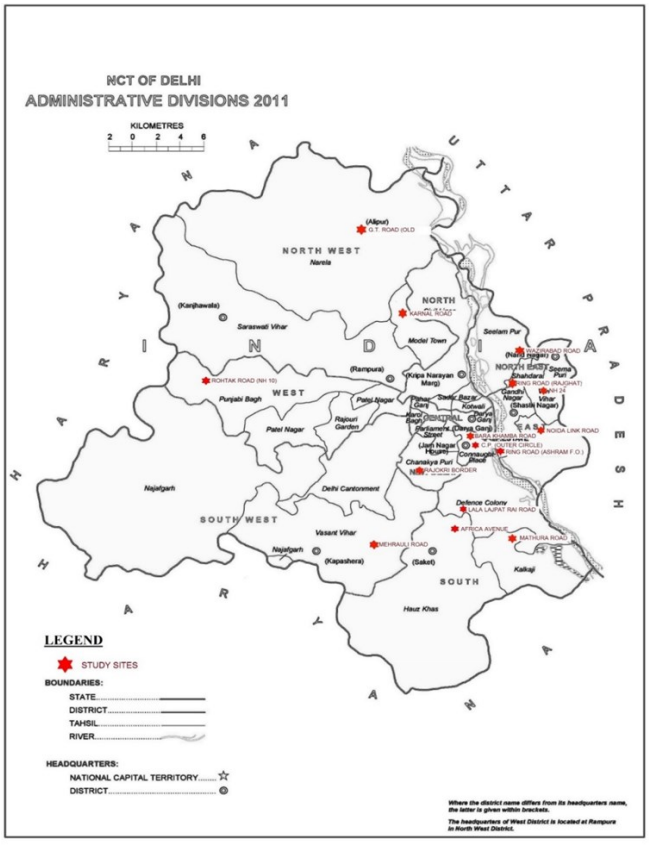

***Figure 1**: Study Area*

3. Methodology

3.1 Relative Risk

In epidemiology, the probability of developing an illness caused by the exposure to various pollutants is called the relative risk (RR) (WHO, 2003; Rothman et al., 2008). Table 1 below shows values of relative risk [per 10 µg/m3 increase of daily averages for Fine particulate matter (PM2.5) and nitrogen dioxide (NO2)] and baseline incidence (per 100,000) corresponding to different types of mortality/morbidity and disease (e.g., cardiovascular, respiratory, etc.).

3.2 Concentration Response Equations

The attributable-risk proportion (AP) is defined as the fraction of health impacts which can be attributed to the exposure in a given population for a certain time period (assuming a causal association between exposure and the health effect and the absence of major confounding effects). This can be calculated using Equation 1 (WHO, 1999; Nagpure et al., 2014).

$$AP = \frac{\sum[(RR(C) - 1) * P(C)]}{\sum RR(C) * P(C)}$$

Equation (1)

where,

RR(c) is the changed relative risk for the health outcome in category c of exposure and

P(c) is the proportion of the population in category c of exposure which could vary according to the degree of exposure in a different area.

However, we must assume the same exposure in all transport corridors throughout the megacity due to the lack of data availability.

$$RR(c) = \frac{(C - T)}{10 * (RR - 1) + 1}$$

Equation (2)

where,

C is the ambient air concentration of a pollutant

T is the threshold level of the pollutant as recommended by the WHO, and

RR is the relative risk for the selected health outcome.

The arithmetic mean of selected concentrations was used for each time unit (daily or yearly). The average value so obtained was then used as an indicator of the whole population's exposure (i.e. one population – one value for a specified time period). For this, daily concentrations data from 15 monitoring stations was used and the yearly average value was taken.

Table 1: *Relative risk for mortality/morbidity due to respiratory and cardiovascular disorder in NCT Delhi.*

Pollutant	Mortality/Morbidity	Relative Risk[a] (RR)	Baseline Incidence Per 100,000 (I)
NO_2	Cardiovascular Mortality	1.00100 (1.0002164-1.001783)[b]	325
	Cardiovascular Morbidity	1.06138 (1.061094-1.061658)	2,533
	Respiratory Mortality	1.00016 (0.9997154-1.00061)	147
	Respiratory Morbidity	0.99505 (0.9941494-995956)	20,465
PM2.5	Cardiovascular Mortality	1.01502 (1.0147869-1.015248)	325
	Cardiovascular Morbidity	1.04560 (1.0453666-1.045842)	2,533
	Respiratory Mortality	1.12824 (1.1279848-1.128498)	147
	Respiratory Morbidity	1.00685 (1.0066255-1.007083)	20,465

Source: Aggarwal and Jain (2015)
Note:
[a]10 ug/m^3 increment in NO_2 and $PM_{2.5}$ concentration.
[b] Lower and upper limits (range) of the 95% confidence interval of RR values.

Knowing (or often assuming) a certain baseline frequency (at threshold concentration value given by WHO guideline) of selected health outcomes (i.e., I), the rate (or number of cases per unit population) attributed to the exposure in population (i.e., IE) can be calculated according to this formula (WHO, 1999):

$$IE = I \times AP$$

Equation (3)

Then IE can be used to estimate the number of cases attributed to exposure (i.e., NE) in the whole population of given size N, using the following equation:

$$NE = IE \times N$$

Equation (4)

Consequently, the frequency of the outcome in the population that is free from exposure (i.e., INE) can be estimated by the following equation:

$$INE = I - IE = I \times (1 - AP)$$

Equation (5)

The RR value at a certain level of pollution and the estimated incidence in non–exposed population can be further used for obtaining the excess incidence [i.e., $\Delta I(c)$] and excess number of cases [i.e., $\Delta N(c)$], respectively, at a certain category of exposure (c) can be calculated using the following equations:

$$\Delta I(c) = (RR(c) - 1) \times p(c) \times INE$$

Equation (6)

$$\Delta N(c) = \Delta I(c) \times N$$

Equation (7)

All the above mentioned formulas are based on the assumption that the RR estimate is adjusted for any possible confounding variables. When the limits of the confidence interval for the RR estimate are used in the first equation, we obtain the corresponding range for AP and the respective range for the number of cases in the population that can be attributed to pollutant exposure.

The last equation is used to calculate the excess number of morbidity cases, which denotes the number of mortalities in the exposed population. In practice, however, the uncertainty of the impact (and the range of the estimated effect) is greater due to presence of errors in exposure assessment and non–statistical uncertainty of the exposure–response function (WHO, 1999; WHO, 2003; Nagpure et al., 2014).

3.3 Case Study Description

The study was performed in the national capital territory of Delhi during the year 2015. Fifteen different transport corridors were selected as study sites for monitoring of various pollutants across NCT of Delhi on twenty four hour basis observation. All the assessment and mortality/morbidity calculations presented in this paper are based on the readings from the case study. This paper focuses primarily on the study for respiratory and cardiovascular mortality/morbidity due to vehicular emissions. Pollutants like PM2.5 and NO_2 are the main concern in this paper.

3.4 Description of the Method

Data was collected on vehicular emission on twenty four hour basis. Then the population attributable-risk proportion concept was implemented on this data for the calculation of excess cases of mortality/morbidity due to cardiovascular and respiratory diseases (Woodruff et al., 1997; Douwes et al., 2002; Rothman et al., 2008). The calculation of mortality/morbidity was performed over sub-district populations for the respective transport corridors of the NCT Delhi. The population related data was taken from census of India 2011 and population for the year 2015 was projected (Sub-district, S. D. (2012)). The projected population was obtained using growth rate for the period 2011-2015, which itself was calculated through linear regression. The relative risk values used were taken from Aggarwal and Jain, 2015.

4. Results and Discussion

4.1 Study Parameters Data

We used the following data for the purpose of analysis as shown in the Table 2 and Table 3.

4.2 Transport Corridors

The first transport corridor lies in the Karol Bagh sub-district of Central Delhi district in NCT Delhi. The sub-district had a population of 136630 persons at that time. Figure 2 illustrates the trend of the excess number of cases of respiratory mortality and figure 3 illustrates the cases associated with cardiovascular mortality. For the year 2015, excess number of cases of cardiovascular mortality was 16. Similarly, figure 4 and 5 shows the trend of respiratory and cardiovascular morbidity respectively for all the studied transport corridors. In case of cardiovascular morbidity excess number of cases in 2015 was 1042. For respiratory mortality, excess number of cases was 31 and morbidity cases were 366 in number. Results indicate that particulate matter is responsible for the majority of the excess number of cases of both cardiovascular and respiratory mortality/morbidity in the area during the study period (2015). However, very few cases of mortality and few cases of morbidity were observed due to NOx pollution.

Mehrauli Road transport corridor passes through the Vasant Vihar sub-district of South-West Delhi district in NCT Delhi. The sub-district hosted a population of 679795 persons. Above figures illustrate the trend of the excess number of cases of cardiovascular and respiratory mortality/morbidity in this region. For the year 2015, excess number of cases of cardiovascular mortality was calculated to be 680 (Figure 3). In case of cardiovascular morbidity excess number of cases in 2015 was obtained as 19979 (Figure 5). For respiratory mortality, excess number of cases was found to be 767 (Figure 2) and for morbidity, number was 21145 (Figure 4). Results indicate that similar to above observations, particulate matter is responsible for most of the excess number of cases of both cardiovascular and respiratory mortality/morbidity in the area. However, few cases of mortality/morbidity were observed due to NOx pollution.

Rajghat stretches through the Shahdara sub-district of North-East Delhi district. A population of 344508 persons was living in the sub-district region at the time of study. Above graph figures 2 to 5 show the trend of the excess number of cases of cardiovascular and respiratory mortality and morbidity in this region. For the year 2015, excess number of cases of cardiovascular mortality was calculated to be 551 (Figure 3). In case of cardiovascular morbidity excess number of cases in 2015 was 13174 (Figure 5). For respiratory mortality, excess number of cases was 551 (Figure 2) and morbidity cases were 17695 in number (Figure 4). Here again, very few cases of mortality and few cases of morbidity were observed due to NOx pollution.

Lala Lajpat Rai transport corridor stretches through the Defence colony sub-district of South Delhi district in NCT Delhi and hosted a population of 680396 persons at that time. The excess number of cases of cardiovascular mortality/mortality and respiratory mortality/ morbidity is shown in above figures. For the year 2015, excess number of cases of cardiovascular mortality was 684 (Figure 3). In case of cardiovascular morbidity excess number of cases in 2015 was calculated

Table 2: *Population and Pollutants concentration values for study sites in NCT Delhi.*

No.	Transport Corridor	Sub District	Population	NO_2 Con-centration [ug/m3]	PM2.5 Con-centration [ug/m3]
1	Bara Khamba Road	Karol Bagh	136,630	213.56	49.33
2	Mehrauli Road	Vasant Vihar	679,795	261.62	261.66
3	Ring Road (Rajghat)	Shahdara	344,508	738.18	489.17
4	Lala Lajpat Rai Road	Defece Colony	680,396	401.39	247.05
5	Ring Road (Ashram F.O)	Gandhi Nagar	421,497	342.85	191.58
6	Africa Avenue	Hauz Khas	1,316,305	286.22	138.92
7	C.P. (Outer Circle)	Connaught Place	29,496	300.90	93.26
8	Rajokri Border (NH 8)	Chanakya Puri	54,758	426.12	379.63
9	Rohtak Road (NH 10)	Punjabi Bagh	840,542	213.11	184.86
10	Karnal Road (NH 1)	Model Town	636,253	439.57	415.13
11	G.T.Road (Old NH 1)	Narela	863,132	316.92	308.22
12	NH 24 Bypass	Vivek Vihar	263,648	214.60	173.22
13	NOIDA Link Road	Preet Vihar	1,137,366	441.64	429.64
14	Mathura Road (NH 2)	Kalkaji	920,802	565.50	538.50
15	Wazirabad Road	Seelam Pur	1,471,599	179.35	156.49

Table 3: *Excess mortality and morbidity values for study sites in NCT Delhi.*

No.	Transportation Corridor	Respiratory Mortality	Cardiovascular Mortality	Respiratory Morbidity	Cardiovascular Morbidity
1	Bara Khamba Road	31	16	366	1042
2	Mehrauli Road	774	680	21,145	19,979
3	Ring Road (Rajghat)	443	551	17,695	13,174
4	Lala Lajpat Rai Road	767	684	20,154	21,389
5	Ring Road (Ashram F.O)	444	352	10,007	12,216
6	Africa Avenue	1,248	858	23,407	34,178
7	C.P. (Outer Circle)	24	15	362	708
8	Rajokri Border (NH 8)	67	72	2,313	1,883
9	Rohtak Road (NH 10)	873	651	19,334	21,805
10	Karnal Road (NH 1)	794	881	28,829	22,304
11	G.T.Road (Old NH 1)	1,019	974	30,793	27,214
12	NH 24 Bypass	269	195	5,723	6,743
13	NOIDA Link Road	1,427	1,606	52,927	40,120
14	Mathura Road (NH 2)	1,195	1,498	50,780	34,682
15	Wazirabad Road	1,450	995	29,158	35,055
	TOTAL	10,825	10,028	312,993	292,492

to be 21389 (Figure 5). For respiratory mortality, excess number of cases was 767 (Figure 2) and morbidity cases were 20153 in number (Figure 4).

The Gandhi Nagar sub-district of East Delhi district in NCT Delhi have Ashram transport corridor. 421497 persons lived in this sub-district at the time of study. The graphs represented in the above figures show the trend of the excess number of cases of cardiovascular and respiratory mortality/morbidity for this region. For the year 2015, excess number of cases of cardiovascular mortality was calculated to be 352. In case of cardiovascular morbidity excess number of cases in 2015 was 12215 (Figure 5). For respiratory mortality, excess number of cases was 444, as shown in figure 2 and morbidity cases were 10007 in number (Figure 4).

Africa Avenue transport corridor lies in the Hauz Khas sub-district of South Delhi district. The district hosted a population of 1316305 persons at the time. The trend of excess number of cases of cardiovascular mortality as well as morbidity and respiratory mortality as well as morbidity is shown in above graph figures. For the year 2015, excess number of cases of cardiovascular mortality was 858 (Figure 3). In case of cardiovascular morbidity excess number of cases in 2015 was calculated as 34178 (Figure 5). For respiratory mortality, excess number of cases was 1248 (Figure 2) and morbidity cases were 23407 in number as in figure 4. Again, very few cases of mortality and few cases of morbidity were observed due to NOx pollution.

The Connaught place sub-district of New Delhi district have this corridor and it hosted a population of 29496 persons. For the year 2015, excess number of cases of cardiovascular mortality was calculated to be 15 (Figure 3). In case of cardiovascular morbidity excess number of cases in 2015 was 708 (Figure 5). For respiratory mortality, excess number of cases was 24 (Figure 2) and morbidity cases were 362 in number (Figure 4).

The Rajokri Border transport corridor lies in the Chanakya Puri sub-district of New Delhi district. The sub-district hosted a population of 54758 persons. For the year 2015, excess number of cases of cardiovascular mortality was 72 (Figure 3). In case of cardiovascular morbidity excess number of cases in 2015 was calculated to be 1883 as shown in figure 5. For respiratory mortality, excess number of cases was 67 (Figure 2) and morbidity cases were 2313 in number as shown in 4th graph figure.

The Rohtak corridor lies in the Punjabi Bagh sub-district of West Delhi district. For the year 2015, it hosted a population of 840542 persons and among these excess number of cases of cardiovascular mortality was 651 (Figure 3). In case of cardiovascular morbidity excess number of cases was calculatd to be 21805 as shown in figure 5. For respiratory mortality, excess number of cases was 873 (Figure 2) and morbidity cases were 19334 in number, from figure 4. However, very few cases of mortality and few cases of morbidity were observed due to NOx pollution.

The Karnal (NH1) transport corridor stretches through the Model Town sub-district of North West district as displayed in the above map figure. A population of 636253 persons was living in the sub-district region at the time of study. For the year 2015, excess number of cases of cardiovascular mortality was 881 (Figure 3). In case of cardiovascular morbidity excess number of cases in 2015 was calculated at 22304 (Figure 5). For respiratory mortality, excess number of cases was 794 as in figure 2 and morbidity cases were 28829 in number (Figure 3).

The GT road corridor is located in Narela sub-district of North-West district in NCT Delhi. It hosted a population of 863132 persons. in the Narela sub-district district of North West district in NCT Delhi. For the year 2015, excess number of cases of cardiovascular mortality was 974 (Figure 3). In case of cardiovascular morbidity excess number of cases in 2015 was 27214 (Figure 5). For respiratory mortality, excess number of cases was calculated to be 1019 (Figure 2) and morbidity cases were 30793 in number (Figure 4). Yet again, very few cases of mortality and few cases of morbidity were observed due to NOx pollution.

This NH24 Bypass transport corridor passes through the Vivek Vihar sub -district of East Delhi district and is displayed in the above map figure. It

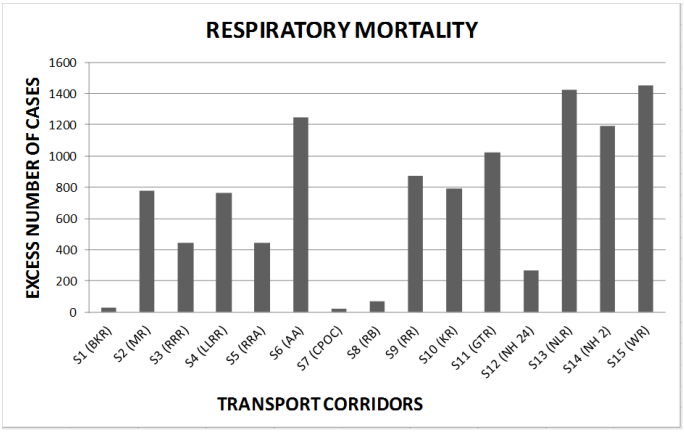

Figure 2: *Respiratory Mortality across observed transport corridors in Delhi.*

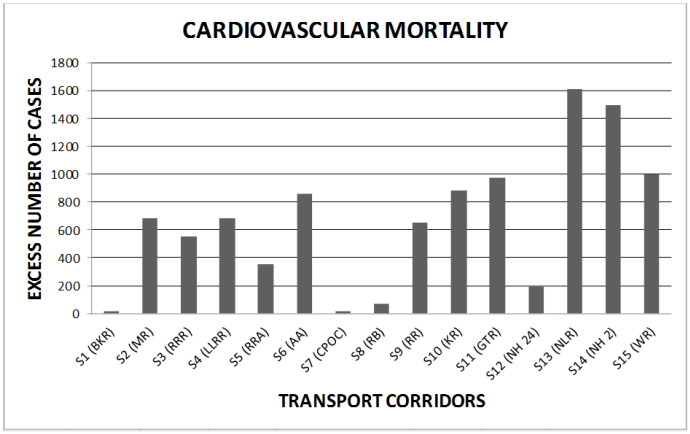

Figure 3: *Cardiovascular Mortality across observed transport corridors in Delhi.*

hosted a population of 263648 persons. For the year 2015, excess number of cases of cardiovascular mortality was 195 (Figure 3). In case of cardiovascular morbidity excess number of cases in 2015 was calculated as 6743 persons (Figure 5). For respiratory mortality, excess number of cases was 269 as shown in figure 2 and morbidity cases were 5723 in number as in figure 4.

The trend of excess number of cases of cardiovascular and respiratory mortality and morbidity in the Preet Vihar sub-district of East Delhi district are displayed in the above figure graphs. This sub-district have the Noida link road. It hosted a population of 1137366 persons. For the year 2015, excess number of cases of cardiovascular mortality was 1606 persons as displayed in figure 3. In case of cardiovascular morbidity excess number of cases in 2015 was 40120 (Figure 5). For respiratory mortality, excess number of cases was 1427 (Figure 2) and morbidity cases were calculated to be 52927 in number as shown in figure 4.

The Mathura transport corridor passes through the Kalkaji sub-district of South Delhi district. A population of 920802 persons was living in the sub-district region at that time. For the year 2015, excess number of cases of cardiovascular mortality was 1498 (Figure 3). In case of cardiovascular morbidity excess number of cases in 2015 was calculated to be 34682 (Figure 5). For respiratory mortality, excess number of cases was 1195 (Figure 2) and morbidity cases were 50780 in number (Figure 4).

The trend of excess number of cases of cardiovascular and respiratory mortality and morbidity in the Seelam pur sub-district of North-East district in NCT Delhi are displayed in the above graph figures. The Wazirabad road passes through this sub-district. It hosted a population of 1471599 persons exposed to the ambient air pollution. For the year 2015, excess number of cases of cardiovascular mortality was calculated to be 994 (Figure 3). In case of cardiovascular morbidity excess number of cases in 2015 was 35055 persons (Figure 5). For respiratory mortality, excess number of cases was 1450 (Figure 2) and morbidity cases were 29158 in number (Figure 4). Again, very few cases of mortality and few cases of morbidity were observed due to NOx pollution.

4.3 Interpretation

Among the fifteen observed corridors, ten have higher respiratory mortality than cardiovascular mortality and five have vice versa. When it comes to morbidity, eight corridors show higher cardiovascular morbidity than respiratory morbidity where seven corridors show the

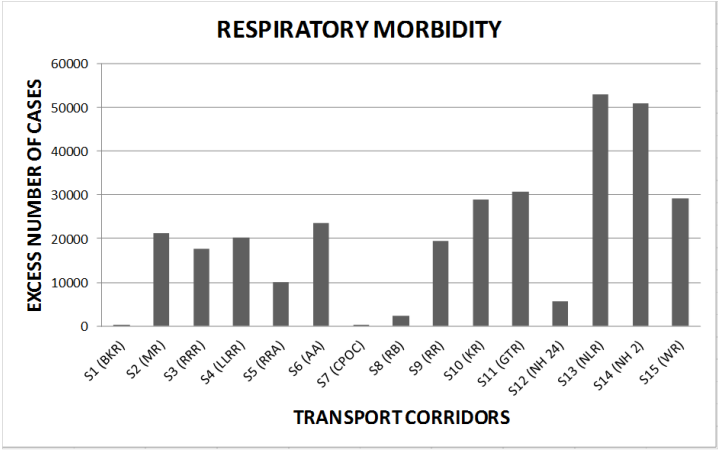

Figure 4: *Respiratory Morbidity across observed transport corridors in Delhi.*

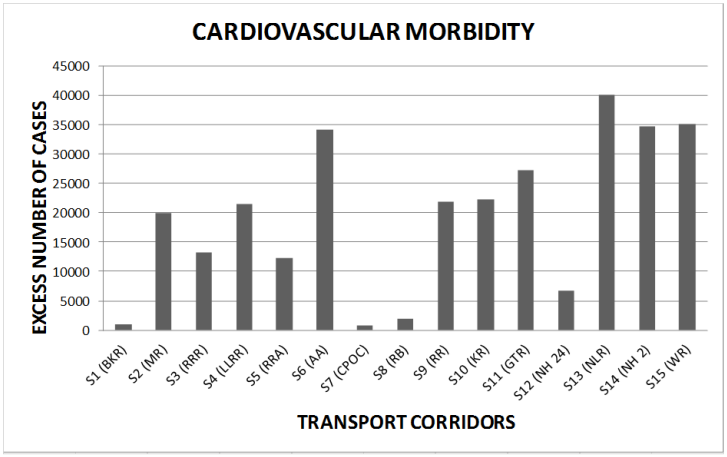

Figure 5: *Cardiovascular Morbidity across observed transport corridors in Delhi.*

Table 4: *Reference for graphs*

No.	Transport Corridor	Sub District	Population	Abbreviation Used
1	Bara Khamba Road	Karol Bagh	136,630	S1 (BKR)
2	Mehrauli Road	Vasant Vihar	679,795	S2 (MR)
3	Ring Road (Rajghat)	Shahdara	344,508	S3 (RRR)
4	Lala Lajpat Rai Road	Defece Colony	680,396	S4 (LLRR)
5	Ring Road (Ashram F.O)	Gandhi Nagar	421,497	S5 (RRA)
6	Africa Avenue	Hauz Khas	1,316,305	S6 (AA)
7	C.P. (Outer Circle)	Connaught Place	29,496	S7 (CPOC)
8	Rajokri Border (NH 8)	Chanakya Puri	54,758	S8 (RB)
9	Rohtak Road (NH 10)	Punjabi Bagh	840,542	S9 (RR)
10	Karnal Road (NH 1)	Model Town	636,253	S10 (KR)
11	G.T.Road (Old NH 1)	Narela	863,132	S11 (GTR)
12	NH 24 Bypass	Vivek Vihar	263,648	S12 (NH 24)
13	NOIDA Link Road	Preet Vihar	1,137,366	S13 (NLR)
14	Mathura Road (NH 2)	Kalkaji	920,802	S14 (NH 2)
15	Wazirabad Road	Seelam Pur	1,471,599	S15 (WR)

opposite result. Five corridors show more than a thousand excess number of cases for respiratory mortality showing the seriousness of the scenario, while for cardiovascular mortality two corridors cross the thousand mark. When it comes to morbidity cases, only one corridor shows excess number of cases less than thousand for cardiovascular morbidity and only two corridors in the category for respiratory morbidity. Cardiovascular morbidity goes as high as 40120 for Noida link road and respiratory morbidity goes to 52927 excess cases, again for Noida link road only showing the alarming scenario of the corresponding sub-district region. There are only three corridors showing excess cases below a hundred mark for both the mortalities.

5. Conclusion

For various transport corridors of NCT Delhi, health risks (e.g. mortality/morbidity) have been estimated using Risk of Mortality/ Morbidity due to Air Pollution (Ri–MAP) model. About 10026 and 10824 excess numbers of cases of cardiovascular mortality and respiratory mortality respectively, and 292489 and 312992 excess numbers of cases of cardiovascular morbidity and respiratory morbidity respectively, were calculated for various sub-districts in NCT Delhi for the year 2015. Direct relation between the number of vehicles and the Mortality/Morbidity cases was clearly observed in all the sub-districts where large-scale transportation activities are present. Maximum excess numbers of cases of cardiovascular mortality as well as morbidity were observed on Noida link road in Preet Vihar sub-district with 1606 and 40120 respectively. It is observed that Connaught Place (Outer circle) in Connaught place sub-district, New Delhi has the least excess number of cases of cardiovascular mortality and morbidity, most likely attributable to the low population of the sub-district and nearby region. In case of respiratory mortality, Wazirabad road in the Seelam Pur sub-district of North East district recorded maximum excess number of cases at 1450 and for respiratory Morbidity, it was again Noida link road on top at 52927. With respect to least excess number of cases, it was again the Connaught Place (Outer circle) with 15 and 708 excess number of cases of respiratory mortality and morbidity respectively. It is found that higher ambient concentrations of PM2.5 and NOx are responsible for excess number of mortality and morbidity in various transport corridors of megacity Delhi. Results indicate that particulate matter is responsible for the majority of the excess number of cases of both cardiovascular and respiratory mortality as well as morbidity in the area during the study period (2015). However, very few cases of mortality and few cases of morbidity were observed due to NOx pollution.

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NMT as Green Mobility Solution for First/Last Mile Connectivity to Mass Transit Stations for Delhi

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ABSTRACT

The objective of this paper is to examine the role of non-motorized transport (NMT) as green mobility solutions in improving the last mile connectivity (LMC) to mass transit systems. There are evidences of its growing significance, which is established through various international experiences, and case studies. The paper discusses transport policies for Indian cities with respect to LMC, NMT and transit systems and their interface. The paper also presents the empirical findings of a study on NMT usage as first/last mile options for a few metro stations in Delhi, India. It analyses metro user characteristics and choices for the selected stations with a lens on NMT usage for covering the last mile. It is observed that NMT comes out as the most preferred option for covering the first/last mile to transit systems, despite the challenging situations under which NMTs operate. The study further points out that the type of NMT mode availed by commuters varies with varying situational context and depends on locational and user attributes. It is interesting to note that while introduction of "bicycles on hire" worked very well at a particular station, the same had no takers at another. The paper contends that resorting to standard solutions for LMC may not be the right approach; rather it must be based on user and other contextual analysis. The paper concludes with outlining a holistic policy approach that treats NMT planning as a non-negotiable component of transit planning to achieve higher ridership (for the transit operator), better journey experience (for the commuter) and larger sustainability goals.

1. Introduction

Concerns for sustainability and equity have seen transport policies, especially in the developing world evolve from being traffic-centric to people-centric. The paradigm shift in policy has been accompanied by metropolitan cities opting for mass rapid transit systems. Yet, the larger context of the entire journey experience that begins at the point one steps out of a place of residence to the final destination remains an area of neglect in most transit planning exercises. In Indian cities, policies till now have remained silent on last mile connectivity (LMC) but talk of low-carbon transport and non-motorized transport (NMT). Most cities take up transit system and NMT planning in isolation to each other. It is also true that while cities have been enthusiastic in introducing transit systems, there has been rather lackadaisical approach towards NMT planning and its integration with transit systems. It goes without saying that cities need to work towards more sustainable ways of addressing the mobility needs of people.

It is rather alarming to note that during the period 1961 to 2011, while the number of cities in India increased three fold (from 2,363 in to 7,935) and the population increased 5 times (from 79 million to 377 million), the vehicular population marked a whopping 214 times (from 0.7 million to 142 million) increase. Of this, larger cities including metro and mega cities constitute the maximum share, with Delhi taking a clear lead.

The road space as percentage of total land area in Delhi is 21%, much higher compared to cities like Tokyo (13%), Hong Kong (12%) and Bangkok (11%); as such, continued and aggressive expansion of road network is likely to be highly unsustainable. On the other hand, the road space availability has halved from 12 kms/1000vehicles in 1990-91 to about 6 kms/1000 vehicles in 2005-06, leading to heavy congestion on most city roads and increasing levels of vehicular pollution. This is a resultant of shifting trend towards personal modes of travel. On some major arterial roads, cars occupy as much as 70% of the road space carrying merely 20% of the total trips. The modal share of public transport (including bus and metro trips) in the city has gone down from 60% to 45.5% between the period 2000-01 and 2007-08 (RITES, 2008), despite introduction of BRT corridors and an expanding network of metro rail. The metro ridership achieved for the year 2011 fell deficit by 1.5 lakh of that estimated for this year. So, while the city clearly identifies transit improvement for its long-term goal of sustainability, it is still grappling with ways to increase its transit ridership.

Yet, the larger context of the entire journey experience that begins at the point one steps out of a place of residence to the final destination remains an area of neglect in most transit planning exercises.

1.1 Significance of Last Mile Connectivity (LMC) in Mass Transit Planning

The Metro in Delhi is further expanding and is projected to have a much larger trip share than its existing patronage. The transport demand forecast and development of public transport network study prepared by RITES in October, 2010 recommends the total Metro length within Delhi to be 330 km by 2021 with an estimated modal share of 20.1%. Achieving this modal share from the present miniscule 4% would be overambitious and far-fetched, unless the city takes proactive measures to make the metro attractive enough to dissuade private mode users towards mass transit patronage. Given the fact that the transit system in itself is built with the state-of-art technology, mere expansion of network, services and overcoming technical glitches at the transit level may not be sufficient; the answer has to be probed elsewhere, in a larger perspective.

The answer also perhaps lies in understanding the limitations of transit system vis-à-vis private modes. Mass transit systems are limited by their lower accessibility, in terms of direct access from trip ends. On the other hand, private modes offer a variety of advantages such as demand mobility, comfort, status, speed, and convenience (Rodrigue, 2013). Stopher et al. (1974) suggested that the attractiveness of public transport can be decomposed into four generic elements: safety, cost, time, comfort and convenience. Unfortunately, most transit planning focus on improvement in these elements of the transit system per se and not of the overall transit journey which includes the first and the last mile connectivity (LMC).

The origin of the term LMC can be traced to telecommunications and technology industries to describe the technologies and processes used to connect the end customer to a communications network. It is the final leg of delivering connectivity from a communications provider to a customer. Although the term reads `mile', the actual distance of this leg may be less or considerably more than a mile, especially in urban fringe and sprawl. In the context of urban transport, the term finds relevance in transit systems where it is referred to as both the initial and final leg of delivering connectivity - from origin to transit nodes and from transit nodes to destination. The term is severally referred to as 'last mile', 'first mile' or 'first and last mile' and has generated considerable interest in recent years over how it influences public transit usage.

A trip made on transit systems usually requires the commuter to utilize more than one mode of transport. The attractiveness of transit as a mode therefore depends not just solely on the quality and attributes of the main mode but also on the quality and attributes of the LMC. Researchers have found the connecting ends to be its weakest link and that they can significantly influence the overall appeal of transit systems given their substantial contribution in terms of travel time and travel discomfort (Krygsman, et al., 2004) (Rietveld, 2000).

1.2 Non-Motorized Transport (NMT) as Last Mile Option

Research also indicates that connectivity issues can arise out of lack of adequate walking and cycling infrastructure; unfavorable walking and cycling conditions; service reliability, waiting time and absence of direct route of feeder bus services; lack of adequate and economical modal interchange options; and the quality and facilities available at transit nodes. Collectively, these weak links can act as a deterring factor in the usage of mass transit modes compared to private modes (Hengky, 2012). While the type of mode used depends on the distance of the origin point to the transit station the use of NMT can greatly be influenced by other factors such as density, landuse, layout, overall environment, etc. (Loutzenheiser, 1997; Parsons Brinckerhoff Quade & Douglas et al., 1996). The use of NMT as a sustainable transport solution to cover the last mile to transits is gaining acceptance and being widely researched upon globally.

It is heartening that NMT (including walk, cycle and cycle-rickshaws) constitute about 40% of the modal share in Indian cities having population greater than 5 million (CSE, 2013). Yet, their potential in serving as last mile solution in a planned and concerted manner remains untapped. A World Bank report on "Demand, Constraints and Measurement of the Urban Pedestrian Environment" in 2008 remarks, "The urban poor make up a city's 'captive walkers,' but since this group has the least resources, it usually has the smallest political voice". In Delhi the lack of adequate walkable and cyclable environment accentuates the problem of mass transit users. Despite difficult conditions, several studies point towards the popularity of NMT, albeit declining, as the last mile option: 82% walked or used a cycle-rickshaw in 2008 (Gupta, Agarwal, 2008), 79% walked or used a cycle rickshaw for covering the first and the last mile in 2010 (Chidambara, 2010), and 37% walked, cycled or used a cycle-rickshaw (Dwivedi, Gupta, 2012). Absence of a safe, comfortable and convenient environment for NMT may be one of the reasons of the declining share of NMT as last mile option for mass transit systems.

2. Profile Of Delhi Metro

The DMRC opened its first corridor between Shahdara and Tis Hazari in December, 2002. Presently (2015), the Delhi Metro network consists of about 193 operational kilometers with 146 stations including that of the Airport Express Link.

The Delhi Metro has 7 lines developed under 3 phases. Phase I of the project consisted of 3 lines with 58 stations and total length of 65 kms. Phase II added 85 more stations with an addition of 125 km. The third phase which is ongoing will add another 159 km to the network. The total length, number of stations developed for various lines, and the average daily ridership for each line are indicated in Table 1. The yellow, red and blue lines carry the highest ridership. Out of the total metro stations only 23 stations have feeder shuttle services. The average daily ridership of metro has risen from about 124,000 in 2004/2005 to about 2,190,000 in 2013/2014, as indicated in Figure 1.

Table 1: *Line-wise characteristics of Delhi Metro*

Line	No. of Stations	Length (in km)	Avg. Daily Ridership
Yellow	34	44.65	962,144
Blue	51	58.67	730,983
Red	21	25.09	818,709
Green	16	18.46	73,542
Violet	18	23.24	153,191
Orange	6	22.7	
Total	146	192.81	2,738,569

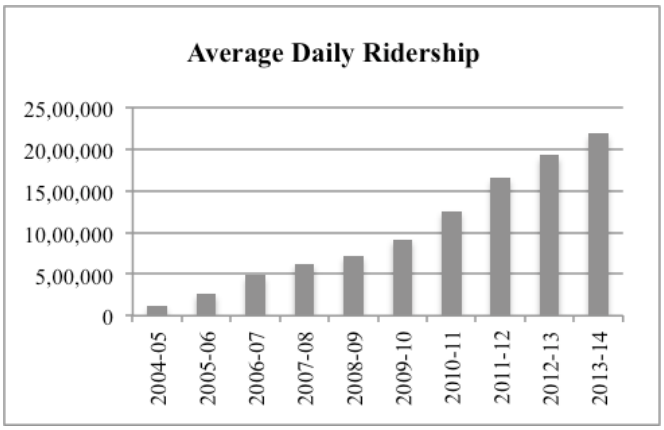

Figure 1: *Average Daily Ridership in Delhi Metro (2004/2005 to 2013/2014)*

3. Research Design and Data Base

The study was conducted on 6 metro stations of Delhi having varying characteristics. The selected stations are located on different lines of the metro network and parameters such as station typology (interchange, mid-block and terminal), ridership, density and type of land use in the surrounding vicinity were considered for selecting the stations. A rapid assessment of the shortlisted stations was conducted in terms of last mile modes availability and quality and stations exhibiting varying quality of last mile were selected. A sample of 30 commuters was taken at each station and surveys were limited to capture commuters alighting the metro station. As such, the last mile characteristic is representative of the sampled station whereas the first mile characteristic is not representative of any known station/locality. The last mile trip characteristics have been assessed in terms of their overall quality that includes the number of options (modes) available and their frequency (or waiting times), cost and time incurred, and other aspects such as safety, comfort, convenience and availability of infrastructure. Non-motorized transport (NMT) in this paper includes walk, bicycle, and cycle-rickshaw.

3.1 Station and its Surrounding Area Characteristics

Table 2 indicates the station characteristics in terms of ridership and typology and its surrounding area key characteristics in terms of density, land uses and availability of modes for LMC.

Rajiv Chowk is the busiest station of Delhi and falls in the CBD of the city with a heavily commercial and public/semi-public (PSP) land use in its vicinity. The average density although low at approximately 200 persons per hectare (PPH), the area attracts a huge number of trips. The fact that it is an interchange station for two of the highest ridership lines (blue and yellow lines) adds to its high ridership. The only LMC mode available is auto-rickshaw although bus is available after a short walk. The station has no cycle-rickshaw or cycle rent facility.

Chandni Chowk station falls in a very dense and congested part of the old city having primarily commercial and mixed land uses. The density is high with approximately 700 PPH. The area is an intense activity zone with its narrow streets and by-lanes, its cultural heritage and a rich variety of formal and informal retail and wholesale commercial activities. Daily commuters as well as a large number of occasional visitors and tourists throng the area. Rickshaws and autos are available at a little walking distance.

Noida City Centre station is on the blue line and falls in the National Capital Region (NCR). Being a terminal station, and a lot of people commuting between Noida and Delhi, the station's catchment area is much higher (averaging 4.2 kms) in comparison to the other stations. A lot of new residential development is in the vicinity of the station. Commercial development in the city center has also commenced which is likely to increase the ridership manifolds. It has a huge parking space for private vehicles and a large number of options, although unorganized, for last mile connectivity are available.

Chhatarpur station, although a mid-block station on the Delhi-Gurgaon line, is located at the periphery of Delhi. As such the station, like the one at Noida city center, has a larger catchment (3 km). The overall density around the station is average (350 PPH), with pockets of Like the 'Vikram' service in Noida the 'Gramin Seva' is an important last mile connectivity to far-flung and peri-urban pockets.

Table 2: *Station Area Characteristics*

Station Name	Ridership	Typology	Adjacent area characteristics		Last mile modes available
			Land use	Density (in PPH)*	
Rajiv Chowk	64,415	Interchange	Commercial, PSP	200	Auto
Chandni Chowk	62,743	Mid block	Commercial, mixed use	700	Rickshaw
Noida City Centre	28,455	Terminal	Residential	250	Rickshaw, auto, shared auto (Vikram), bus
Chhatarpur	24,331	Mid block	Informal residential, PSP, informal commercial	350	Auto, shared auto (gramin seva), feeder shuttle, bus
Vishwavidyalay	23,182	Mid block	Residential, commercial, institutional	400	Rickshaw, auto, e-rickshaw, bicycle on rent, feeder shuttle, bus
Akshardham	14,589	Mid block	PSP, residential	350	Rickshaw, bicycle on rent, auto, feeder shuttle, bus

Source: DMRC and Primary Survey, 2015.
** the densities in persons per hectare (PPH) are approximate and generalized for the entire vicinity; it does not reflect the mix of high and sparse density pockets separately that may be present around the same station.*

Vishvavidyalay is a mid-block station located on yellow line. The station has Delhi University (institutional), and dense residential and mixed uses in its vicinity. The area is also popular amongst the youth for recreational and shopping purposes. The station has many options for transfer including a highly popular 'bicycle on rent' facility providing a comfortable last mile journey.

Akshardham station has a public/semi-public facility (Akshardham temple) with sparse development on one side and dense low-income residential on the other side. The station also has a parking facility for private vehicles, although the supply is much higher than the actual demand. The station is well-served by a number of options for last mile connectivity. Significantly, it has a 'bicycle on rent' facility, which has no takers.

4. First/Last Mile Trip Characteristics and Quality

4.1 User Characteristics

The maximum percentage of users fall in the category of monthly income ranging between Rs10,000 - Rs20,000 (28.3%) and Rs20,000-Rs50,000 (27.2%). This is followed by the income range Rs50,000 – Rs100,000 (18.9%), less than Rs 10,000 (14.4%) and greater than Rs 100,000 (11.1%). At Chandni Chowk commuters predominantly belonged lower to middle income category with no users captured in the highest income category whereas at Akshardham none of the commuters belonged to the lowest income bracket. [NOTE: Rs100=USD1.5]

4.2 Last Mile Trip Characteristics

The last mile trip characteristics can be analyzed in terms of several characteristics and not merely the availability of a mode. Table 3 represents a brief summary of the various components of LMC that different research have considered. These identified components have been discussed in the context of this paper.

4.2.1 Modes opted

The use of NMT for covering the first and last mile is popular (more than 50%) for all stations with the exception of Noida (46%) and Chhatarpur (27%). Better walkability conditions combined with shorter last mile trip lengths and non-availability of other NMT modes gives Rajiv Chowk the highest (87%) share of walk trips.

At Vishvavidyalay, where there is 'bicycle on rent' facility available, a significant percentage (13%) of commuters are using this mode for their last mile trip. This indicates that availability of a facility does impact user choices. However, one needs to be cautious and also take into considerations contextual factors while planning for a facility. The presence of a significant proportion of college-going and young age-group commuter at this station may account for the cycle's popularity. Whereas in the case of Akshardham, which has a similar and better quality 'bicycle on rent' facility it has no takers, as the area is largely visited by tourists (generally families) for recreational and religious purposes, who prefer cycle-rickshaws to cycling. The intensity of activity and the user group need to be considered while planning for such facilities.

4.2.2 Trip purpose

At Rajiv Chowk almost 97% trips work and recreation (that includes shopping) related with an almost equal distribution between the two. Chandni Chowk has higher share of work related trip (60%) and almost the entire rest as recreational. Noida City Centre shows a high work-related trip (73%) and almost the entire rest as educational. Chhatarpur has maximum share of work trips (56%), followed by recreational which is also on account of the Chhatrapur temple located in the vicinity. At Vishvavidyalay, there are almost equal share of trips for educational and recreational purpose (40% and 36% respectively) and the rest for work. Akshardham has 63% trips for recreation followed by work and education. The use of cycle increases when the

Table 3: *Components of Last Mile Connectivity*

Literature Source	**Identified Components**				
	Mode	**Time**	**Dis-tance**	**Cost**	**Other**
Iseki, Taylor, Miller (2006)	√	√	√	√	Frequency, reliability, safety, amenities, walk/cycle environment
Tay (2012)	√	√	√	√	Experience (including waiting)
Nelson/Nygaard (2009)	√	√	√	√	Safety, frequency, reliability
Wang/Odoni	√	√	√		Frequency, reliability
Puello, Geurs (2015)	√				Quality of infrastructure, safety
Giovani, Rietveldt (2008)	√	√	√	√	Service schedule, reliability, comfort, safety, information, infrastructure

Table 4: *Average Trip Length*

Station Name	Main Haul		First mile		Last mile		First & Last mile		Total trip
	in kms	in %age	in kms	in %age	in kms	in %age	in kms	in %age	in kms
Rajiv Chowk	12.6	79.8	2.2	13.9	1.0	6.3	3.2	20.2	15.8
Chandni Chowk	10.6	81.2	1.3	9.8	1.2	9	2.5	18.8	13.1
Noida City Centre	18.4	77.3	1.2	5	4.2	17.7	5.4	22.7	23.8
Chhatarpur	20.8	80.3	2.1	8.1	3	11.6	5.1	19.7	25.9
Vishwavidyalay	21.3	80.1	2.7	8.1	2.6	9.7	5.3	17.8	26.6
Akshardham	17.3	86.5	2	10	0.7	3.5	2.7	13.5	20.0

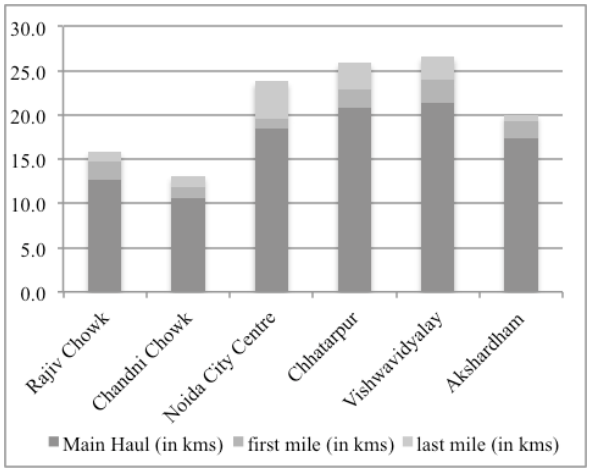

Figure 2: *Average Trip Lengths (in kms)*

educational trips are higher. Walking and cycle-rickshaw are more preferred modes for recreational purpose. However, it cannot be concluded that the overall use of NMT varies much with respect to the trip purpose; rather it appears to vary with the station characteristics and availability of modes, facilities and walking conditions.

4.2.3 Average Trip Length

Table 4 gives the average trip lengths of the different sections of the trip including the transit main haul, the first and the last mile and for the entire trip for the different stations. The average trip length for the first and last mile, although relatively lesser for stations located in the center of the city (2.5 km for Chandni Chowk and 3.2 km for Rajiv Chowk), it yet constitutes a significant percentage of the total journey (18.8% and 20.2% respectively). It is also interesting to note that commuters prefer at least one end of the journey to be shorter, preferably less than 2 kms, which is an easily negotiable distance for NMT.

It can be seen from Figure 2 that the last mile distance is higher for stations located in outlying areas (Noida city center, Chhatarpur), both in terms of absolute numbers (4.2 km and 3 km respectively) and as a proportion of the total trip length (17.7% and 11.6% respectively). The applicability of using NMT as the last mile option would thus vary with varying station area characteristics.

4.2.4 Cost and Time

The time and cost incurred in the last mile are important reflections of the last mile connectivity. Figure 3 (a) & (b) indicate the proportion of cost and time spent in the first and last mile to the total journey. The time for each trip segment is inclusive of the waiting time incurred in that segment. It can be seen from the figure that in terms of absolute numbers, the cost and time spent in the last mile is maximum for stations located in outer areas, i.e., Noida City Centre and Chhatarpur. This accrues from the larger trip lengths in these areas. However, for all stations combined, the average cost and time spent in the first and last mile is almost 50% of the total journey (49.7% and 47.7% respectively), indicating a poor quality of the last mile.

It can also be inferred from the figure that commuters try to balance the cost and time by keeping it low for one leg of the journey when the other leg gets considerably high, as is very clear in the case of Noida and Rajiv Chowk. This further gives potential to develop proper NMT facility and infrastructure.

4.2.5 LMC quality with respect to NMT

The quality of the last mile to a great extent influences transit ridership and the choices opted by users. Nelson/Nygaard (2009) talk of first mile/last mile barriers for commuters who "could potentially take transit but whose starting point or final destination cannot be conveniently accessed from the nearest transit stop/station due to distance, terrain (hills, street patterns), or real or perceived safety issues (traffic, crime)". As mentioned in the introductory section, poor walking and cycling infrastructure and conditions are significant deterrents to use of public transport.

The study analyses the quality in terms of service connection (frequency, reliability), comfort, accessibility (including walking/cycling environment), safety (in terms of crime and traffic), attractiveness, and amenities. These aspects are being discussed in the paper with respect to NMT.

At Rajiv Chowk, despite recent efforts to improve walking infrastructure, the infrastructure is far from satisfactory. The condition of sidewalks is poor. Pedestrians have to negotiate vehicular traffic to cross roads. However, the crossing is not critically dangerous because of relatively low vehicular speeds and well-located tabletop at-grade crossings. Undesignated spaces for auto-rickshaws restrict the free movement of pedestrians. While there is a bicycle parking facility, there is no facility for 'bicycle on rent', which given the short last mile trip lengths, the user categories and the weekly "raahgiri" activity held in the

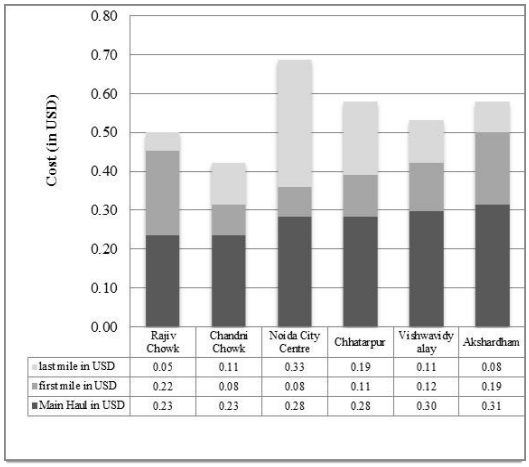

Figure 3(a): *First/Last Mile Travel Cost*

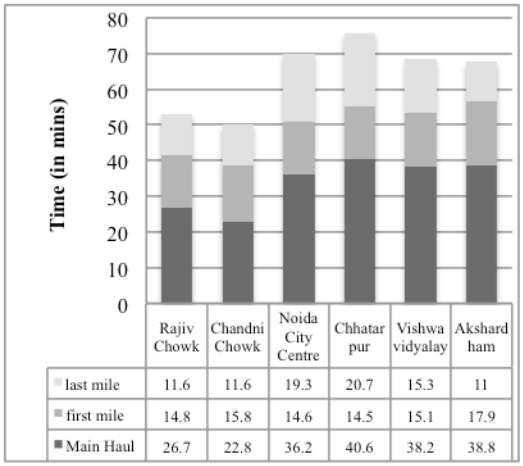

Figure 3(b): *First/Last Mile Travel Time*

area has tremendous potential. The overall safe feeling in this area is good.

Chandni Chowk has a huge potential for NMV facilities improvement. Safety from the point of view of traffic is rated as good as pedestrians do not come in direct conflict with vehicles, but the overall safe feeling is ranked as poor. There is a lot of encroachment on road making it difficult for pedestrians to move freely and also creating conditions conducive to petty crimes such as pickpocketing. Sidewalks and crossings are not available but these are not required as the entire street is pedestrian dominated with minimal vehicular traffic. However, the surface condition of the road is poor and extremely unfriendly for people with special needs. Also there is scope for improvement of sidewalks in the surrounding areas. The cycle-rickshaws are parked in a chaotic manner. Bicycle on rent facility is not available although there is opportunity, given the low-income category and heavy tourist ridership.

Noida City Centre is one of the worst when it comes to provision of NMT infrastructure. The only good feature here is a designated place for cycle rickshaws. However, commuters have to negotiate through unsafe vehicular traffic movement to access the cycle-rickshaws. The condition of the sidewalks is not good and not at all designed with consideration for universal accessibility. Being located right near an intersection of an arterial and a sub-arterial, there is heavy pedestrian crossing negotiating through heavy vehicular movement. The level of illumination and low level of street activities in the surrounding areas, presence of a bus depot at another end of the crossing with buses queuing up on roads, rash driving and chaotic parking by shared auto-rickshaws, gives the area an overall unsafe rating.

At Chhatarpur, while the condition of pedestrian infrastructure within the station premise is satisfactory: the sidewalks and crossings are good and there are tactile pavement and escalators; the same cannot be said of its surrounding vicinity. The overall safe feeling of this area is ranked poor. Lack of NMT modes, poor walking and cycling conditions in the vicinity and unsafe feeling result in heavy dependence on motorized modes for last mile connectivity.

The Vishvavidyalay station has a fair quality of NMT facilities. The NMT options available are higher. The walking and cycling conditions are comparatively good and the overall safe feeling is rated good. However, there is scope for improvement in terms of more and better quality provisions for "bicycle on rent" as the present supply runs short of the huge demand.

In almost all the stations, barring Chhatarpur, there is significant usage of NMT to cover the last mile. Despite the heavy patronage, there is little attention given to creating a reasonably good environment for NMT.

5. Policy and Planning Environment

Transport policies in the past were almost silent on the importance of last mile connectivity for transit systems. While transport policies did talk of promoting public transit systems, multi-modal integration and non-motorised transport, they were by large silent on the LMC aspect of transit systems.

In recent years, however, policies do recognize the significance of both LMC and NMT. The Working Group on Urban transport for the 12th FYP does not deal separately with the aspect of LMC but it does point out its significance in the context of integration. "The most critical requirement is the creation of multimodal interchange facilities where commuters can change modes or routes without much time penalty and in safety without coming in conflict with other vehicular modes. Such locations occur at the point where two public transport services cross and at various road junctions where commuters may need to change direction or to take a feeder service. In addition commuters will need to interchange at inter-state bus terminals, railway terminals and airport. All these interchange points will also need to cater to interchange with personal modes, from the surrounding areas, such as car, 2-W and bicycle and public modes i.e. para-transit, autos, taxis and cycle rickshaw etc., by providing 'Park and Ride' and 'Pick up and drop off" facilities."

The report further recognizes the role of "cycle rickshaw as an intermediate public mode of transport and best suited to provide the last mile connectivity in an integrated citywide multimodal public transport network".

The new National Urban Transport Policy (NUTP) for the first time talks explicitly on "last mile connectivity". It broadens the scope of multi -modal integration to include "private modes of transport i.e. walk,

cycle, cars and 2-wheelers and para transit modes i.e. tempos, autos, mini bus and cycle rickshaw to the mass rapid transit network" which was previously "limited to integration of buses with Metro rail" (IUTI, 2014). The policy also recognizes the significance of improving last mile connectivity to public transport through provision of footpaths and cycle lanes, provision of feeder services, and incorporating design principle to promote safety, accessibility, reliability and affordability, amongst other measures.

However, the realization of policy to planning is yet at a very nascent stage in most Indian cities including Delhi. Most cities take up transit system and NMT planning in isolation to each other. It is also true that while cities have been enthusiastic in introducing transit systems, there has been rather lackadaisical approach towards NMT planning and its integration with transit systems. There is very little work done in the field; and little of what has been done, has focused on mere provisioning of feeder services, and that too in bits and pieces, without understanding user behavior with respect to varying conditions.

More than 10 years since its first operation, Delhi metro is yet to prepare a plan, which addresses LMC issues in a holistic manner. Ad -hoc efforts in the form of starting feeder routes, which cover a miniscule percentage of total stations (less than 15%) and public bike sharing at 3-4 stations, do not indicate of the seriousness that the issue requires. The callousness of transport agencies towards lack of provision or demarcation of spaces for IPT and NMT modes at stations, while ensuring private vehicle parking spaces wherever possible also speaks volumes of the attitude towards NMT users. The key challenge, thus is to create sensitivity amongst transit planning agencies towards the role that good LMC can play in increasing the overall transit ridership and thereby profitability. Another challenge is perhaps in building safe and comfortable NMT friendly environment in the larger context, given that most of Delhi roads lack even the basic pedestrian infrastructure, that is, sidewalks. The good intentions in the policy can only be realized through better and sincere planning efforts.

6. Conclusion

The study comes up with a few significant findings that need to be considered while planning for last mile connectivity to mass transit systems. Firstly, for shorter last mile trip lengths, there is greater tendency amongst commuters to opt for NMT. Secondly, in absence of walking-friendly environment or other NMT modes, higher percentage of polluting and unsustainable modes are used even for shorter distances. The propensity to resort to private motorized modes for LMC also increases with lack of or sub-standard para-transit and NMT options. Thus, a significant amount of last mile travel to and from metro stations is being undertaken by unsustainable personalized mechanized modes. NMT have a clear edge over other motorized modes, especially for short distance trips as they have zero carbon emission, and greater flexibility and accessibility. Non-provision of safe and adequate environment for these modes leads to congestion around metro stations, pedestrian and cyclist accidents and fatalities and higher levels of crime against the more vulnerable groups. A report by Centre for Science and Environment (CSE, 2014) shows rise in accidents by 1.3 to 4 times around public transport nodes, markets, etc. The report also cites high percentage of NMT users (44.5% pedestrians and 6.1% cyclists) as victims in road accidents (MORTH,2012 in CSE, 2013).

Provision of safe and convenient environment for NMT is important for long-term sustainability of transit systems. Previous researches (Clever, 2011) also indicate that commuters have a clear preference to walk at least one leg of their transit journey. This fact is reinforced by this study where a large percentage of commuters are seen to have opted for walking and other NMT modes for first/last mile connectivity, despite inadequate infrastructure and conditions. A large majority of the NMT users are captive and for them walking or cycling or negotiating through risk-prone areas to catch a cycle-rickshaw, may not be a pleasurable experience. If NMT operating conditions continue to remain unfavorable it is more likely that commuters would shift to private automobiles or other motorized transport for LMC, the moment it becomes affordable to them.

The attractiveness of the mass transit lies not just within the transit system (and station) but in the entire surrounding that leads to it. Thus creating a network of safe and people-friendly streets in the vicinity of transit stations is imperative for long-term sustainability. One can learn from Singapore policy on transport connectivity that lays focus on improvement of services not just at the hubs but enhancing accessibility of these hubs from the areas surrounding it, thereby improving the last mile experience. The city has also successfully translated policy to planning by not only making all stations barrier-free but through creating at least 2 barrier-free access routes for more than 80% of the hubs.

It is also not sufficient to merely create sidewalks and cycle lanes. The walking and cycling conditions will determine how well these facilities are put to use. Cities like Singapore, Guangzhou have created extensive networks of sheltered or landscaped walkways connecting the transit hubs. This is of utmost significance for Indian cities, given our harsh climatic conditions.

It is important to give commuters choices of modes. The study also points out that standard prescriptive solutions cannot be implemented across all mass transit systems. Contextual planning is important. While certain NMT options may be extremely suitable for a particular situation, the same may be meaningless in other circumstances. Local context specific planning guideline for LMC is required. Environment-friendly and people-friendly modes such as cycle-rickshaw, battery operated rickshaws (which are already plying in certain parts of the city) can play a great role in enhancing LMC in Delhi and many other Indian cities. If cities are serious about reducing vehicular pollution and congestion and making their mass transit systems work effectively, the potential of NMT as green mobility solution for last mile connectivity needs to be duly tapped. Inclusion of NMT in last mile planning has to be a non-negotiable component, to achieve higher ridership (for the transit operator), better journey experience (for the commuter) and larger sustainability goals.

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The Needs for Professionalism and Competency in the Construction Industry

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ABSTRACT

The quantity surveyors, in the present day construction industry, analyze cost components of a construction project in a scientific way and applies the results of the analysis to a variety of financial and economic problems confronting the developer and the designer. However, competence, in any sphere of work, can be a difficult concept to pin down, especially, when it relates to professional occupations where such roles are complex and involved diverse professionals in the built environment sector. This paper aims to investigate the competencies of quantity surveyors in the discharge of its professional duties by evaluating the effects of professional competency on quantity surveying practices in Nigeria. The study population comprised professional quantity surveyors who are in the private construction/consulting firms in Lagos State, Nigeria. Data were obtained to investigate the professional views on the quantity surveying profession, the roles of quantity surveyors in the construction industry and the need for professionalism and competencies in the surveying industry. Questionnaires were administered to randomly select 200 practicing quantity surveyors in Lagos state. Findings revealed that the major role of quantity surveyors in the construction industry is the preparation of the bill of quantity as it ranked 1st with RII value of 1.00; it was also discovered that quantity surveyors were in agreement with client service delivery as the first ethical standard that construction professionals should consider when performing their professional obligations in order to avoid project failure and over-cost. It is therefore recommended that the professional bodies and the academia should organize proper and adequate service trainings, workshops and seminars which will enhance the possibility of acquiring more skills and experience so as to improve competence in the discharge of quantity surveyors professional duties.

1. Introduction

Quantity surveyors are one of the key professionals in the construction industry, as they are involved in cost planning, cost management, project procurement, contract administration, feasibility studies and asset financial management. Clients such as developers, government bodies and agencies, building proprietors, architects and contractors requires the services of the quantity surveying profession, especially, on cost estimation. The quantity surveyors, in the present day construction industry, through skills and ability, analyze cost components of a construction project in a scientific way and apply the results of the analysis to a variety of financial and economic problems confronting the developer and the designer (Ilias and Mohd 2010).

Badu and Amoah (2004) held that the changing roles of the quantity surveyors had been redefined by the quality of education received. The wide array of the quantity surveyors' responsibilities requires that they are educated, trained, and highly skilled in diverse subjects. Lenard (2000) argued that the changing nature of the construction and development industry as regards the adoption of innovative technological processes and development, emergence of highly focused professionals and the full range of advanced technologies necessitate a much stronger emphasis on job competencies than ever before. However, competence, in any sphere of work, can be a difficult concept to pin down especially when it relates to professional occupations where such roles can be complex, and the knowledge and skills involves many and varied professionals (Cheetham and Chivers, 1996).

According to Ilias and Mohammed (2010) quantity surveyors are construction economists who fulfill various comprehensive duties to support cost-effective construction and property development projects. The core competencies of quantity surveyors include determining project budgets, measuring project quantities, preparing contract documentation such as bills of quantities and cost control documents, administering contracts, and preparing final accounts. Despite being recognized as a professional discipline distinct from architecture and civil engineering since 1836, quantity surveyors are not immune to the threats and changes within the operating environment. While some parties in the construction industry have been critical about the quality of works and services rendered by quantity surveyors, some question the importance of appointing quantity surveyors as project consultants. Nonetheless, Nkado (1999) gives an overview of certain skills in quantity surveying profession

which are pertinent to meeting clients' demands. Poon (2004) notes that some quantity surveying firms do not seem to understand how to handle clients finance and are culpable of certain actions that could severely damage the clients' interests which in turn affect the integrity and competencies of quantity surveyors. Pearl (2005) attributed this ugly phenomenon that has robbed quantity surveying profession to the much expected pride of place among professionalism in the industry.

This paper aims to investigate the competencies of quantity surveyors in the process of discharging its professional duties by evaluating the effects of professional competency on quantity surveying practices in Nigeria. To achieve this, the followings questions are investigated (1) What are the roles and functions of quantity surveyor in Nigeria? (2) What are the areas of competences required of a quantity surveyor in the construction industry? (3) What are the effects of quantity surveyor's competence on the performance of quantity surveying firms?

2. Concept of Professional Competency

Stewart and Hamlin (1992) defined competency as something which a person who works in a given occupational area should be able to do. Holmes and Joyce (1993) also view competency as an action, behavior or outcome which a person should be able to demonstrate, or the ability to transfer skills and knowledge to new situations within the occupational area. Meyer and Semark (1996) described competence as the demonstration of an integration of knowledge, skill, personal attributes and value orientation. Wisher (1994) insisted that competencies provide a common cultural thread, a language for success, a framework for thinking about excellence and a way of communicating the future. Baker et al., (1997) observed that companies were starting to look into workers' competencies when they realized that providing a framework which brings greater clarity to the idea of competence in business in general, and operations and technology management in particular, would bring competitive advantage to their organizations.

Rankin (2000) reported that a significant number of companies in the UK are using competencies to improve individual and corporate performance. Roggema-van Heusden (2004) attempted to define competence from professional personnel point of view. They held that, competence is the ability to perform well in a professional situation that involves the accomplishment of a certain task or the dealing with a problem, in a manner that can be observed and be judged by others. That is to say: a competent professional is capable of applying the necessary expertise in confluence with effective behaviour. Competent quantity surveyors must have a range of skills, knowledge and understanding that can be applied in a range of contexts and organizations (Hassall et al., 1996). Yet pressing issues which confront the quantity surveying profession today include increasing the relevance and level of awareness of the profession's services in the built environment and increasing the range of business opportunities for continued growth.

2.1 The Roles of Quantity Surveyors

A qualified quantity surveyor can gain employment in quantity surveying firms, construction companies, or with private property developers. Large organizations (public or private) that deal with a significant amount of building or construction procurement as part of their activities normally employ quantity surveyors among other construction professionals to become their project managers. Most quantity surveyors who work in consulting firms are retained by the construction clients to ensure that what is eventually built is in line with the client expectation and within budget (National Commercial Services UK, 2004). The responsibilities of the client's quantity surveyor include the preparation of Bills of Quantities and the giving of advice on what a project would cost. He also does cost planning during the design stage of a project, examine tenders, price quantities and report his findings. He also negotiates rates with contractors on negotiated contracts, prepares valuation on ongoing construction work.

Badu and Amoah (2004) noted that the distinctive skill of a quantity surveyor lies in his ability to analyse a project applying his skills and knowledge to the competence areas like progress payment and making recommendations as to payments to be made to the contractor including advising on the financial aspects of variations. The contractor's quantity surveyor on the other hand engages in matters relating to costs and estimates from the perspective of 'entrepreneurial' contractor, and agrees on measurements with the client's contractor for any specific project.

According to John Austen Associates (2004) the principal services that could be offered by any quantity surveying firm are: (1) Preliminary cost advice and feasibility estimates (2) Cost planning (3) Advising on contractual methods (4) Advising on selection of other consultants (5) Advising on contractor selection (6) Preparing tender documents (7) Obtaining or negotiating tenders (8) Reporting on tenders received or package deal/design and build offers (9) Evaluating construction work (10) Preparing and agreeing accounts for/with contractors (11) Preparing expenditure statements for tax accounting purposes (12) Periodic financial reporting (13) Technical auditing (14) Assessing replacement value for insurance (15) Project management related services (16) Giving expert evidence in arbitrations, adjudications and legal disputes, and (17) Preparing/defending against construction contract claims. Thus, the quantity surveying professionals must posses these skills and competencies to deliver their jobs successfully.

2.2 Quantity Surveying Professional Competencies

Royal Institution of Chartered Surveyors, RICS (1971) and Male (1990) opined that the competencies of the quantity surveyor are usually associated with the measurement and valuation that provides the basis for the proper cost management of the construction project in the context of forecasting, analyzing, planning, controlling and accounting. Hassal et al. (1996) noted that the process of professionalization demands that a profession should take responsibility for a prescribed body of knowledge by first defining the substantive field of knowledge that the professional should command and secondly the process of applying that knowledge. Thus, Leveson (1996) concludes that the area of quantity surveying competencies lies in the financial and contractual control of the building project and therefore the need for quantity surveyors to pay attention to developing soft skills.

Willis et al. (1994) described the body of knowledge of the quantity surveyor as one which incorporate the services of: preliminary cost advice; cost planning including investment appraisal, life-cycle costing and value analysis; procurement and tendering procedures; contract documentation; evaluation of tenders; cash-flow forecasting, financial reporting and interim payments; final accounting and the settlement of contractual disputes; cost advice during use by the client; project management; and specialist services. RICS (1998) therefore sets out the requirements and competencies for the assessment of professional competence by listing the competencies required of quantity surveyors in three categories which are: the basic competencies, the core competencies and the optional competencies. The basic competencies

under the RICS structure are common to all construction professions such as land surveying, building surveying, etc. the core competencies are those uniquely required of quantity surveyors while the optional competencies reflect areas of specialization or future career diversification. Moreover, Akosile, Ogunsemi and Owoeye (2007) identified and classified areas of competencies required of quantity surveyors into three categories viz. basic, core and optional. In 1998, The Royal Institution for Chartered Surveyors (RICS) put forward a model of competencies for quantity surveyors. The model was presented in three categories of mandatory/basic, core and optional competencies.

2.2.1 Mandatory Competencies

The basic competencies are widespread to all construction profession under the RICS structure and they are the personal and interpersonal skills, professional practice and business competencies common to all pathways and compulsory for all candidates. There are basic competencies required for all positions. A basic competency is defined as a knowledge, skill, or behavior essential for one to function as an effective member of the University of Michigan. The basic competencies include: (1) **Ethics and Integrity:** Consistently demonstrates the organizations values through behaviors; (2) **Customer Service:** Consistently meets the organization's expectations for customer service, striving constantly to achieve them; (3) **Communication:** Effectively communicates verbally and in writing; (4) **Problem Solving:** Develops effective approaches, addresses needs, and solves problems; (5) **Flexibility:** Demonstrates flexibility in one's job roles, and manages change in ways that result in productive performance; (6) **Technology:** Uses available equipment and technology safely, efficiently and effectively; (7) **Safety:** Complies with safety instructions, observes safe work practices, and provides input on safety issues; (8) **Self-Management:** Maximizes own time and talents to achieve organizational goals; (9) **Seizes Opportunities:** seeks opportunities to innovate and continually improve; (10) **Change Resilience:** develops effective approaches for managing self through organizational change; (11) **Teamwork:** Works effectively with team/ work group or those outside the formal line of authority to accomplish organizational goals; and (12) **Cost effectiveness:** Prudently uses resources based on organizational priorities.

2.2.2 Core Competencies

The core competencies are exclusively vital to the profession of quantity surveying and it entails construction contract practice, construction technology and environmental services, economics of construction and procurement and financial management. In other words, core competencies are those capabilities that are critical to a business achieving competitive advantage. The starting point for analyzing core competencies is recognizing that competition between businesses is as much a race for competence mastery as it is for market position and market power. The main idea about Core Competencies was developed by C K Prahalad and G Hamel through a series of articles in the Harvard Business Review followed by a best-selling book – "Competing for the Future". The central idea was that over time companies may develop key areas of expertise which are distinctive to that company and critical to the company's long term growth. Prahalad and Hamel (1990) asserted that the managers will be judged on their ability to identify, cultivate, and exploit the core competencies that make growth possible. They will have to rethink the concept of the corporation itself. These areas of expertise may be in any area but are most likely to develop in the critical, central areas of the company where the most value is added to its products. For example, for a manufacturer of electronic equipment, key areas of expertise could be in the design of the electronic components and circuits. For a ceramics manufacturer, they could be the routines and processes at the heart of the production process. For a software company the key skills may be in the overall simplicity and utility of the program for users or alternatively in the high quality of software code writing they have achieved. Core Competencies are not seen as being fixed. Core Competencies should change in response to changes in the company's environment. They are flexible and evolve over time. As a business evolves and adapts to new circumstances and opportunities, so its Core Competencies will have to adapt and change.

2.2.3 Optional Competencies

A set of competencies selected by the candidate from a list defined for the particular pathway. In most cases there is an element of choice. These are mostly technical competencies, but certain mandatory competencies also appear on the optional competency list and candidates are permitted to select one of these at a higher level. The

Table 1: *Categories of Competencies of Quantity Surveyors*

Categories of Professional Competencies		
Basic	**Core**	**Optional**
Personal and Interpersonal skills	Construction Contract Practice	Arbitration and Other Dispute Resolution Procedures
Business skills	Construction Technology and Environmental Services	Development Appraisal
Data, Information and Information Technology	Economics of Construction	Facilities Management
Professional Practice	Procurement and Financial Management	
Law		Insurance
Measurement		Project Management
Mapping		Property Investment Funding
		Research Methodologies and Techniques
		Taxation Allowances and Grants

Source: RICS (1998)

optional competencies reveal areas of specialty or future career diversification and these include arbitration and other dispute resolution procedures, development appraisal, facilities management, insolvency, insurance, project management, property investment funding, research methodology and techniques, taxation allowance and grants and valuation. Table 1 shows the three categories of competencies required of quantity surveyors as identified by RICS (1998).

The Australian Institute of Quantity Surveyors (AIQS) attempt to define and develop a model of competencies for the quantity surveyors (AIQS, 1998). The institute proposed 31 competency standards that need to be adhered to by the professional body in producing competent quantity surveyors. Apart from the competency standards, the Australian Institute of Quantity Surveyors also recommended 13 basic characteristics of abilities that lead to a competent quantity surveyor. These basic abilities in turn, form the platform from which a competent quantity surveyor can develop and are an integral part of the 31 units of competency standards. The basic abilities include (1) Quantification/measurement – the ability to quantify and enumerate (2) Analysis – the ability to observe, assess, identify problems and find innovative solutions (3) Appraisal/ evaluation – the ability to assess value (4) Communication – the ability to impart knowledge, ideas and concepts through oral, written and visual means (5) Interpersonal skills – the ability to effectively work with others and to be part of a team (6) Leadership – the ability to lead and motivate (7) Self-development – the ability to set goals, display enthusiasm, self-motivate and undertake research (8) Management – the ability to organize, monitor, control and plan the effective use of resources (9) Documentation – the ability to prepare written information in a format which clearly conveys meaning (10) Synthesis – the ability to combine fact or ideas into a complex whole (11) Computer literacy – the ability to understand and apply basic computer skills (12) Construction technology – the ability to understand basic construction technology (12) Construction law and regulation – the basic knowledge of national laws and regulations related to construction.

In 1999, The Pacific Association of Quantity Surveyors (PAQS) analyzed a full range of competencies required by a modern quantity surveyor. In principle they agreed to accept 10 competency standards for the quantity surveyors. Those are: strategic planning, budgetary process, cost estimating, cost planning, procurement advice, documentation, tendering process, construction account management, construction change management, feasibility studies. The most recent competency of a quantity surveyor which is beginning to gain popularity among professionals in the construction profession is the use of Building Information Modeling (BIM). It is currently in use by a number of engineers and architects during practice and also has the potential to improve the Quantity Surveyor profession. BIM is the process of creating an information data base for a project in which the life cycle information is expressed in an inter-operable manner to create, estimate, illustrate and construct a project (Schwegler, 2001). Succar (2008) claims that BIM is presenting an organized set of data to construct, analyze, manage, maintain and calculate the construction cost of a building project. Lee et al., (2005) sees BIM as a three or four dimensional drafting application that generates data intensive plans.

According to Aouard et al., (2007) BIM has the potential to automate measurement and facilitate the preparation of accurate estimates. According to the study there have been successful attempt to produce Bills of Quantity automatically with the use of Industry Foundation Class (IFC) data by the Cooperative Research Centre for construction Innovation. Lee et al., (2003) observe that the hallmark of BIM allow contractor to receive design document which have specified materials and accurate quantities in electronic format. According to Thomas (2010), BIM is adopted in the quantity surveying profession for the following reasons (1) The designers drawing are not sufficient for construction which was agreed by 92% of client (2) Project that did not meet the original budget were above 30% (3) 38% of carbon emission are from buildings and not cars (4) 10% of the cost of a project is due to change other (5) Material waste in the construction site is estimated to about 37%.
Therefore BIM can help in improving the overall reliability of a project cost (Eastman et al., 2008). Azhar and Brown (2009) states that BIM is highly significant for the future development of the construction industry. BIM can also help to improve project and improve cooperation among the project team which would lead to reduce cost, proper time management and improve profit (Azhar et al., 2010). It is therefore necessary for quantity surveyors to get used to BIM to enhance the quality of project delivery.

3. Methodology

The study population comprised the quantity surveyors who are professionals in the private organization in the Nigerian construction industry. Data obtained involved assessing professional views on the profession, examining the roles of quantity surveyors in the construction industry and assessing the need for professionalism and competencies in the industry. Questionnaires were administered to the practicing quantity surveyors in Lagos state. The respondents were randomly selected among the various firms in Lagos state. Two hundred (200) questionnaires were distributed with the aim of eliciting response from the private organizations toward determining the need for professionalism in carrying out construction project.

4. Results and Discussion

The various roles of quantity surveyors in the construction industry were identified in Table 2 and ranked using its Relative Importance Index (RII). The roles of quantity surveyors in the construction industry revealed that preparation of the bill of quantity ranked 1st with RII value of 1.00; cost estimation relating to construction materials, time and labor and cost advise ranked 2nd with RII value of 0.94; work in progress variation and materials on site for interim payment ranked 3rd with RII value of 0.87; materials schedule for building project ranked 4th with RII value of 0.79, while cash flow payment ranked 5th with RII value of 0.76. The findings from the table revealed that all the roles are significant with the least role having 76 (0.76) percent significance.

Table 3 shows the mean item score (MIS) for the level of compliance of ethical practices as perceived and ranked by the quantity surveyors. From the result of the analysis, generally all the fifteen (15) ethical practices identified by the study were highly ranked with MIS ranged $3.29 > 3.0$ above averages. Three ethical standards which are client's service delivery, educational training and professional qualification and standards of practice respectively indicating client service delivery as the most significant ethical standard were ranked 1st, 2nd, and 3rd by the quantity surveyors. However, we found that public welfare and fair compensation factors are two least importance aspects that the quantity surveyors professionals must have. The respondents considered that these two things are loosely correlated with the profession of quantity

Table 2: *Assessment of the roles of Quantity Surveyors in the construction industry*

Roles	Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree	Relative Importance Index	Rank
Preparing bill of quantity	195	0	0	5	0	1.00	1
Materials schedule for building project	5	30	15	75	75	0.79	4
Cost estimation relating to construction materials, time and labor and cost	0	5	0	45	150	0.94	2
Work in progress variation and materials on site for interim payment	0	5	30	60	105	0.87	3
Cash flow payment	15	45	20	50	70	0.76	5

surveyors. One surprise found in the survey was that the sustainability aspect was not considered as important factor in quantity surveying profession. The case will be different if the survey were conducted in more advance country, where the sustainability becomes a very important aspect in construction industry.

The quantity surveyors were in agreement to client service delivery as the first ethical standard that construction professionals should consider when performing their professional obligations. Quantity surveyors in some cases can also be contractors or consultant quantity surveyor, either working for an organization or for the contractor as they are saddled with the responsibilities of preparing the cost estimate of any proposed project, preparation of interim valuation and physical measurement of works among others to enable payment to the contractor among others. They also monitor the clients' resources to ensure services are delivered with the best standards and at minimum cost which is the major service delivered by quantity surveyors.

Educational training and professional qualification is also of great importance, because this is where professionals gain academic training, technical competence and skills about a particular profession. It is therefore important for professionals to have sound educational background to be able to cope with the projects challenges. This finding conforms to Chan and Chan (2002) that; professionals need to be placed in appropriate educational framework to ensure their continuous relevance. Quantity surveyors should only accept to offer services for which they are qualified by education, training and professional experience.

Quantity surveyors deals basically with financial management of the contracts and this is the area where the integrity of most professionals are put into the mud especially if there is a conflict between personal and professional values. The moral standing and upbringing of each individual professional appears on how they protect their own integrity in dealing with clients rather than being mindful of their personal gain. The findings corroborated Cardammone (2011) that established that professionals are linked with notion of services they provide, hence the need to focus more on personal professional development so as to provide services that are of high quality for all that needed their services.

The characteristics/knowledge and abilities required of a competent quantity surveyor are ranked in Table 4 according to its significant to quantity surveying profession. The table clearly indicated the areas of competence characteristics that are significant to the performance of quantity surveying firms in Nigeria. The area of quantification and measurement is been selected as the most important/significant competence required in the performance quantity surveying firms in Nigeria, with a mean score of 4.66, while synthesis is considered less

Table 3: *Ethical standard and competence requirements of a quantity surveyor*

Ethical Standard and Competence	Mean Value	Rank
Standards of practice	3.17	3
Education and professional qualification	3.24	2
Fair competition	3.10	8
Confidentiality	3.14	6
Integrity	3.15	4
Public welfare	2.98	14
Conflict of interest	3.01	11
Safety	3.04	9
Environmental friendliness	3.02	10
Maintenance culture	3.01	11
Client's service delivery	3.29	1
Cost effectiveness	3.12	7
Fair compensation	2.96	15
Professional development	3.15	4
Sustainability	3.00	13

NOTE: The scale used: (1) Highly unimportant (2) unimportant (3) either unimportant or important (4) important (5) highly important.

Table 4: Characteristics/Knowledge/Abilities required of a competent quantity surveyor

Characteristics	Mean Value	Ranking
Computer and Information Technology Literacy	4.38	6
Leadership	3.87	11
Construction Law and Regulation	4.36	7
Self-development	4.03	10
Appraisal/Evaluation	4.34	8
Management	4.26	9
Synthesis	3.74	12
Documentation	4.56	2
Communication	4.53	3
Construction Technology	4.49	4
Interpersonal Skills	4.41	5
Quantification/Measurement Analysis	4.66	1

NOTE: The scale used: (1) Highly unimportant (2) unimportant (3) either unimportant or important (4) important (5) highly important.

important to the performance of quantity surveying firms in Nigeria, with a mean score of 3.47.

This indicated that the most important characteristics, abilities and knowledge for quantity surveyors to possess are quantification/ measurement analysis, documentation, communication, construction technology and interpersonal skills which are also regarded as highly important for quantity surveyors to achieve an accepted level of competency. Other less important characteristics, abilities and knowledge to acquire are management, appraisal/ evaluation, construction law and regulation, self-development, leadership, synthesis, and computer and information technology literacy.

5. Conclusion and Recommendations

Quantity Surveying is one profession that has attracted unprecedented ubiquitous demand in the construction industry in the recent times with increasing opportunity for service diversification and adaptive applicability. Client's satisfaction is also a function of professional ethics in relation to respecting public interest with respect to the willingness to serve the public, good sense of responsibility and practice technical competencies. Therefore, as challenges and ubiquitous demands expand with new entrants of quantity surveying practice professing with different goals, it may be difficult to hold them under serious legal obligation to uphold ethical practices. This is because they may not be recognized as members of professional bodies until they are duly examined and registered, which may not be a mandatory requisition to operate within their delimited scope. Also, except in exceptional cases, academic establishments are not so keen in monitoring the ethical conducts of their products out of school. Thus the need to reposition the profession and ensure strict monitoring to ensure that quacks and non-professionals do not bastardize the profession especially in the face of the growing economy.

Professionalism and competency is the bedrock and soul of the success in handling construction works. Thus, in achieving the need for professional competence in the industry, the following are hereby recommended:

Organizing proper and adequate service training, workshop and seminars by the professional bodies and the academia which will enhance the possibility of acquiring more skills and experience so as to improve competence in the discharge of duties. Frequent training and retraining is inevitable to season members of the profession with current trends in ethical development and uncertainties, not only to equip members' competencies but to give the much needed rebirth to nurture and protect the goal of the professionals serving the public interest to exist.
Quantity surveyor should not settle down with just the roles and function of the profession but should also acquaint themselves with the roles and function of other professionals in the field which can also be referred to as self-development to improve on their competence.

Quantity Surveyors should ensure that they possess skills that are inclusive of personal qualities, core skills and process skills. The personal qualities should include independence, adaptability, initiative taking, willingness to learn and ability to reflect on what has and what has not been achieved. The core skills of a quantity Surveyor should include the ability to present clear information within a group, self-management, critical analysis and the ability to listen to others while computer literacy, commercial awareness, prioritizing, negotiating, acting morally and ethically, coping with ambiguity and complexity are the process skills required of a quantity Surveyor.

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Between Land and People: A Review of Socioeconomic Issues within the context of Rapid Development in Iskandar Malaysia

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ABSTRACT

In response to globalization and economic competitiveness, Malaysia launched six economic development corridors, covering all the potential areas in Malaysia, and Johor Bahru is one of them. Iskandar Malaysia was launched in 2006 for future economic development in the country as well as to cater the needs of Johor Bahru to modernize its urban and economic infrastructure. Situated in a strategic location and space, Iskandar Malaysia is targeted to be the player of catalytic investment role that will bring direct and indirect investment to Johor. The whole landscape of Johor Bahru is now transforming dramatically, thus worrying the locals and the environmentalists. Environmental issues as well as the concern for social inequality issues have been raised by the locals. Hence, the aim of this study is to address the issues created by the rapid development of Iskandar Malaysia, particularly in Johor Bahru and Nusajaya. The objectives of this paper are to assess the consequences of the coastal land reclamation for Danga Bay waterfront city development and to identify the impact of new-build gentrification towards the local people. The research identifies key social and economic issues and the impacts of these issues have also been identified. To achieve the objective of the study a detailed review on secondary data has been done. The study found that more cooperation and attention from the local authorities, stakeholders and public is needed to ensure urban regeneration and to achieve the objective of social inclusiveness as promised by the vision of Iskandar Malaysia.

1. Introduction

Land is considered to be the most fundamental resources for any means of developments. Land use developments reflect human interactions with the environment at scales from local to global (Moeinaddini et al., 2014a and b; Asadi-Shekari et. al, 2015a, b, c and d). Urban growth is a major component of global environment change and the danger of potential undesirable environment and social effects caused by high rates of growth is ever-present (Asadi-Shekari et. al, 2014 and 2016; Moeinaddini et al., 2015a, b and c). Issues often surface on who is to maintain control particular area of land, who possesses the right to participate in decision – making about its management, and the social or environmental impacts of its development (Sultan, 2016; Andrew, 2003; Moeinaddini et al., 2012a and b). In the same time, problems may occur when demands for a limited resource is high due to the uneven distribution of costs and benefits that result from the development and of environmental impacts that arise when the land use changes (Peltonen & Sairinen, 2010; Sultan et. al, 2015;Asadi-Shekari et. al, 2013 a and b; Moeinaddini et al., 2013 and 2016).

Iskandar Malaysia, a regional development corridor located in the southernmost part of Peninsula Malaysia, has resulted in massive land use development particularly in Johor Bahru. The implementation of regional development policies and strategies resulted from the government concerns to regenerate rural deprivation, aiming to accelerate the economic change of a local population. It is also one of the government's strategies to enhance living standard of the population as well as improving the economic convergence of the states in Malaysia.

Regional development in Malaysia was started in 1950s after the independence. The purpose of urban regeneration measures and initiatives was to reduce problems of land hunger, poverty and unemployment in a rural area (Kasim, 1992). In Malaysia, the implementation of regional development policies and strategies resulted from the governments concern to regenerate rural deprivation. During the last forty years, reducing regional disparities and underdevelopment through the implementation of five year development plans are among the government serious concerned during the last forty years (Muzafar et al., 2012),). Moreover, urban regeneration and re-development of brownfields' areas are among the strategies underline in the National Urbanisation Policies. Furthermore, urban regeneration strategies implemented through regional development policies becomes the major development strategy in Malaysia to speed up the economic and social development of its population. Consequently, all the states in Malaysia are divided into six regions namely Northern region, Central region, Eastern region, Southern region, Sabah and Sarawak (Cho, 1990). According to Eskandarian and Ghalehteimouri (2011), regional development strategy was targeted to rebuild the economic development. Among the strategies is including the establishment of regional economic development in Malaysia (Zainul, 1989).

Iskandar Malaysia is currently undergoing rapid development, chasing its vision to become an international and sustainable metropolitan region in 2025 in Johor Bahru particularly. Constructions are heavily taking place within the city centre and the new administrative and commercial areas in Nusajaya. The whole landscape of Johor Bahru is now transforming dramatically, thus worrying the locals, the environmentalists, and the Singaporeans. New land is reclaimed from the coastal area in Danga Bay, Johor Bahru, while lands and homes of the original people are taken to make way for multi-billion dollars skyscrapers development and other "sustainable" developments in Nusajaya. This situation has witnessed widespread urban renewal and new urban and suburban projects which resulted in distinct physical and socio-economic changes.

Nevertheless, the establishment of regional developments in Malaysia is consistent with the rapid economic growth (Lee, 2004). There are three regional economic development formed in Peninsular Malaysia namely the Northern Corridor Economic Region (2007-2025) encompasses the states of Perlis, Kedah, Pulau Pinang and North Perak, the Iskandar Development Region (2006-2025) covering area of south Johor and last is the East Coast Economic Corridor (2007-2020) that covers for Kelantan, Terengganu, Pahang and the north of Mersing district Johor. The development of Iskandar Malaysia is set to become Malaysia's latest and most exciting region offering diverse business opportunities to the potential investor. The introduction of regional economic development in Malaysia was aimed to accelerate the economic change of a local population. Moreover, it was also one of the government's strategies to enhance the living standard of the population and to improve the economic convergence of the states in Malaysia (Salleh, 2000). However, the emergence of regional economic development specifically in Malaysia differs depending on various development objectives and goals.

In the spatial context, the research evaluates the progress of regional development programme towards the socio-economic of local people based on its past and existing approach and implementation mechanism. Based on the problem statements, there are three main derived research questions that the study hopes to answer; i) To what extent establishment of Iskandar Malaysia able to promote sustainable development in the region?; ii) Does the establishment of Iskandar Malaysia affect the social development of the local people?; and iii) What are the factors contributing to the economic development and growth in Iskandar Malaysia?. From the research questions derived, the following objectives of the study are formulated; i) To analyze the strategies and policies for economic growth and their means to accelerate economic development and overcome issues and problems;, ii) To identify the factors contributing to the Iskandar Malaysia's regional economic development; and iii) To suggest and recommend improvement on the regional economic development.

The development of Iskandar Malaysia, especially the development of Danga Bay Waterfront City in Johor Bahru city has become controversial and people begin to question the 'sustainability' concept that Iskandar Malaysia has been using. Environmental issues as well as the concern for social inequality issues have been raised by the locals. Hence, the aim of this study is to address the issues created by the development of Iskandar Malaysia, particularly in Johor Bahru and Nusajaya. As the objectives of this paper, it is fundamental: (i) to assess the consequences of the coastal land reclamation for Danga Bay waterfront city development; and (ii) to identify the impact of new-build gentrification towards the local people.

2.0 Developments in Johor Bahru

Developments in Johor Bahru had already started since its early establishment in 1855 right after the agreement between Sultan Ali and Temenggung Daeng Ibrahim was signed (Sulaiman, 1941; Husain, 1995). It was previously known as Tanjung Puteri, and later as Iskandar Puteri, situated right behind Singapore. Since the land in Iskandar Puteri was so prosperous, it was initially developed for agriculture purposes, mainly for *Gambier* and *Pepper* plantations. The Temenggung brought Chinese immigrants from Singapore to Iskandar Puteri to work and manage the agricultural areas. Small houses and cabins were built for the Chinese immigrants nearby the Segget River, followed by small markets and wine houses to cater their needs.

Johor Bahru as known today is the state capital of Johor, located within Johor Bahru district (Figure 1). Generally, the district is administered by three local authorities as mentioned in Figure 2, which are Johor Bahru City Council (MBJB), Johor Bahru Tengah Municipal Council (MPJBT), and Pasir Gudang Municipal Council (MPPG), covering up a total area of 107 077 ha. Johor Bahru city continues to develop in becoming a great metropolitan region of the southern Peninsular Malaysia, administered by MBJB. The population of Johor Bahru metropolitan area is now growing in a rapid pace, from 1.3 million in 2006 to about 1.7 million in the early term of 2012, as being reported in Johor Bahru Local Plan (RTDJB) 2020.

In Johor Bahru, agriculture is the main land use with a total of 98 083.23 hectares, covers up 53.96 percent of the total area. Meanwhile, residential area is the main built-up land use with an area of 10 301.45 hectares or 2.64 percent of the total area. Until the early term of 2012, Johor Bahru still has a huge portion of land, called the land bank that covers up of 127 140.11 hectares or 69.94 percent for future development purposes (MBJB, 2012).

In social terms, majority of the inhabitants are Malays, encompassing approximately 60 percent of the total population, while 30 percent are Chinese and 10 percent are Tamil. It is the second largest metropolitan area in Malaysia after Kuala Lumpur. It is also an industrial and commercial hotspot of southern Johor, promoting more branches of a

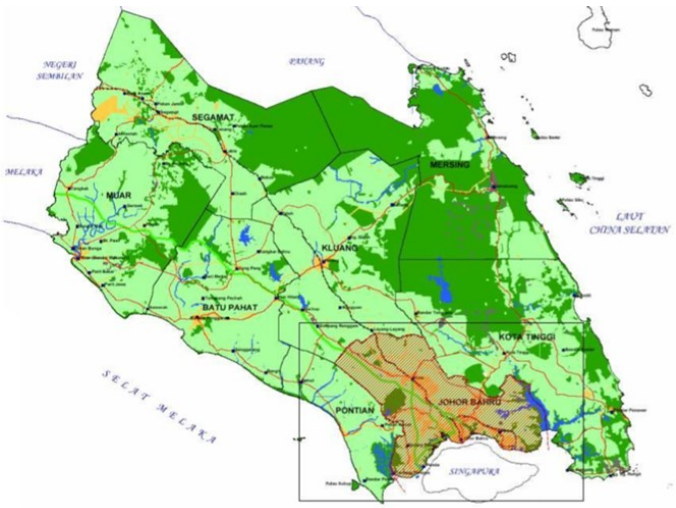

***Figure 1**: State of Johor and Johor Bahru district (MBJB, 2012).*

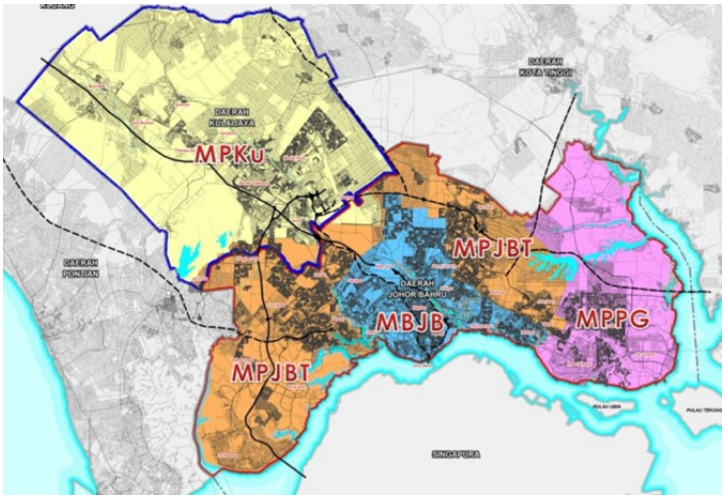

Figure 2: *Johor Bahru municipalities' councils (MBJB, 2012)*

wide range of major commercial and industrial brands. Located between two powerful regional hubs, Kuala Lumpur and Singapore, Johor Bahru has natural locational advantage as a getaway between these two Southeast Asian (SEA) global economic powerhouses (Rizzo & Khan, 2012). To drive the development growth in Johor Bahru, the state government through the Local Structure Plan 2020 adopted 'Urban Development Strategy', focusing on the development of Johor Bahru city conurbation that covers Kulai in the North, Pasir Gudang in the east, and Tanjung Pelepas in the west. The strategy will raise up the hierarchy of Johor Bahru conurbation as the southern region growth pole, competing and integrating with Kuala Lumpur conurbation as well as complementing the Indonesia-Malaysia-Singapore Growth Triangle (IMSGT).

In response to globalisation and economic competitiveness, Malaysia launched six economic development corridors, covering all the potential areas in Malaysia, and Johor Bahru is one of them. Iskandar Malaysia (formerly known as Southern Johor Economic Region, SJER) was launched in 2006 for future economic development in the country as well as to cater the needs of Johor Bahru to modernise its urban and economic infrastructure. Since Johor Bahru is neighbouring Singapore, the general purpose of Iskandar Malaysia is to compete with and integrate with Singaporean economy.

Situated in a strategic location and space, Iskandar Malaysia is targeted to be the player of catalytic investment role that will bring direct and indirect investment to Johor. A year after its establishment, the Iskandar Regional Development Authority (IRDA) was formed as a statutory Federal government body to execute the Comprehensive Development Plan (CDP) for Iskandar Malaysia. IRDA Act 2007 (Act 664) is then established by Federal Act of Parliament, empowered to plan, promote, and facilitate the development implementation of Iskandar Malaysia. Iskandar Malaysia is established to become "A Strong, Sustainable Conurbation of International Standing", displaying a commitment to have a sustainable urban development. In order achieve its objective, CDP highlights five strategic pillars, underpinned by three foundations that act as the overarching guiding principles in the development. The five pillars covered the importance of international rim positioning, the establishment of hard and soft infrastructure enablers, investment in catalyst projects, establishment of a strong institutional framework and regulatory authority, and ensuring socio-economic equity and buy in from the local population (CDP, 2006).

Iskandar Malaysia development is focusing on five flagships or key economic zones (Figure 3), which are the Johor Bahru city centre (Zone A), Greenfield of Nusajaya (Zone B), Western Gate Development (Zone C), Eastern Gate Development (Zone D), and

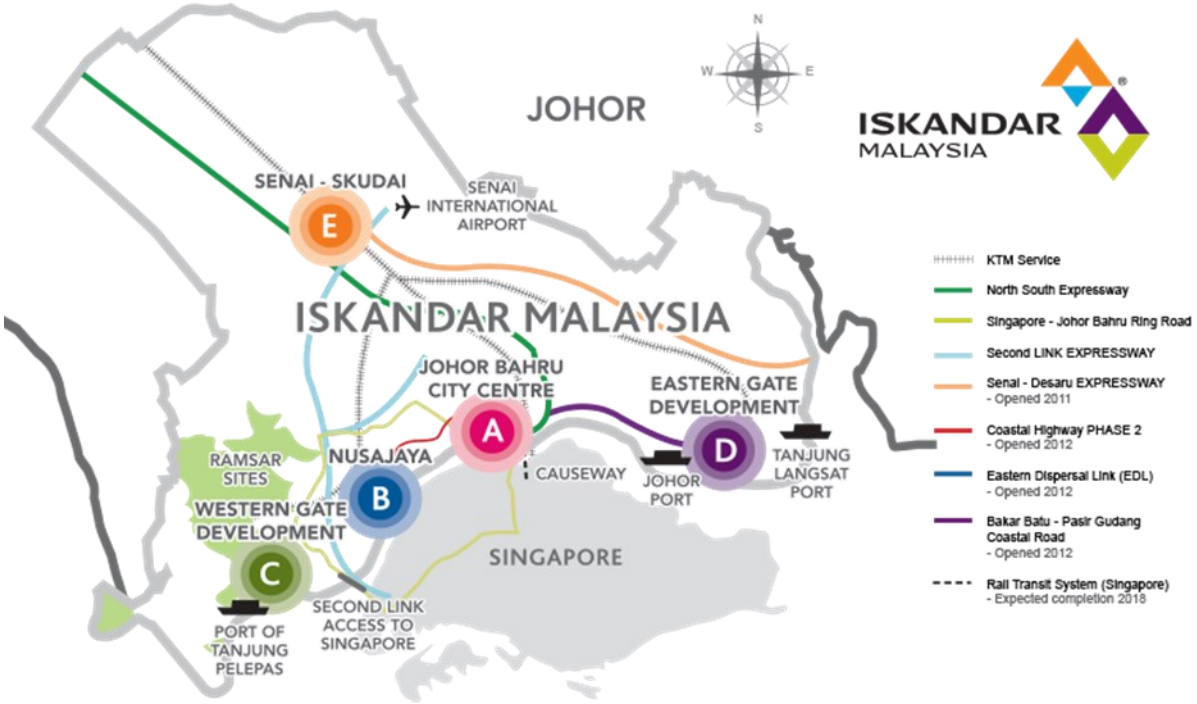

Figure 3: *Five flagships of Iskandar Malaysia development (IRDA, 2011)*

Senai-Skudai (Zone E). RM4.3 billion was initially allocated by the Ninth Malaysia Plan to build necessary infrastructures in Iskandar Malaysia and it will acquire another RM 335 billion of public and private investments to complete the project by 2025 (IRDA, 2011).

After eight years of its establishment, Iskandar Malaysia is said to be well on track to realising its vision. Economically, as of the first quarter of 2013, Iskandar Malaysia has a total of RM111.37 billion cumulative committed investments, surpassing the Phase 1 (2006-2010) target by 47.9 percent. The total committed investments made in 2001-2012 already make up 50.4 percent of the RM 73 billion target for Phase 2 (2011-2015). Iskandar Malaysia has emerged as the second largest recipient committed investment in manufacturing, services, and primary sectors as at end 2012. It also generated the most employment opportunities, creating 154 000 new job openings since 2006 until December 2012, marking up nearly 19 percent of it 2025 target or 817 500 new jobs.

3. Land Use Development Issues

3.1 The "Land": Coastal Land Reclamation in Danga Bay

There was once a famous place in Johor Bahru that had caught attentions amongst tourists and local residents. Lido Beach or locally known as *Pantai Lido* was a tourist attraction, located along the banks of the *Tebrau Straits*, erected as long as 3 kilometres from *Teluk Danga* mangroves to the city centre. It used to be an ideal place for the urbanites to relax, strolling, enjoying the breeze, and even a great spot for fishing (Figure 4). Historically, the Johor royal families used to have picnics on the beach during weekends and stay in their vacation palace, called the *Istana Hinggap*. During festive seasons, *Pantai Lido* became lively with stalls of local delicacies lined the coastal pavement selling delicious food (Thukiman, 2011).

Unfortunately today, *Pantai Lido* can never be traced back since the whole beach has been reclaimed for multi-billion dollars development.

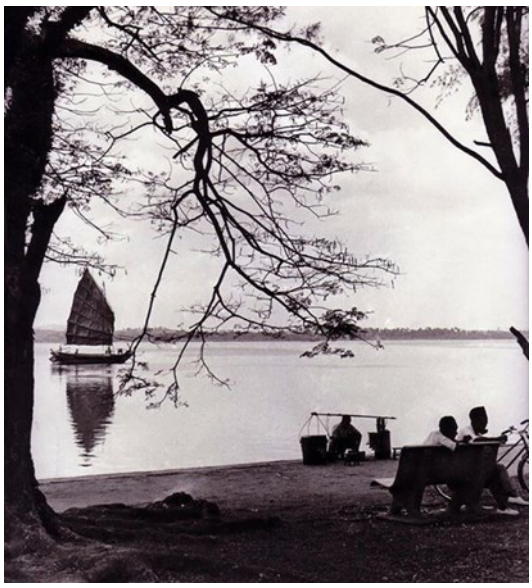

Figure 4: *Pantai Lido in 1950s*
Source: Courtesy to *Persatuan Bangsa Johor* (Johor Nation Society)

Figure 5: *Danga Bay waterfront city*
Source: Iskandar Waterfront (2014).

The natural elements of the beach and mangrove were totally demolished in 1997 to make way for Danga Bay development and it was completed in 2003. With Iskandar Malaysia being introduced to the nation in 2006, more coastal developments were proposed in order to achieve the vision that is so called as "sustainable development".

The CDP (2006) has defined the coastal zone for Iskandar Malaya which encompasses the waters of Johor Straits within Malaysian boundary and a 3 kilometres inland zone along the coastline of Johor Straits. It extends all the way into Pontian and Kota Tinggi where the Johor Straits waterway leads into two open waters which are the Straits of Malacca on the west and the South China Sea (on the east). According to the Integrated Land Use Blueprint for Iskandar Malaysia, the coastal development is included in Urban Spatial Strategy for Johor Bahru City Centre (JBCC) to promote more mixed use development in particular on the waterfront precincts and to encourage city living as well as optimising urban facilities for city dwellers (IRDA, 2011). There are four waterfront precincts that have been identified by Iskandar Malaysia and are now being aggressively developed to supposedly preserve and enhance good quality urban environment and the scenic view of Johor Bahru waterfronts.

It is true that the strategic location of Johor Bahru for being closed to Singapore offers a great opportunity to invest and regenerate the urban landscape for the sake of economic development of the nation. The development will not only create an attractive new feature for the city but also provide the opportunity to create new public spaces for the benefit of the growing population. The opportunity to reshape the coastal area will result in a new and vibrant waterfront that will link Johor Bahru City Centre to Danga Bay development. The government has assigned *Iskandar Waterfront Sdn Bhd* to be the master developer of 4000 acres of prime waterfront land in Johor Bahru with about 2000 acres of land that will be reclaimed for a new waterfront city.

One of the Danga Bay development projects is the *Tropicana Danga Bay* by *Tropicana Corporation Sdn.Bhd*. RM 8.3 billion was invested for two phases of luxury urban-residence development, involving reclamation of 450 acre of coastal land in Danga Bay. Tropez Residences, the first phase of Tropicana Danga Bay is recently completed, located just above the Danga Bay waterfront. 38 stories of luxury condominiums stand majestically with gardens, greeneries, and water features in the open spaces, a concept that is called as "redefined" trendy urban living. The development is also claimed to be environmental-conscious because Tropez Residences is the first residential development in Johor Bahru to implement a purpose-built Automated Waste Collection System

Figure 6. *Tropez Residence, Tropicana Danga Bay*
Source: Tropicana Danga Bay (2015).

(AWCS) for a cleaner, greener and more cost-efficient waste handling (Tropicana Danga Bay, 2015).

In terms of economic, there is no doubt that investing towards such development will bring more benefits and profits to the nation economic development, particularly for Johor state. However, it will be questionable regarding with the concept of "environmental-conscious" development and also the buyers. The development concept somehow might be in line with the concerns for green urban designs and buildings. But in this case, to build such green development, a hundred years mangrove forest was reclaimed, replacing it with man-made land served as the base for the development. Tropicana Danga Bay development only covers a small part of the waterfront city project, but there are others including *Country Garden, Senibong Cove* to name a few, waiting to be completed in 2025 on the 2000 acres of reclaimed coastal land so that the vision of having a so called "integrated waterfront city with green design and eco-friendly urban environment" would be realised.

Singapore has voiced out concerns for the development because it will give huge potential trans-border impact, particularly the environment. But then Johor backs up the coastal development project, saying that Singapore is also doing the same thing, reclaim the coastal land for development purposes. For Singapore, although it is controversial, coastal land reclamations are intended for residential development since land in Singapore is very limited and it is crucial to cater the booming population. Unlike Singapore, Johor Bahru still has plenty of lands that are waiting to be developed and the population, although is increasing, is not as many as the Singapore has. However, thanks to the potentiality of Johor Bahru coastal areas, developers are more preferred to invest on waterfront city development. When questions about environment are issued, the Chief Minister of Johor, *Datuk Mohamed Khaled Nordin* said that all projects on reclaimed land in Johor had receive environmental impact assessment (EIA) approval from the Department of Environment (DoE) (Lee, 2015).

On the other hand, the Malaysian Nature Society observed that the huge coastal land reclamation affect the annual migration of thousands of birds that flocked here from East Asia to Australia (Shah, 2014). Migratory birds, such as the storm storks, could usually be found along the riverbeds at Danga Bay as the birds feed on small crabs, fish and mudskippers. However, the massive development along the coastline has influenced the ecosystem where food becomes scarce for these birds since the mangrove forest is no longer exist. Again, the vision of Iskandar Malaysia development towards "Sustainable Metropolitan Region" is questioned since the natural ecosystem of Danga Bay is not maintained even though environmental measures had already taken.

The second issue regarding to the coastal reclamation for waterfront city development will be the question on who is going to live there. Iskandar Malaysia as well as the state government, of course, always came out with the promising statement that the developments that are being constructed will benefit all Johoreans, enhancing the local quality of living in a modern sustainable metropolis that will put Johor Bahru in the eyes of the world. The statement, for certain reasons, will never be wrong. However, looking back to the Tropez Residences, a single unit is opened to the market starting from about RM 630 000 to RM 1.5 million, and one unit is open for rental for about RM 4000 per month. Country Garden and the other following residential developments along the reclaimed land would offer the same or even higher than that. Hence, this situation will never please the locals because it is beyond their ability to own such houses although median monthly gross household income has very much increased from RM 2211 in 2004 to RM 4585 in 2014 (Malaysia Economic Planning Unit, 2014). In the nearest future, the whole waterfront city will be inhabited mostly by foreigners, especially the Singaporeans and the Chinese, not by Malaysians. Most of the investors are from China, and Country Garden Holdings, investor for the proposed development is one of the Chinese company for which the Sultan of Johor is a minority partner. There are several other projects that are intervened by the power of the sultan. As a businessman, the sultan always want developments that are profitable for its own state. In economic sense, such developments are needed to bring wealth to the country, but for the locals, sustainable, green luxury houses would never be in their to-buy lists.

Once the reclaimed coastal area is fully developed, Johor Bahru will become an international metropolitan area greater than Kuala Lumpur. The economic development would be promising, but there is another issue that is waiting to surface within the region. As mentioned, the waterfront city comprises many luxury houses, condominiums, and apartments, with shopping malls and parks for leisure and tourist attractions. In the same time, it is expected that new job opportunities will be created for vast numbers of citizens. The whole area will be inhabited by more than 10 000 residents and will attract thousands of employees and tourists within the city centre and Danga Bay, which is a positive sign for economic development. However, upon its completion, *Jalan Skudai*, the main road that connects the whole area of waterfront city would have to accommodate thousands of motorised vehicles. Until today, there is no clear sign from the government to create new means of effective public transportation and if this is persisted until 2025, Johor Bahru will terribly become congested (Sultan et al., 2015). With 3 million populations for the upcoming 10 years, the state and federal governments have to figure out any possible means to

Table 1: *Median Monthly Gross Household Income by Ethnic Group, 2004-2014 in RM*

	2004	2007	2009	2012	2014
Malaysia	2211	2552	2830	3626	4585
Ethnic Group					
Bumiputera	1862	2228	2531	3282	4214
Chinese	3089	3452	3631	4643	5708
India	2469	2760	2836	3676	4627
Other	1567	1884	2088	2762	4372

Source: Malaysia Economic Planning Unit (2014).

improve public transportation system in Iskandar Malaysia before disasters happen.

The reclamation project today has already become controversial and concerns about transboundary impacts, environment, and the marketing have been raised both by Singaporeans and the locals. Since the project is massive and still under construction, the authorities will only inform the locals all the good things it will serve to them. Whatever controversial questions are asked, the construction is still going, by any means and to any extend so that the vision of Iskandar Malaysia to become "Sustainable Metropolitan Region" will be realised.

3.2 The "People": Gentrification in Nusajaya

Gentrification, referring to the displacement of low-income groups by wealthier ones in central and working-class urban areas (Lees et al, 2008) has been claimed to be a powerful force that often rapidly transforms the physical, economic, and social characteristics of a city, and it is now happening in Iskandar Malaysia (Khalil et al, 2015; Sultan et al., 2016). RM43 billions of private investment is received to develop Iskandar Malaysia for the establishment of firms, institutions, and professionals related to the knowledge economy in order to raise the value chain in Iskandar Malaysia (Khazanah Nasional, 2006). Nusajaya, the new administrative and commercial centre of Johor, is built from a green field area into high-end, new-build developments, thus making it clear that Nusajaya is now experiencing phenomena of new-build gentrification (Khalil et al, 2015). It is in the form of the development of large-scale, luxurious apartment blocks and their consumption mostly by middle and high classes. Although residential developments in Nusajaya are not merely focusing on large-scale luxurious condominiums and apartments, it is still in luxurious form that can only be afforded by the wealthy. The development has taken up land owned by villagers including their agricultural land. 400 households in *Kampung Baru* and *Gelang Patah* were evacuated, while several families in eight traditional Malay villages namely *Tiram Duku, Pekajang, Tanjung Adang, Kampung Pok, Tanjung Kupang, Ladang, Pedas Laut* and *Paya Mengkuang* also had to move elsewhere. Some people were relocated to new settlement such as *Taman Perintis 1*. Villagers and fishermen communities are being relocated elsewhere in Johor Bahru, including to the periphery of the metropolitan region, to facilitate Iskandar Malaysia development. Before the implementation of Iskandar Malaysia, Nusajaya was a rural area. The surrounding area was inhabited mostly by an aborigine group called the *Orang Seletar* or Seletar people. Most of the household involved in agriculture and fisheries activities. The trends have now changed as the percentage of households involved in agriculture and fisheries activities have declined significantly. The rapid development of Nusajaya as a new town centre caused not only displacement and loss of agricultural land, but it also change the pattern of the employment sector. The *Seletar* people as well as the local people living in the area can be categorized as poor since the monthly income of most of the head of household (HOH) is still low. The average monthly income of HOH in 2011 is RM 1,022 a slight increase compared to RM 911 in 2007. However, the average monthly income of the household increased from RM 1,486.25 (in 2007) to RM 2, 094.41 (in 2011) (Rostam et al., 2011). In 2007, the number of HOH with monthly income below RM 1500 was 59.5 per cent. The percentage decreased further to 35.5 percent in 2011.

The new residential schemes of Nusajaya, have transacted prices exceeding RM 600,000. The transaction of 2-storey terraced house located in *Sutera Utama* and *Horizon Hills* are in the range of RM 260 to RM 456 per square-feet in 2012 in average. *East Ledang* achieved a higher transaction value in the sub-sale market at RM480 per square feet followed by *Horizon Hills* RM400 per square feet. Meanwhile, the *Puteri Harbour Service Residence* was launched at RM 625,000 to RM 2,300,000 per unit. The older single and double-storey terraced houses in *Bandar Bukit Indah* have however not increased at the same rate indicating that the price of the surrounding older residential schemes has not been affected by the Nusajaya development. Gated and guarded security and better management remained the main features for better popularity. Demand for bungalow land in Johor Bahru has pushed up the transaction value on a year to year basis. Leisure Farm, *Ledang Heights, Taman Ponderosa and Taman Impian Emas* are the popular housing estates that provide bungalow lands. Average prices in these estates range from RM 40 to RM 120 per square feet (William & Abdul Rahman, 2013).

Rising property values may be good for owners as well as developers but bad for the poorer households trying to purchase a home in the area. In the context of developing countries, for some extent, the housing problem is more quantitative than qualitative due to the high rate of urbanization and the wide gap between the demand and supply of houses

Table 2: *Head of Household (HOH) and household income changes in Nusajaya*

Monthly Income	2007		2011	
	HOH	Household	HOH	Household
< RM 499	12.5	11.5	8.0	6.0
RM 500 – RM 999	27.0	25.5	13.5	14.0
RM 1000 – RM 1499	20.0	27.5	14.0	14.5
RM 1500 – RM 1999	17.5	11.0	20.0	20.5
RM 2000 – RM 2499	6.0	6.0	14.5	14.5
RM 2500 – RM 2999	6.0	6.0	9.5	9.0
RM 3000 – RM 3499	3.0	4.0	7.0	7.5
> RM 3500	8.0	8.5	13.5	14.0
Total	**100**	**100**	**100**	**100**

Sources: Rostam et al (2011)

(Jaiyeoba & Aklanoglu, 2013; Gul et al., 2016). In Iskandar Malaysia, as most developer competes to build luxury homes, it raises some concern since there is already an oversupply of those types of homes. If overbuilding occurs in Iskandar Malaysia, it can be detrimental to the mid-term overall physical market. Although such development may not pose an issue since foreign developers are attracting foreign buyers, it raises concern among the locals who have to purchase more affordable properties further away from this area. The non-Malay poor, particularly the ethnic Indians, cannot even afford low-cost housing due to increasing house price. The property purchases by the foreign expatriates in Nusajaya have resulted in housing unaffordability for the middle and low-income residents. As Nusajaya consists of exclusive residential area, new-economic profile has emerged. Only people with higher socio-economic status can afford to buy such houses. This is evidenced by more than 40% of foreign ownership of properties in Nusajaya.

4. Conclusion

Iskandar Malaysia seems to be promising in developing a better urban living condition with ambitious vision to compete and stand together with the strong Singaporean economy. However, the regional development is somehow too ambitious and too rapid since it aims to achieve its vision within 2025. This has resulted the development that supposed to be sustainable into unsustainable because important natural elements of the environment are wiped out and the residential developments are only for those who are rich enough to live in a million dollar house. In fact, gentrification has been adopted in Nusajaya as a desirable urban strategy, striving to upgrade their places in the global urban hierarchy. If this situation keep on persisting, the objective of Iskandar Malaysia that aspires to help strengthen the socio-economic of the local people would never be possible to achieve. The perception that local community cannot even afford to purchase a comfortable home at an affordable price is extremely unpleasant situation. New build gentrification has inevitably changed the socio-spatial structure of the region. Therefore, if no further effort is taken to improve the impacts of these situations, it is difficult to achieve the objective of social inclusiveness as promised by the vision of Iskandar Malaysia.

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Spatial Pattern, Transportation and Air Quality Nexus: The Case of Iskandar Malaysia

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ABSTRACT

Spatial pattern, transportation, and air quality are three development entities which significantly affecting one another. This nexus exhibits the urbanization imprint accouter transportation generating air pollution as a reflection of spatial distribution. The integration among them is a vital part of development as it affects the societal living environment. It provides unfavorable air quality and directly cause health problems. The developing region of Iskandar Malaysia exhibits huge spatial distribution transformation accompanied by large percentage of urbanization rate, but seems less integration of land use and transportation planning which causes the exaggeration of air pollution. We carry out the research on the nexus of spatial distribution, transportation and air quality in Iskandar Malaysia by analyzing and evaluating the interconnectivity of these three entities. The spatial analysis and evaluation on the land use development pattern and spatial policy shows that the Iskandar development region are growing in the polycentric manners, where the spatial development policy drives the distributional growth of new sub-centers. We undertook a household-based travel survey that reveals the poly-centricity reflected by the de-concentration of workplaces which shifted from the single point towards multiple centers. On the other hand, this phenomenon has created a distributional traffic pattern amid the high dependency on the private vehicles of the citizens in Iskandar Malaysia. With a predominantly fossil fuel consuming vehicles, this has generated air pollution. Based on the traffic survey and the dependency of the citizens on private cars for their daily mobility, the concentration of air pollution is seemingly at risk. This research reflects that Iskandar Malaysia development region currently undergoes towards polycentric development with some new urban centers. We found that land use and transportation planning policies require serious attention as the current trend of spatial pattern development tends to reinforce high dependency on the motorized travel.

1. Introduction

Capello (2011) asserted that a region exists with a determined feature and function, which then will determine the future development of its physical and cultural landscape identity. He added that a geographical location plays a very important role towards the development of each region as this feature will determine the potential accessibility and economic advantages. This notion seems valid every where including Iskandar Malaysia. Iskandar Malaysia, the study area, is strategically situated at the southernmost tip of Peninsular Malaysia making its location a strategic point of access to Peninsular Malaysia from the southern gateway. The additional feature of economics potential of the region is good locational setting and it has stimulated the growth of the region and creating multiplier effects towards the development of its surrounding areas. The potentials of the advance economic region exposed Iskandar Malaysia to high development pressure and thus, recognized as the second fast growing economic region in Malaysia (NPP2, 2010). The existing potentials of Iskandar region have promoted the economic growth in the region with its primary urban center, which is Johor Bahru City Center, JBCC. Johor Bahru has reached over 65 percent of national urbanization rate (NPP2, 2010). The development of Johor Bahru itself is associated with the long history of Johor Bahru as the capital of the Sultanate Johor since the 18th century, and has drawn an urban dispersion pattern especially from the concentrated nucleus of the development of Johor Bahru city center (SJER CDP 2012-2025, 2012). This has partially caused a concentrated traffic movements towards the center (Gubins and Verhoef, 2013). This occurrence has drawn an imbalanced spatial distribution growth in the region with respect to job and working places, which was mostly concentrated in the single point while sprawling along the major access. As a reflection to the trends of spatial growth, new comprehensive development plan were developed to induce the imbalanced regional growth towards more balanced one. The newly developed spatial setting of Iskandar Malaysia has promoted growth of new sub-centers with promising economic potentials in each growth center.

Within an urban development context that encourages the economic growth, an environmental associated issue, which is air quality, may generate. Air quality can be reflected from the human and

environment interrelation. The daily mobility that is performed by the Iskandar Malaysia society, which is relying highly on the private vehicle, can increase the emission discharge due to the burn of fossil fuel, since most private vehicles now are depending on the fossil fuel resource. Current situation of Iskandar Malaysia in the aid of new comprehensive development strategy tend to promote the growth of a polycentric spatial pattern from sustainable transportation viewpoint, with the support of 'within walking distance' principles', maximizes the dependency on the private vehicles. The shorter distance of 'willingness to walk' of the citizens -as a result of spatial planning- in addition to insufficient public transport system –as eventual reflection of transport planning- would enhance the dependency on private vehicles, and thus amplify the air pollution. This simple example shows that the nexus of spatial pattern, transportation and air quality do exist, and it is important in the development timeline.

Land use, transportation and environmental nexus was deliberately discussed in a sequent manner through few studies advocating integration promotion throughout the planning system. Permana, Perera and Norsiah (2015a) noted that there is a linear connection between the three important development elements of land use-transport-air quality. The study took place in a developing city where a concentric characteristic is reflected. In line with it, Burgalassi et al., (2015) discussed the spatial structure and transport-generated emission that influences environmental quality. They also asserted that spatial structure can be reflected in presence of carbon emission as a result of transportation habit. This issue has also been discussed prolonged enough by, for example, Pauker (1974), Anderson, Kanaroglou and Miller (1996), Geerlings and Stead (2002), Holden and Norland (2005), Belaieff, Moy, and Rosebro (2007), Gakenheimer (2008), Manins et al. (2011) and Lee (2012). This study intends to analyze the nexus of land use -as reflected in spatial structure-, transportation and the impacts on urban air quality, which certainly will affect the living environment.

2. Iskandar Malaysia at Glance

Iskandar Malaysia is located at the southern part of peninsular Malaysia (Figure 1) and exhibits a strategic geographical location as it possess as the major gateway into Malaysia. Dating back in the 14th century, the Straits of Tebrau which separates Johor and Singapore was well acknowledged as a fluorescent point of ship harbor coming from around the globe under the ruling of Johor Sultanate. Its prominent identity has prospered the region economically while simultaneously embark richness in physical while cultivating cultural landscape setting into the region as a whole. Looking at its potentials, Iskandar Malaysia becomes one of the major economic growth center i.e. SJER in 2006, addressing vast socio-economic growth as initiated in the Tenth Malaysia Plan (RMKe-10) along with the trust of the specially designed development plan. The region has been exposed to the pressure due to high development needs since the official ratification Iskandar Malaysia in 2006. It is also recognized as the second fast growing economic region in Malaysia after the central economic growth region of Klang Valley (NPP2, 2010).

Iskandar Malaysia exhibits a high value of land and property which grow along with the physical and economic developments guided by current spatial policy. The increase of property value is in line with the population growth and spill over of the property demand from the neighboring country Singapore. Singaporeans are allowed to own their property in Iskandar Malaysia with differentiated price to local citizens. Iskandar Malaysia, with access opportunity through Johor Bahru causeway link gateway and the Malaysia-Singapore Second Link, at the same time increases the numbers of property buyers from the developed country of Singapore. The access presents good potential interaction between the developed country of Singapore and the developing nation of Malaysia in terms of economic growth and population. Population growth in Iskandar Malaysia shows that the population in the region has reached 1.8 million in 2015 over the projected growth by 0.2 million (Khoo and Tan, 2015). The growth, on one hand has created Iskandar Malaysia as the region with highest economic growth in Peninsular Malaysia. On the other hand, it carries environmental social impacts. Environmental impact exhibited is particularly with respect to the degradation of air quality. The social impact appeared, although subject to an in-depth study, the gap between the rich and the poor. This issue must be addressed appropriately.

3. The Fundamental Principles of Spatial Structure, Transportation and Air Quality

3.1 Overview

The fundamental concept of sustainable urban development is basically to allow a controlled urban growth within the corridor of economic, environmental, social and cultural constellation. Thus, sustainable urban development requires, for example, no sprawl as sprawl may generate more waste and resources use, and no unjust eviction of urban poor as they are also human-being who have their rights. Also, closer economic gap between the rich and the poor, and respectful to other faiths, beliefs, races and other cultural backgrounds, while promoting environmental protection and minimizing pollution as a result of anthropogenic activities within acceptable limits. Urban development is visually exhibited by urbanization process as part of the development process and has drawn changes in the management and uses of land (Manins et al., 2011). Permana et al. (2015b) argued that the sprawling city, which is as a result of an uncontrolled urbanization, is also part of the development which physically appeared as spatially dispersed. In line with this notion, Aguilera et al. (2010) stated that low density urban development gradually draws on the impacts on social and environmental dynamics. The spatial distribution formed by urbanization process will build a tendency towards the elevation of transportation demand as the need of mobility increases. When the citizens with high dependency on private vehicles that consume fossil-based fuel to perform the daily commuting, then it affects the quality of living environment due to the discharge of air pollutants by the transportation activities. One of the most significant results of urban development that amplify and exacerbate air pollution is sprawl. Cheng (2003) stated that sprawl is created due to uncontrolled urbanization in the aid of economic booming and with technological influence, which also draws complexities towards the transportation system. The complexity in the process of urbanization requires strong acknowledgement of the interrelationships and interdependence of land use, transport, and energy consumption to adhere the optimization use of land, increase the efficiency of transport networks while discouraging energy consumptions. The key word in this process is the space and the process on it.

3.2 The Element of Space

Space is a prominent element of an area that must be sufficiently present in determining potential growth. It is based on the idea that spatial elements is associated with the use of space and ensuring the processes on it (Horton and Reynolds, 1971; Burgalassi and Luzzati, 2015) and the interrelation between the space and the development processes (Priemus, Najkamp and Banister, 2001). A spatial setting will lead to the flavor of development as described by Cheng (2003) in which, spatial setting involve the perspectives of space and time within a spatial arrangement. Thus a development flavor will largely depend on this setting. A development system requires strong interrelation as in the urban and regional development concept. Angel and Blei (2015) figured out that the of land uses pattern, the characteristics of the transportation system and the reactional behavior of people towards the system will determine the development process. It can be defined by the interrelation in between the residential development and land use, for example, transportation system in associated with the land use distribution (Lee, 2006; Burgalassi et. al, 2015; Angel et al., 2015; Giuliano, Agarwal and Redfearn, 2008. The spatial setting and development system will determine the spatial pattern i.e. monocentric model (Figure 2) and polycentric city model (Figure 3) of the specific region and the efficiency towards a balanced growth.

Figure 2: *Monocentric City Concept*

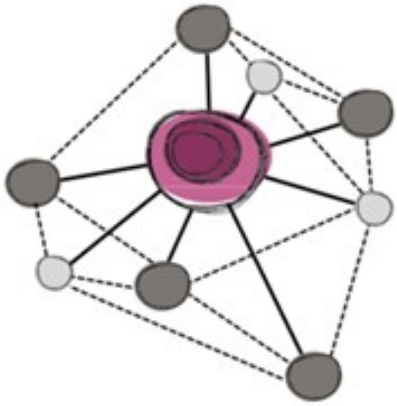

Figure 3: *Polycentric City Concept*

3.3 Transportation and Automobile Dependency

Transportation is a prominent part of a regional system. The modern development pattern increases the transportation demand due to the distributed spatial pattern. Permana and Aziz (2014) suggested that a transportation system must be a complete sets of the infrastructures, modality and the users which particularly referring to the road, vehicles and people respectively. In addition, transportation system also should consider the flows and management, because there is a distance and needs to travel and it therefore will determine the mobility habit and modal choice (Sun, Wu and Ma et al., 2013). Reflecting to the present development and modernization, modern citizens considered transportation and mobility as their way of life to fulfil their daily needs because the locational setting of residential area is separated from the other use of land i.e. commercial area. The auto mobile has become trends among them due to well developed motor vehicle as mode of transportation. Moreover, the dependency have increased over the time significantly among the developing countries allowing 6.2 billion daily automobile trips took place (Audenhove et al., 2014). The dependency is well associated with the preference of using private automobile because of inefficient public transportation system. This has caused the environmental problem generated by the transportation sector to amplify over the time.

3.4 Space, Society and Air Quality

Good air quality is needed anywhere for the good life of people and environment. Thus, air quality is associated directly and particularly with the spatial distribution of the regions, the population density and the transportation system. Air quality can affect the society's way of life and health. Exposure to air pollutants can directly and biologically harm the health. Air quality can affect the lifestyle of society such as avoiding to stay outdoor for a long time. From the transportation viewpoint, it will dictate people to predominantly depend on the private cars and avoid walking and cycling as daily transportation even to travel within the walking distance zone. Fecht et al. (2016) figures out that common air pollutants which affect human health comes mostly from the vehicular traffics. The air pollutants found in the atmosphere includes Carbon Monoxide (CO), Nitrogen Dioxide (NO2), Ozone (O3), particulate matter (PM), Sulphur Dioxide (SO2) and lead (Pb) (U.S. EPA, 2016; CA.GOV, 2012; NYSDEC, 2010). Human exposure to CO can harm the health condition involving the cardiovascular system and nervous system, ground-level ozone and particulate matter infect the respiratory system while lead (Pb) can affect the sets of respiratory, cardiovascular, reproductive system, as well the immune systems (U.S. Department of Transportation, 2010). This impact shows the importance of addressing the air quality issues stem from urban development and transportation interconnectivity.

4. Spatial Pattern, Transportation and Air Quality Interconnectivity

The analysis of land use, transportation, and environmental nexus attempts to advocate the integration of these elements throughout the planning system, to ensure that the adverse impacts particularly on end results are addressed appropriately. Anderson, Kanaroglou and Miller (1996) conducted a review on urban form and energy consumption and the impacts towards the environmental biology. Their study deduced the necessity to put into consideration in particularly defined the generation of the released pollutant in the context of urbanized area to address the prevailing environmental issues. They highlighted that the policy design for transportation and land use will definitely create a form which will determine whether or not the policy is pro-environment. In the same line, Permana et al. (2008) reported that there is a strong correlation between urban form, energy consumption and air pollution. This study has confirmed the presence of nexus, and thus it can be safely said that spatial pattern, transportation and air quality are interconnected. Addressing air quality from transportation sector, must address all the elements within the nexus.

With the same idea of integration, as suggested by Anderson et al. (1996) and Burgalassi et al. (2015), also brought the evidences that uphold the spatial structure interconnection with transportation would address the emissions produced by the nexus. Considering the importance of empirical evidence as suggested by Anderson et al. (1996), they deduce that the spatial distribution which is described as the polycentric pattern comes with maximum potential of emission due to the high dependency on private vehicle. On the other hand, polycentric pattern in combination with compact and mix development have a potential to reduce the emission discharge. This is how the urban form promotes energy consumption. Permana et al. (2015a) asserted that the interlocking elements of land use, transportation and environment nexus can potentially generate co-benefits for the climate change adaptation and mitigation when all the elements were taken care. In a broader sense, U.S. EPA (2001) suggested that the interplay of land use, transportation and air quality can be assessed through emission modelling from the land use development through three sequential steps, which are estimate, forecast and model. The forecast of future land use estimation must consider the projection of the population, economic activities associated with land use development. The forecast of travel demand that involves the traditional four-step model is to acquire the traveling model of the integration of the land use and transportation economic activities of the distinct population in determined zone. The emission model is generated from the estimation of the emitted pollutant from the transportation process. Attention on the land use induced transportation system and the emission discharged can potentially promote better plan towards sustainability while reducing environmental impacts generated by the anthropogenic activities (Anderson et al., 1996).

Wagner and Wegener (2007) agreed that the modelling of the integration of land use, transportation and environment requires s microsimulation process to dig up further deep solution. The model describe microscopic submodule to each of land use, transport and the environment. The microscopic model of land use should account for prominent elements of population, firms, residential mobility, firm location/relocation, residential buildings and non-residential buildings to understand the trip process between origin and destination. The transportation model characterizes the people's travel behavior to track down the travel demand as reflected in the traffic flow, the traffic links loads and the pick time of travelling. The micro module for environment modelling relies on the forecast of transportation cost towards the environment. By this arrangement, the microsimulation can provide the possibility towards the developments of better transportation system, improving societal behavior on their mobility and provide clear image of land use-transportation integration to improve the environmental quality. Considering the above arguments, we conducted the study by employing known methodology towards the accomplishment of the objectives.

5. Methodology

5.1 Definition of the Nexus

The idea of Wagner et al. (2007) on the importance of critical research on each elements of the nexus to address on individual issues of the element gives rise of the evidence in the urban development timeline involving the nexus. The configuration of the nexus can be equally determined as each development sectors and they are confirmed co-related to one another. This study encompasses three urban and regional planning prominent sectors accommodating spatial growth and distribution, urban mobility and transportation and environmental air quality generated by the traffic flow (Anderson et al., 1996). It can also generate energy consumptions from transportation sector. To assess and understand all of them can be acquired through empirical study. The prominent part of the research acquires the nexus of these three sectors in accomplishing the sustainable growth as envisioned by the national spatial setting of Malaysia through regional comprehensive plan of Iskandar Malaysia. To empirically conduct this research, each individual sector was analyzed by a specific method underlying the technical and social measures to address as the objectives.

5.2 Research Organization

We undertook the study by analyzing the current spatial configuration of Iskandar Malaysia. The spatial configuration of the region was determined through identifying the clustered residential areas and understanding the centers of economic, which are usually formed the

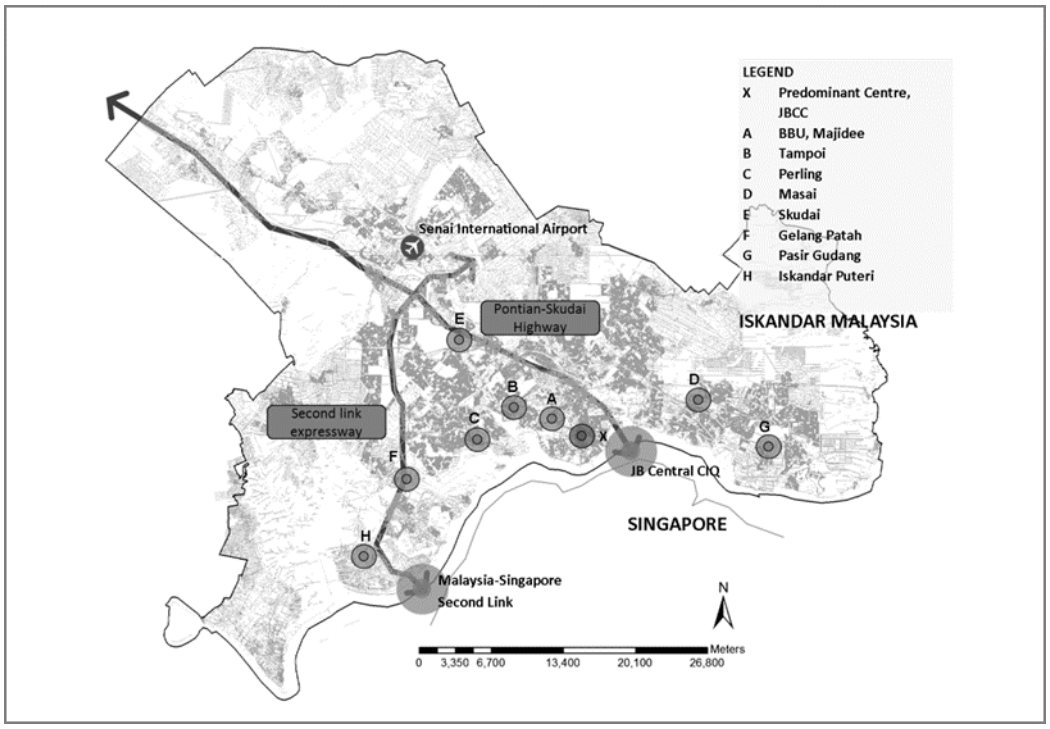

Figure 4: *Predefined Origin (Residents of Respondents)*

concentration of working places. Origin and destination survey of the commuters was conducted. The identification was based on the idea of quantifying spatial structure as suggested by Lee (2006). He focused on the population distribution and employment agglomeration. The interaction of between residential distribution and the primary job centers would depict the spatial pattern. The identification of spatial pattern could also be established through the identification of land use pattern by assessing working places (the destination) and commuter's living quarters (the origin) that is conducted through questionnaire survey and with the aid of review on spatial policy for the Iskandar development region.

The primary data was collected via a questionnaire survey. We organized a random sampling survey method by considering the population size of Iskandar Malaysia. An estimated population was 1.7 million, and with an error of 2.5%, the respondents were determined and selected randomly. The household travel survey was conducted by acquiring 400 randomly selected respondents to distinguish and understand the origin and destination sectors in the city. Some city sectors were predefined to easily recognize the origin and destination and for further analysis to define the spatial pattern of Iskandar Malaysia. The predefined sectors of residential areas shown in Figure 4.

The household travel survey provides information of the prominent linkages connecting the origin and destination of respondents. Based on this, we selected some important points that most probably the connecting points of origin and destination of the commuters. The traffic volumes were estimated at the selected points as shown in Figure 5. On site traffic volume counts to further estimate the air pollution by using the correlation model of traffic and air pollution. The of air pollutants i.e. SO2, CO, and PM10 were estimated based on the existing traffic volume and air pollutant correlation model. The model was derived from a study in a developing city with obvious mono-centricity. The application of the model was decided by considering the similarity on the dependency on private cars, traffic flows as the major source of air pollution and all particulate matters are dominantly generated from the vehicles.

6. The Nexus Configuration in Iskandar Malaysia

6.1 Spatial Setting of Iskandar Malaysia

Under the statutory plan of Peninsular Malaysia, Iskandar region is ruled by the spatial policy setting through the National Planning Policy 2, Five -Year Malaysian Plan, Iskandar Malaysia CDP-I (2012) and further Iskandar Malaysia CDP-II (2014). The serial development plans set up a system in coordinating and controlling the spatial growth in Peninsular Malaysia in particular. The Iskandar Malaysia development region covers the total areas ruled by five local government authorities, with approximately 2,216.3 sq. km (Iskandar Malaysia CDP-I, 2012), and with the total of 1.7 million population residing within (Iskandar Malaysia CDP II, 2014). The growth was formally guided by a comprehensive development plan, CDP for Iskandar Malaysia under the regulation of Khazanah Malaysia with the monitors of Iskandar Region Development Authority, IRDA. Since the first comprehensive plan, most developments in Iskandar Malaysia have been translated into vast economically and socially catalytic projects to deliver the vision of developing a strong, sustainable conurbation of international standing as stated in the Iskandar Malaysia CDP-I (2012).

Spatial development of Iskandar Malaysia before the new development concept was introduced counteract the imbalanced growth pattern that was existed with a single economic center (see Figure 6). As the single economic center was the major concentration point, it has become a densely populated center holding the highest capacity of job

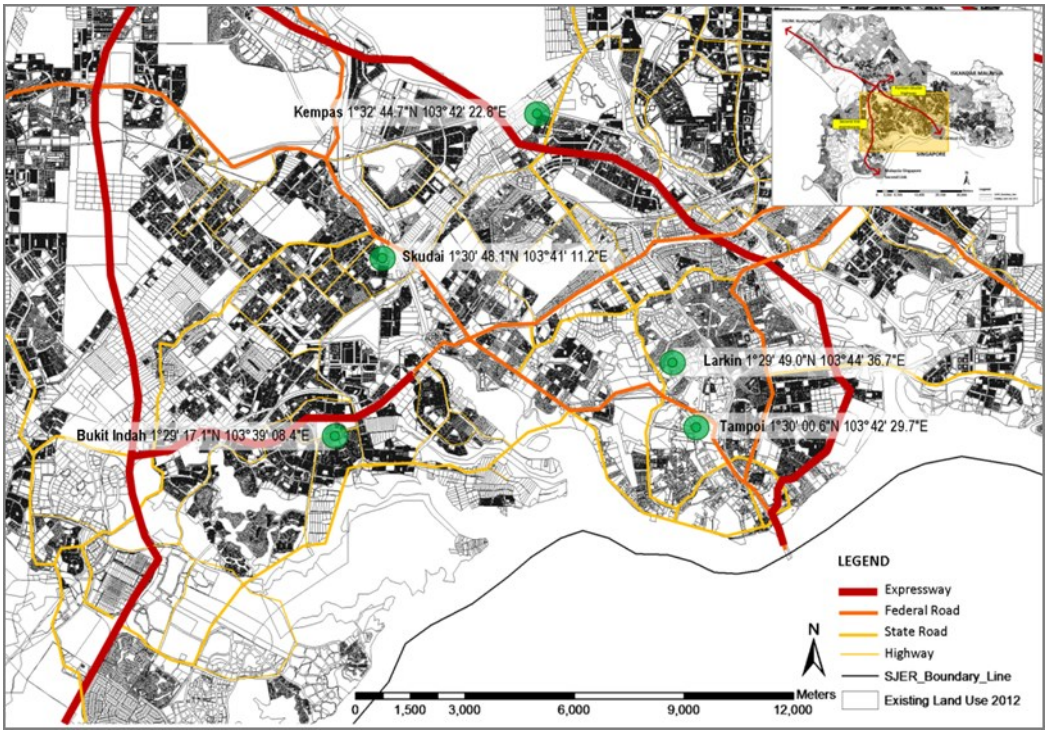

Figure 5: *Predefined Prominent Traffic Points Connecting Origin and Destination*

agglomeration. This has caused development pressure in the single center. On the other hand a sprawl takes place along the major access towards the center (Iskandar Malaysia CDP-I, 2012). The sprawl shows an extrapolation that is originated from the major center which promotes separation of land uses causing most population to live away from the center but highly accessible to the center because of the strong transportation network (Anderson et al., 1996). This is causing the less concentration in the center from time to time. The spatial distribution of Iskandar Malaysia as exhibited in Figure 6 shows that the JBCC is connected by major expressways towards the center.

The comprehensive development plan which was specifically design to guide the development in Iskandar Malaysia was projected to that development in the region meets the national 2020 vision as a fully developed nation by 2020, by delivering the vision of developing a strong, sustainable conurbation of international standing as stated in the Iskandar Malaysia CDP-I 2012. Stimulated by existing spatial growth,

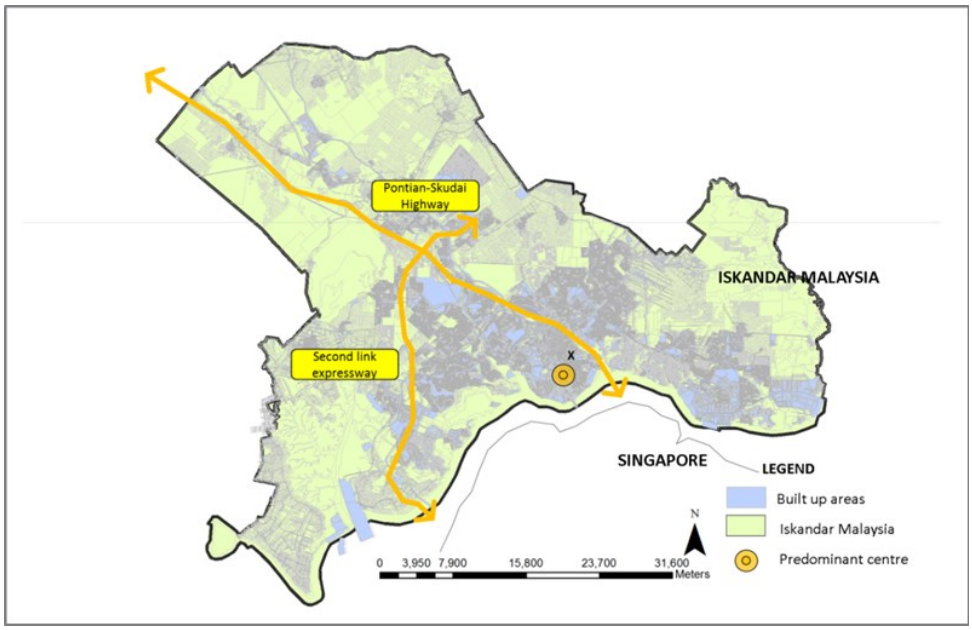

Figure 6: *Spatial Distribution of Iskandar Malaysia (2012)*

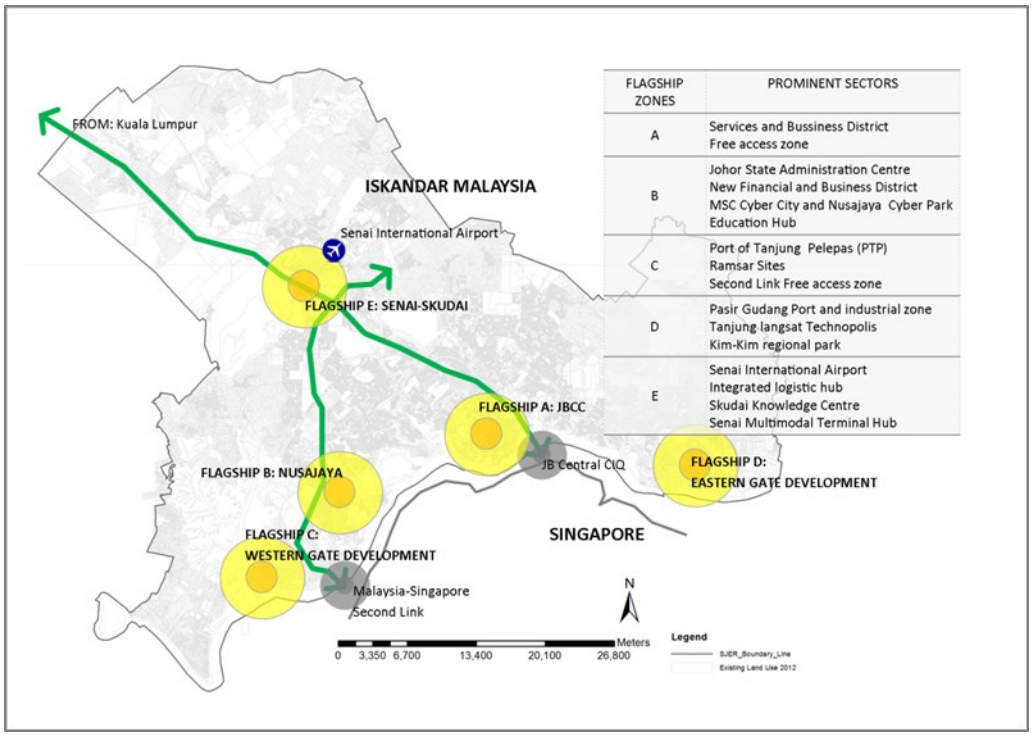

Figure 7: *New Sub-nucleus Promotion*

the new development sets up the promotional growth of sub-centers to advocate balanced growth. To nurture a balanced growth towards a polycentric system, the spatial setting for the development timeline of 2005-2012 was designed with the recognition of new centers (Figure 7). Based on the economic potential of each new center, the overall objectives is to spur the growth of the region as a whole entity of Iskandar Malaysia Region. This is as a long-term spatial planning in promoting less dependency on the private cars trough well design transportation system in line with overall development of Iskandar Malaysia.

Based on a study by Burgalassi et al. (2015), the poly-centricity will not reduce the air pollution generation from the transportation sector but the system is viable to reduce automobile dependency for a long-term development. In the perspective of Iskandar Malaysia, the region was determined as the monocentric regional system with concentrated development at the primary commercial center of JBCC. The sole commercial center of Johor Bahru, the presence of JBSS has driven the high traffic concentration towards the center and generated air pollution do exist. However, later on as Iskandar development region was formally established in 2006 and recognized as the southern economic growth region, the traditional concentric development was shifted towards a development of multiple growth center. This has cultivated new spatial pattern as polycentric regional system decelerating the sprawling process that may create imbalanced regional growth. The traffic concentration generated by a monocentric city has shifted accordingly towards more distributed traffic pattern along with the polycentric system, and thus reducing the concentration of emission. However, this is not improving the air quality rather distributing the concentration of air pollutants towards lesser concentration. Moreover, the travel behavior of citizens in Iskandar Malaysian shows major dependency on the private cars would definitely exacerbates the air pollution.

6.2 Poly-centricity as a Reflection of Distributional Travel Pattern

Development of multiple centers in Iskandar Malaysia would influence the sub-centers and its surrounding areas to sequentially grow as well in terms of physical and economic sectors. This arrangement in return can promote a balanced population distribution throughout the region rather than concentration at only one point as previously happen. The promotion of polycentric system with multiple numbers of centers has potential to adjust the transportation system when the working populations tend to wisely determine their residential and locational setting of their workplace (McMillen, 2001). Based on Ding and Zhao (2013), the job decentralization, to some extents, will determine its efficiency with respect to energy and environment. The commuting habit will therefore change as the working population would probably prefer to live nearby their workplace (McMillen, 2011). It is because, they are no longer dominantly depending on the major center to be their workplace and possibly choose to live as close proximity to their workplace. Further, this situation will create a less travel distance to work place and at the same time reduce the automobile dependency as proved by Burgalassi et al. (2015). The poly-centricity is therefore has a long-term potential to reduce the automobile dependency.

The household travel survey based on the origin-destination in eight predefined residential and economic centers reveals that the predominant center i.e. JBCC (Figure 8) is no longer exist as the major destination of working place. Based on the travel survey, as shown in Table 1, there is a significant numbers of concentrations towards zone G (11.25%) followed by zone E (11.00%) and zone H (8.75%). However, the highest numbers of concentration towards JBCC is only 5.75% and in average, and only 3.00% of working population is still travelling towards the center. The figure as shown in Figure 8 reveals the emergence of zone G, E and H as the new sub-nucleus in Iskandar Malaysia which holding high capacity of job agglomeration. The

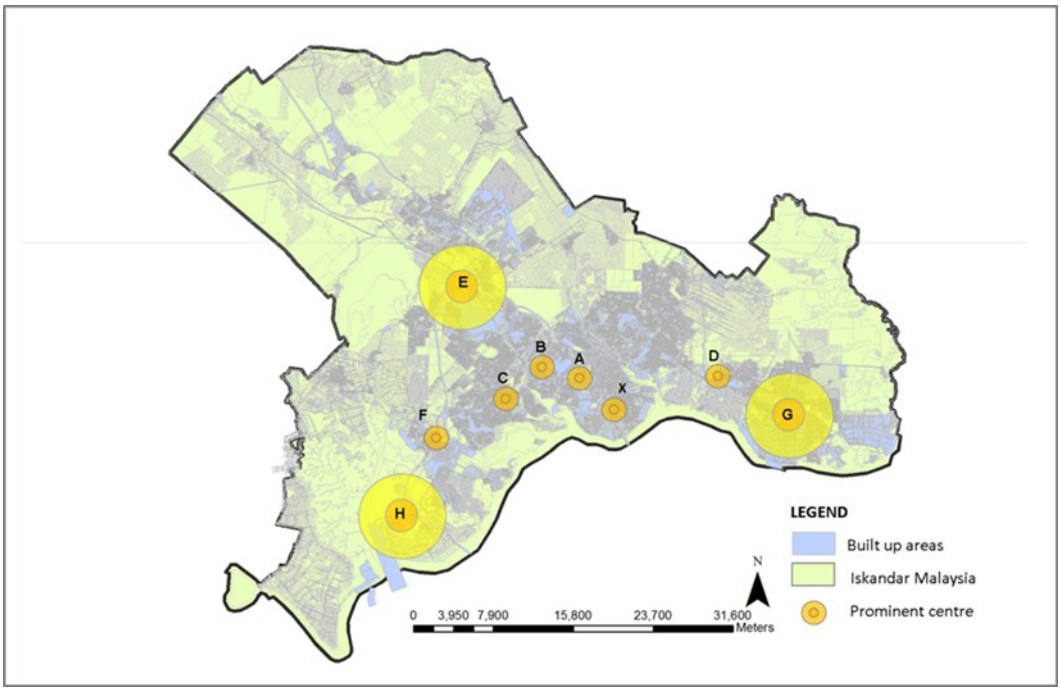

Figure 8: *New Sub-nucleus Promotion*

phenomenon shows that the development of spatial distribution in Iskandar Malaysia is going in coordination with the setting of spatial policy towards the development of polycentric region system.

The prevailing concept of development setting has as well promoted a balanced job-housing distribution through self-contained sub-nucleus. Evidently, zones G and E accommodate more than 10% of working population who travel within the same zones to their workplace (Table 1). The figure then followed by zones H and F with concentration of 8.75% and 6.50% respectively. The development of economic centers in the new-sub nucleus has advocates the growth of residential as well as other facilities and infrastructure development within and surrounding the zone of development to accommodate the working population. There is significant numbers of working population who travelling from zone F (5.75%) to JBCC with 0.75% different to the figures of population of working and living within the zone. This figure explains the situation where the populations of zone F dependency on the zone X (JBCC), as the major center of job agglomeration, is still high. This is because, zone F used to be an under developed zone before zone H was promoted into a new center accommodating the state administration center. This development has strong influence on the concentration of air pollutants resulting from transportation sector.

6.3 Traffic Generated Air Pollution

Fossil-fuel-consuming automobiles those emit pollutants to the atmosphere show a tendency to be increasing and become prevailing figure in Iskandar Malaysia. Based on our survey, the citizens of Iskandar Malaysia have very high dependency on the private vehicles for travelling thus contributed to high emission into the urban atmosphere. In relation to this, we have subscribed a model of traffic and air quality correlation. Since the study also analyzed the traffic volume at some selected points, and by using the existing model of traffic volume and air quality, the quantity of pollutants have then been derived from the model. The model was based on the study of Permana and Aziz (2014), as shown in the following correlations:
The correlation between traffic volume and CO resulting in the following regression equations. Regression equations can be calculated by using Excel or SPSS.

Linear:	$y = 0.0004x + 1.1379$ $(r2=0.5977)$
Logarithmic:	$y = 0.810\ln(x) - 3.9863$ $(r2=0.5604)$
Polynomial:	$y = -3E\text{-}08x2 + 0.0006x + 0.9009$ $(r2=0.6127)$
Power:	$y = 0.553x0.4671$ $(r2=0.4683)$
Exponential:	$y = 1.0753e0.0002x$ $(r2=0.4274)$

Based on the model and data acquired from the survey on traffic volume, the generated air pollution is shown in Table 2 and it reveals that there is high concentration pollutant in Skudai area, although the concentration is still below the National Air Quality Standard of Malaysia. The selection of the measuring points was to justify the linkages between resident (origin) and working place (destination). Table 2 confirms the function of the trunk road of Skudai as the main linkage connecting the residential areas and economic centers where the job agglomeration takes place. Atmospheric pollution due to traffic generation embraces three types of pollutants, which are SO2, CO and PM10, and estimated by using the correlation between air pollutant and traffic volume as based on the above model.

The nexus of land use as reflected in spatial structure, transport and environment have been reflected in the above discussion and confirmed that the nexus does exist. Addressing air quality in Iskandar Malaysia stems from transportation sector should not be undertaken with silo-effect manner, rather simultaneously organized within all the elements of nexus. Fail to address all the elements in the nexus, there will be a significant tendency of the increase of air pollution issue in Iskandar Malaysia, with primary factor of high dependency of the citizens of Iskandar Malaysia on private vehicles. This is an inconvenient truth and serve as a warning for the authority to cope with the issue.

Table 1: *Origin-Destination Matrix Table*

ORIGIN ZONES	DESTINATION ZONES										
	X, JBCC	A	B	C	D	E	F	G	H	Y	Y1
A	4.00%	0.75%	1.00%	0.00%	0.50%	0.50%	0.00%	0.00%	0.00%	0.00%	0.25%
B	1.75%	2.25%	0.25%	0.00%	0.75%	1.00%	0.25%	0.75%	0.25%	0.25%	0.75%
C	2.75%	0.00%	1.00%	0.00%	0.00%	0.50%	0.00%	0.50%	0.00%	0.25%	0.25%
D	1.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.00%	0.00%	0.00%	0.00%
E	5.25%	0.75%	1.00%	0.50%	0.25%	11.00%	0.00%	0.75%	0.25%	0.25%	0.25%
F	5.75%	0.75%	1.25%	0.25%	0.75%	1.25%	6.50%	0.50%	1.25%	2.25%	4.50%
G	3.00%	0.25%	1.00%	0.00%	1.00%	0.25%	0.50%	11.25%	0.00%	0.75%	0.25%
H	0.50%	0.00%	0.25%	0.00%	0.00%	0.00%	1.75%	0.00%	8.75%	0.25%	0.75%

Notes

X	Predominant Center
Y	Outside the region, within Malaysia
Y1	Singapore
	Working and living within the same area
	Highest concentration towards an area

7. Concluding Remarks

As a concluding remark, it is obvious that Iskandar Malaysia was a monocentric region of single concentration towards the single center of JBCC as Central Business District. However, with the current spatial policy and development of Iskandar Malaysia, the mono-centricity has gradually shifted to poly-centricity in combination with mixed development. This has promoted development of the region to spatially grow in polycentric manners. The poly-centricity has been confirmed through spatial assessment through the analysis of the travel pattern of the citizens in Iskandar Malaysian. This pattern resulting in the dispersal traffic pattern within Iskandar Malaysia and helps to reduce the pressure of traffics in certain links, as well as the concentration of carbon generated by traffics. However, the polycentric development does not well integrated with the development of transportation system to be in line with the spatial growth as stated in the comprehensive development plans.

The poly-centricity is believed reducing the pressure of traffics in certain links, as well as the concentration of carbon generated by traffics towards the predominant CBD, JBCC. However, the dispersal of GHG over vast areas within Iskandar Malaysia will also be remarkable. Thus, without noteworthy reduction of carbon emission generated by traffic through, for instance, the notable shift of the commuters from private transport to public transport, Iskandar Malaysia will suffer from

Table 2: *Quantity of air pollutants at some selected points*

POINTS	SO_2 Concentration *=0.0183×ln(traffic volume)-0.0993*	*CO* Concentration =1.3193×ln(traffic volume)-7.4258	PM_{10} Content =0.013×ln(traffic volume)+81.331
Skudai Coordinate: 1°30' 48.1"N 103°41' 11.2"E	0.064 (1 hour)	4.377 (1 hour)	81.447 (1 hour)
Kempas Coordinate: 1°32' 44.7"N 103°42' 22.8"E,	0.050 (1 hour)	3.359 (1 hour)	81.437 (1 hour)
Tampoi Coordinate: 1°30' 00.6"N 103°42' 29.7"E	0.048 (1 hour)	3.166 (1 hour)	81.415 (1 hour)
Bukit Indah Coordinate: 1°29' 17.1"N 103°39' 08.4"E	0.055 (1 hour)	3.672 (1 hour)	81.421 (1 hour)
Larkin Coordinate: 1°29' 49.0"N 103°44' 36.7"E	0.036 (1 hour)	2.348 (1 hour)	81.407 (1 hour)
Malaysian Standard Pollution Content			
SO2 (ppm)	0.04 (1 hour)		
CO (ppm)	9.00 (1 hour)		
PM10 (ppm)	260 (24 hour)		

noticeable degradation of air quality. This is what we would like to warn, if not to offer, through this study.

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