A Model of Eco-welfare Planning: Sustainable Urban Development of Chennai Metropolitan City, India

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Abstract—In the face of the global financial crisis and pressing environmental and climatic threats, green growth has emerged as a new development paradigm capable of achieving economic and environmental objectives simultaneously. Cities are central to the green growth debate, as they are both the locus of economic activity and the drivers of energy consumption and resulting greenhouse gas emissions. International pressures, national legislations and growing public awareness of climate change and environmental degradation are all requiring a change in approach to our cities. A case study of Chennai, a Metropolitan city in India has been chosen for the investigation. The authors have analysed based on the survey research on the current state of knowledge on environmental performances and identified seven crucial greening opportunities /challenges for an urban system. From among the survey results and inferences of literature review the authors have made an attempt to recognize their causal relationships with green energy future and suggested a model of eco-welfare. Finally, concluding with plausible guidelines of eco-welfare and energy green system to navigate towards sustainable urban development of India.

Keywords — Green Energy, Green Growth, Green City, Urban Energy, Sustainable Urban Development

1. INTRODUCTION

Cities currently account for about two-thirds of the world's annual energy consumption and about 70 per cent of the greenhouse gas (GHG) emissions. In the coming decades, urbanization and income growth in developing countries are expected to push cities' energy consumption and GHG emissions shares even higher, particularly where the vast majority of people remain underserved by basic infrastructure services and where city authorities are under resourced to shift current trajectories. The global energy crisis coupled with the threats of climate change bring into sharp focus both opportunities and challenges for developing countries. Developing countries have to address the increasing energy demands of growing economies and also need to deal with the real and potential impacts of climate change. In addition to these challenges is the global imperative to reduce carbon emissions in order to prevent climate change. Within this context developing nations need to follow a very different development path from that established by first world countries. This development path is a low energy, low carbon, and generally a resource efficient one to attain eco-welfare in the system.

The use of energy, the types of energy used and the lack of access to sufficient energy have far reaching implications for a city's economic development, its environmental health and for the poor. The burning of fossil fuels to provide energy is major contributor to excess carbon in the atmosphere which is the cause of global warming. Cities which implement sustainable energy and climate action plans reduce their vulnerability to energy scarcity and to energy price rises; they have less traffic congestion and lower energy input costs; they have cleaner air and their low-carbon economies can afford them a competitive economic edge globally. More specifically for cities in developing countries, a sustainable energy and climate action plan should consider the users' needs first – this means that poorer households and small energy users should be prioritised. As local governments manage or oversee all city activities and city development, they should play a central role in determining the energy and

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carbon emissions picture of their cities. Every city is unique – it has different resources at its disposal, different needs, different development paths and different mandates and powers. A city's energy plan must be built on its particular needs and the resources at its disposal under green way. When *green energy* is used, the primary objective is to reduce air pollution and resources and minimize or eradicate completely any impacts to the environment. Green energy can replace fossil fuels in all major areas of use including electricity, water and space heating and fuel for motor vehicles. Here are 6 of the most common types of green energy: They are Solar Power, Wind Power, Hydro Power, Geothermal Energy, Biomass and Biofuels respectively in the system.

The Green City Index methodology was developed by the Economist Intelligence Unit (EIU) in cooperation with Siemens AG which presented in **Figure 01**. This figure used as basis for the current study, as it is applied to Asian countries. Cities were selected for their size and importance. They were picked independently, rather than relying on requests from city governments to be included or excluded, in order to enhance each Index's credibility and comparability. The figure 1 reveals that Green City Index series measures cities on approximately 30 indicators across eight to nine categories depending on the region. It covers CO_2 emissions, energy, buildings, land use, transport, water and sanitation, waste management, air quality and environmental governance (Asian Green City Index; European Green City Index; U.S. & Canada Green City Index, 2012). About half of the indicators in each Index are quantitative – usually data from official public sources, for example, CO_2 emissions per capita, water consumption per capita, recycling rates and air pollutant concentrations. The remainder are qualitative assessments of the city's environmental policies – for example, the city's commitment to sourcing more renewable energy, traffic-congestion-reduction policies and air quality codes. Measuring quantitative and qualitative indicators together means the Indexes are based on current environmental performance as well as the city's intentions to become greener.

2. GREEN ENERGY PLANNING FOR 21st CENTURY: CONTEMPORARY URBAN CHALLENGES AND PERSPECTIVES

Planning for future urban growth within the constraints of available land, water and energy is a difficult task for urban planners. The authors have observed that the Current planning strategies for future urban development often target issues such as housing, transport, water and infrastructures; but very few strategies comprehensively consider the urban climate and its interaction with the built environment. (Andrew Coutts, et al., 2010). In rapidly growing cities, present development trends are choked with emissions and urban way of life. Cities have the unique ability to respond to a global issue, such as climate change at local, more tangible level. Green House Gas (GHG) emissions are premeditated for linkages to global climate change, the impacts of localized climate effects worth consideration because of common connections. The mechanism that connects the Urban Heat Island (UHI) effect to global climate change is that of increased energy demand.The lifestyle residential opportunities induce the land speculation and demand for lifestyle properties which leads to reduction in the greenbelts. Normally the tensions being created by growth pressures on the urban fringe and investigates various planning tools that may strengthen the Council's ability to control urban growth. The authors have made an attempt to understand the difficulties for containing urban growth to reduce the sprawling effects in the system. (James E. Rowe, 2012).

The contemporary urbanizing world, escalating human faces and growing urban energy demand alarming the urgent need of Ecologically sustainable local area planning to encounter the mitigate the global climate change effects. Here, the concept of ecological sustainability is theoretically framed by social justice and eco-centric values, which calls for an integrated local area planning approach in the system. The current generation may enjoy the affluence associated with that development, but will the next generation be poor as a result of diminished resources and poor environmental quality? In the local government context, this integrated planning approach aims to achieve the development of broad and balanced plans that express a local area vision and strategies by the integration of green energy planning. There are significant synergies between environmental and economic objectives in urban areas; greening actions at the local scale can reap considerable benefits.

The social goals of reducing unemployment and enabling ecologically sustainable development are more likely to be achieved if the spatial dimensions of economic policy are made explicit. The expansion of 'green' jobs is considered in relation to the prospects of marrying concerns of growth, equity and sustainability with proactive urban and regional policies.(Frank Stilwell & David Primrose, 2010).The authors have established that expenditure on infrastructure and job creation occurs has major implications for urban efficiency, equity, sustainability and quality of life. The relationship between the global financial crisis and the federal government's policy approach to carbon pollution reduction is contentious. This treats the economic and environmental crisis and their potential remedies in zero-sum terms, implying that policy-makers must choose a stable economic and a sustainable ecological system. By contrast, numerous international non-governmental organisations calling for a 'green new deal' (Juniper et al., 2008), have claimed a more comprehensive and far-sighted policy could link the two concerns economic and ecological through a focus on the creation of 'green jobs'. Direct green employment opportunities through renewable energy projects such as, Solar, Biomass, Geothermal, Hydro, Photo Voltaic, Wave, and Wind have ample scope in the system. The authors have believed that there are two potentially powerful policy instruments to be used more effectively to promote recovery and drive structural economic change. One is government infrastructure spending, the other is investment in the generation of 'green' jobs through ecologically sound green energy planning.

Historically energy consumption has had significant impact on the development and operation of World cities. The estimation of urban energy consumption for a city plays decisive role for administrators/urban planners. The authors such as Patrick Troy et al., 2003; Darren Holloway, et al., 2006; Peter Rickwood, 2009; Peter Rickwood et al., 2007, have suggested that embodied energy consumption may be more significant than previously thought and suggests how estimates of embodied and operational energy may be used as a development control tool in the planning system. Embodied energy is the energy required (directly and indirectly) to produce a product and is traceable from the finished product to the consideration of raw materials. Operational energy for each residential and non-residential property includes the energy used for heating, cooling, lighting and appliances. The basic unit used in this study to measure energy consumption is gigajoules of primary energy. In some cases it is relatively easy to 'convert' energy consumption to greenhouse gas emission; however, the emissions are a function of the form of energy consumed. The concept of sustainability is a multi-dimensional one, with many meanings, yet one that has immersed itself in our everyday lives. One of the critical issues associated with sustainability, including urban sustainability, is how to reduce our use of energy and therefore greenhouse gases. Higher density housing is not necessarily more energy efficient as per the studies of Myors et al., (2005); Perkins et al., (2007); Randolph & Troy (2007). The nature and form of the urban environment is a critical determinant of the sustainability of our society, as it is responsible directly for a large proportion of consumed energy, and influences indirectly the patterns and modes of energy consumed in everyday activities. Much of the existing data on both embodied and operational energy use in high-rise apartments is troubling, as it suggests that the energy savings possible in such a structure are, in practice, not achieved, due to poor design. Even worse, the theoretical savings are small compared with the increase in energy use observed when such buildings include energy-hungry luxury features. This research suggests that medium-density dwellings (including low-rise apartments) may prove more energy efficient than detached dwellings. (Peter Rickwood, 2007, 2009).

Currently there is a significant level of understanding relation between the urban governance and sustainability discourses (Brendan Gleeson, et al., 2004; Caroline Miller, 2006). The aim of the author is to undertake a socio-theoretic analysis of how planning, drawing on a diverse heritage, is responding to the challenges posed by the current theoretical and policy discourses on governance and sustainability in Indian context. There is a consensus that the apparently unsustainable car dependent, `sprawling' morphology of capital cities requires to redress by directing activities and investment into regional centres, increasing densities, improving alternatives to the motor car, providing open space and protecting natural resources. Eventually concluding

that the plans acknowledge that some measure of traditional `blueprint' control is crucial if cities are to be restructured to protect natural resources and achieve a more sustainable morphology. The car, used for urban driver only commuting has become a serious problem .The use of energy from non-renewable resources has a number of impacts and effects on the environment. The use of fossil fuels releases substances into the environment which natural systems are unable to break down at the same rate at which they are released - so they accumulate (Ben de Waard, 2008; Frank Fisher, 2002). Every motor vehicle on the road generates a significant number of pollutants and summarized in **Table 01**.

It is the sheer number of vehicles which generates enough pollution to make a creek uninhabitable for a particular species of fish or that creates demand for a new or wider road. The primary environmental benefit associated with working from home is reduced energy consumption and petrol emissions associated with reduced use of the motor car. The low carbon development is the important trend of Chinese urbanism, and the gap between transportation infrastructure resource and travel demand induces to the transportation problems, such as congestion, energy, and safety (Mingquan Wang, 2013). Transit Oriented Development Strategy is an obviously solution to reduce the usage of private car, especially for the Chinese cites which have large amount of commuting residents and high density land-use mode, by transferring car use trips to transit. Transit Oriented Development Strategy face the two major challenges in China, one is the development of private car market with the rapid increasing almost 20 per cent per year from 2008-2012 (Bureau of Traffic Management, China, 2012) making the gap between infrastructure and car travel demand becoming wider; the other one is the missing connection with the nature pattern of urban development, since most of the city is constructed already and maybe not suitable for transit at all. The result shows around 30 per cent energy consumption and CO_2 emission could be waived if we choose the low-carbon city development mode. The issue of spatial structure of the most appropriate patterns of urban and regional development is one particularly important aspect. The most successful societies will be those that adapt their spatial structure and their patterns of production and consumption most rapidly to meet the complex requirements of sustainability (Frank Stilwell, 2007). The study of literature exposes that assessing overall environmental performance is very much essential to set the world on a path to more sustainable development. Energy and CO_2, Land use and Buildings, Transport, Waste, Water, Sanitation and Air Quality are the important parameters to be considered to analyze the environmental performance. These parameters are centered around and induce the green energy futures for the twenty-first Century cities, as indicated in figure 1.

Therefore, one can easily conclude that reduction of urban energy demand will play a pivotal role in achieving sustainable urban development in the system. Furthermore, the review of literature reveals the inevitable requirement of green energy planning for eco-welfare to encounter the modern challenges, turns as brain nerve for navigating towards the sustainable urban future.

3. ASSESSING SUSTAINABLE DEVELOPMENT SCENARIO OF THE STUDY AREA

The authors have made an attempt to understand the sustainability and environmental conditions which exists in the study area i.e., Chennai Metropolitan Area, Tamil Nadu, India, which is presented in **Figure 02.** To realize the tangible functions of the study area at the public official level, survey research techniques have been employed to conduct the investigation. A detailed investigation has been conducted to understand the dynamic functions of the system by considering the following major variables. They are: Local agricultural economy, Traffic congestion, Green economy, Natural and Environmental resource base, Sprawl, Air pollution, Dependency on fossil fuels, local non-profit organizations in public planning, local planning efforts, Compact and mixed use development, Issue of fuel poverty, Comprehensive legislation mandating reductions in greenhouse gas emissions, Removal of restrictions on Floor Space Index (FSI).

Most influential parameters toward attaining energy efficient urban development by removal of FSI restrictions in the system, such as rising energy prices, involvement of Local Governments and Corporate in Energy Planning, property owners, understanding Solar and Other

Renewable Energy by the Government and private sector, Local government and Corporate commitment to reduce carbon footprint, anticipation of carbon emission regulations, improving energy performance, more energy-efficient products and services, Technology advancement-efficiency efforts, awareness of Energy audit.

Most important factors to adopt energy efficient retrofits, such as, awareness of energy efficiency, better understanding of audit, rebates and subsidies for Green energy, better options for improving energy efficiency, energy efficiency strategy, quantification of energy performance, Planning policies; bottom-up collaborative visioning process by the Government, development process with citizen involvement, result of a technical and political plan development process and ad- hoc responses arising out of the current situations. The Authors have conducted the detailed professional survey by using the pre tested schedule among 101 senior officials of various Government Departments/Agencies located in Tamil Nadu, India, which involved in planning and development activities to understand the dynamic functions of the system.

The abstract of the survey respondents participated in the survey are furnished in **Table 02**. The respondents are grouped in six categories. They are: (i) Academicians (9.90per cent), (ii) Scientists (10.89 per cent) (iii) Urban Planners (37.62 per cent) (iv) Civil Engineers (11.88 per cent) (v) Environmental Engineers (8.91 per cent) and (vi) Municipal Administrators/Policy makers (20.79 per cent) respectively. It is on the basis of this information and discussion that the present inquiry is proposed, namely, an evaluation of the extent to which the adoption by communities of sustainable development policies can be explained by the local government of Chennai Metropolitan City, India. It is proposed that this study still has relevance is the extent to which the studied communities can be characterized as displaying a necessary foundation for the emergence of appropriate or sustainable behaviour. Secondly, it will provide some sense of dynamics behind the adoption of sustainable development policies among the people of study area.

3.1. PLANNING AND DEVELOPMENT OBJECTIVES OF THE STUDY REGION: LOCAL GOVERNMENT PERSPECTIVES

This paper uses the results of professional survey conducted in May-June,2013 interviewed by the researcher and opinion obtained randomly from selected local government officials involved in planning and development activities in the study area. The purpose of this study is to identify the initiation of sustainability policies for Chennai which is one of the largest cities in India. The city tends to be more inflicted with the types of dysfunctions which affect the sustainability (i.e., pollution, congestion, sprawl, etc.), in the system. Respondents were asked to indicate the best reflection of their opinion about the following sustainable planning and development issues of the study region.

Figure 03 indicates clearly about the seriousness for protecting farmland and the local agricultural economy in the study area. The figure reveals that more than 50 per cent of academicians, scientists and urban planners are strongly believed that the issue is very serious in the system. Furthermore, less than civil engineers, environmental engineers and municipal administrators/policy makers believe less than 50 per cent opined that the issue is serious.

Figure 04 illustrates the issue of reducing traffic congestion in the system. The figure depicts that the nearly two-third of Scientists and more than half of urban planners / environmental engineers opined as the issue is very serious. Further, it indicates that less than 50 per cent of academicians and nearly half of the civil engineers and municipal administrators/policy makers believed that issue should be addressed seriously. The opinion about the objective of creating green economy in the system is presented in **Figure 05.** This figure reveals that, nearly 50 per cent of scientists, municipal administrators/policy makers believed that this issue should be addressed very seriously. Further, half of the academicians and less than 50 per cent of environmental engineers opined that the issue is serious. In addition, 42 per cent of civil engineers opined that it is somewhat serious in the system.

Figure 06 indicates clearly the opinion about the protecting the local, natural and environmental resource base. This figure reveals that nearly 75 per cent of academicians, more than 50 per

cent of urban planners and municipal administrators/policy makers of believed that the issue needs very serious attention. Further, more than 50 per cent of civil engineers, less than 50 per cent of academicians and environmental engineers opined that issue should be addressed seriously. The opinion about the objective on reducing sprawl is presented in **Figure 07.** This Figure reveals that more than one-third of scientists believed this issue as very serious. Further, it depicts that more than 50 per cent of academicians, 50 per cent civil engineers, more than 50 per cent of municipal administrators/policy makers and less than 50 per cent of urban planners/environmental engineers are opined this issue as serious. **Figure 08** depicts objectives on reducing air pollution in the system. This figure illustrates that nearly two-third of academicians, scientists, urban planners, environmental engineers and municipal administrators/policy makers opined the issue as very serious. Furthermore, it shows that more than half of the civil engineers believe that it needs serious attention in the system.

The opinion towards reducing dependency on fossil fuels in the system is summarized in the **Figure 09**. This figure reveals that 50 per cent of academicians believe this as very serious issue in the system. Further, more than two-third of civil engineers, more than 50 per cent of municipal administrators/policy makers, less than 50 per cent of environmental engineers and just above one-third of urban planners /scientists believed that as serious issue. **Figure 10** demonstrates the opinion about the involvement of local non-profit organizations in public planning process. This figure reveals that more than 50 per cent of scientists and civil engineers are somewhat serious. The majority of the respondents opined that there is less of their involvement in the public planning process in the system.

The opinion about guidance / control of study region's requirements by the local planning efforts is presented in **Figure 11.** This figure reveals that more than one-third of academicians and environmental engineers believed that they are not especially serious to guide/control the study region's requirements. Further, more than one-third of civil engineers opined that it is serious in the system. Furthermore, more than 50 per cent of Scientists, urban planners and municipal administrators/policy makers believed that it is somewhat serious in the system.

Figure 12 illustrates the opinion about new urban development on a form of compact and mixed use in the study region. This figure reveals that more than 50 per cent of municipal administrators/policy makers, nearly 50 per cent of the urban planners and one-third of environmental engineers believed that it is serious issue and very much essential in the system. Further, it explains that more than 50 per cent of civil engineers, more than one-third of academicians and scientists opined that it is somewhat serious in the system.

The opinion towards the awareness of fuel poverty in the system is summarized in the **Figure 13.** The authors have made an attempt to establish level of understanding about the spending towards energy from their income and the quantum of energy consumption in the system. The results demonstrates that 100 per cent of civil Engineers and academicians well aware of fuel poverty. Remaining category of respondents, scientists, urban planners, environmental engineers and municipal administrators/policy makers are more than 75 per cent aware the same. Therefore the awareness towards spending on urban energy among the survey respondents is sound in the system.

Figure 14 illustrates the opinion about enactment of comprehensive legislation for reductions in GHG emissions. All six categories underline the importance (more than 70 per cent) believed that, for all nations, the equitable responsibility is required to cater the needs of Kyoto Protocol. The opinion of the respondents reflected the expected period of enactment of comprehensive legislation for reduction of Kyoto gases and is presented in **Figure 15.** This figure demonstrates that majority of the all six respondents presumed that such comprehensive legislation for mandating the reduction Kyoto gases between the year 2015 to 2020. Opinions on removal of restriction of Floor Space Index for achieving energy efficient urban development in the inner core area of study region are summarized in **Table 03** and **Figure 16.** The majority of the respondents believe that there is strong relationship between "sustainable and energy efficient urban development" and "removal of FSI" in the inner areas. The table 3 reveals that, the survey respondents evaluated their rating of 12 most influential parameters for achieving energy efficient

urban development in the system. Further, by considering their maximum score in each column of table 3, which will decide the rating of specific parameters. The table 3 demonstrates that the parameter "*Limiting the FSI restriction within the Carrying Capacity*" has been rated as number '**1**' and has been given highest priority. Accordingly the lowest priority is given to the parameter" *Choice of Individual preference - too high or too low density*" and rated as number '**12**'.

Further, researchers have made an attempt to identify the most compelling motivations for energy efficiency strategies in urban development in the system and the survey results are summarized in **Table 04.** The table 4 reveals that, the respondents have agreed to the suggested motivations and top five scores are highlighted. The chosen final set of motivations is to be adopted for enhancing the energy efficient urban development in the system. This table 4 clearly indicates that the top most priority is for "*Understanding Solar and Other Renewable Energy Incentive Programs by the Government*" with a maximum score of about 83 per cent. The least one is "*Understanding Solar and Other Renewable Energy Incentive Programs by the Private sector* ". Therefore, the study results show that all these selected five motivations are essential for achieving energy efficient urban development in the system.

The authors have attempted to prioritize the best character of four selected planning policies to be formulated for the community in the study region. The results of the survey respondents are summarized in **Table 05.** This table reveals that the *plan development process which included citizen involvement* is ranked one. *Technical and political plan development process* is ranked as two and *bottom-up collaborative visioning process by the Government* ranked three, for achieving sustainable and energy efficient urban development of the study region.

In conclusion, Energy is central to socio-economic well-being and also to meet environmental demand. Integrated planning approach in energy production and consumption of an urban system in sustainable way is indispensable for achieving energy efficient urban development. Energy plays vital role for improving human, social, economic, environmental conditions on one hand and on the other, it pollutes the environment and increase greenhouse gas emissions. Therefore, Energy for sustainable development must be visualized in social, economic and environmental dimensions, which is very much essential to achieve sustainable and energy efficient urban development in the system. It is important to understand the forces that shape the growing mega cities of the world, in order to mitigate the climate change and its consequences. This will pave the way for energy efficient urban development, through the guiding principles of sustainable development.

4. A MODEL OF ECO-WELFARE PLANNING FOR GREEN GROWTH AND SUSTAINABLE DEVELOPMENT

Based on the inferences of literature and survey results, the authors have made an attempt to understand the current state of knowledge about green growth in cities from the world cities experiences. The authors identified seven essential greening opportunities /challenges viz., *(i) Clean Energy, (ii) Mobility (iii) Buildings, (iv) Natural Resources Management, (v) Pollution prevention, (vi) Population Growth and (vii) Green Services* respectively for an urban system. These parameters are interrelated /interdependent to each other and its functional integration calls for a holistic approach toward green energy future for achieving eco-welfare in the system. Furthermore, the authors have made an attempt to understand their causal relationship with green energy future and developed a conceptual model to achieve desired outcomes of eco-welfare and green city, which are summarized in **Figure 17**

4.1. Clean Energy

As the locus of the major global energy use (IEA, 2008b), cities are increasingly taking action to influence the type and amount of energy consumption with policies to increase energy efficiency and to enable the transition to cleaner energy sources.

4.2. Mobility

The movement of people and freight in and around urban areas, while fundamental to the functioning of urban economies, can have substantial environmental and economic consequences. The transport sector is responsible for CO_2 emissions from fossil fuel combustion and a source of tremendous localised pollution pressures (OECD, 2008b and 2011).

4.3. Buildings

The built environment, in terms of building design and location, is responsible for a large share of energy consumption and greenhouse gas emissions in urban areas and faces challenges from anticipated climate impacts, including urban heat-island effects, flooding and related extreme weather events.

4.4. Natural Resources Management

Cities are heavily reliant on natural resources, such as water, open space, urban forestry, urban agriculture and local biodiversity, to sustain life and economic activity and provide other ecosystem service functions. Water and land resources are nevertheless under constant pressure from overexploitation and are often given lower priority in terms of public investment, when compared to transportation or economic development.

4.5. Pollution prevention, treatment and abatement

To manage air and water pollution and solid waste in urban areas, local, regional and national governments employ regulatory powers, information and advocacy techniques and direct expenditures (WHO, 2006).

i. *Air Pollution:* Air quality has a number of co-benefits, including effects on public health, and is heavily influenced by policies in other sectors.

ii. *Water pollution and wastewater management:* Wastewater management challenges can vary widely by country, and thus will require different policy responses. A large share of the population in many developing countries lacks access to sewerage infrastructure, suggesting that local governments could prioritise the development of infrastructure.

iii. *Solid waste management:* Solid waste management typically falls under the purview local government, which has considerable latitude in terms of how or who will collect waste, where and how it will be disposed of, and whether some waste will be targeted for recycling or reuse.

4.6. Population Growth

According to National Geographic Magazine, 2011, World population passed 7 billion persons during the year 2011 and it is currently growing at 1.2 per cent annually. The population of the world is expected to increase by 2.1 billion during the next 40 years, from 7 billion today to 9.1 billion in 2050. Therefore, the population numbers plays a vital role, which is deciding factor for energy demand on functional aspect and ecological footprint on spatial aspect of green cities of the world.

4.7. Green Services

Green service firms provide the essential support functions to deliver greener growth, often in the form of knowledge to design, finance, permit, build, and test or market green products and services, (UNEP, 2008 and 2011). These firms include:

i. *Planning, architecture and engineering firms*: many traditional architecture and engineering firms have developed units specialised in urban sustainability and specialised technologies designed to address greening challenges in cities.

ii. *Permitting and certification services:* Regulatory permitting has long been an area of specialisation for many firms, given the intricacies of permitting processes. With the advent of many green design and building energy efficiency labelling systems (*e.g.* LEED, HQE, BREEAM, Energy Star).

iii. *Environmental testing*: Environmental testing firms specialise in measuring the environmental pollution problems related to air, water and soil.

iv. *Brownfield remediation:* In cities with a long legacy of industrial pollution, brownfield projects can provide steady business opportunities for firms with expertise in soil remediation.

v. *Construction (including technology installation)*: Green building development also requires specialised building contractors with the ability to install more complicated energy- or resource-efficient technologies or specialised supply chain knowledge which makes procurement of certain products faster or cheaper

vi. *Project financing:* Cities with a large financial sector may opt to explore the green financial marketplace, where new financial instruments such as carbon credits, renewable energy certificates, and ESCO and green building project financing create opportunities for specialised knowledge

vii. *Eco-tourism:* Eco-tourism services can capitalise on consumer demand for recreational or sightseeing opportunities in or near a city, including beaches, sailing, bird watching, bicycling, golf, or hotels/resorts. Cities serving as gateway communities to national parks or areas of great natural beauty may have an advantage in this sector.

viii. *Farmers markets in urban areas:* Cities located near farming districts or interested in promoting urban farms may look to facilitate the development of farmers markets that sell high quality foodstuffs.

Green growth and sustainable development are integrated three pillars of sustainability i.e., Social, Economic, and Environment. This approach indicates that all the efforts of green energy/green growth converging at the focal point of social justice for a green city. Therefore, the authors have identified the above seven constraints and also recognized their functional integrity toward planning for eco-welfare. In view of the above, integrated planning approach through green energy pathway is very much essential to get the desired outcome of green city (Green job, Green Consumption and Healthy living) and act as Vitamin-G to reach the destination of sustainable urban development in the system.

5. SUGGESTED GUIDELINES FOR ECO-WELFARE AND MAKING ENRGY GREEN SYSTEM:

As cities keep growing because of urbanization, more and more cities are becoming congested. To make cities liveable for the citizen and to make their life beautiful, it has been the constant endeavour of the Government to encourage for green building, keep city pollution within the limit and to create sufficient green belt (Green Building Certification Institute, 2011).

5(a) Green Building is a philosophy of design and construction incorporates the following guiding principles:

(i) Using natural and manmade resources efficiently;

(ii) Considering the impact of buildings and development projects on the local, regional and global environment;

(iii) Reducing building footprint and development size;

(iv)Allowing ecosystems to function naturally;

(v) Conserving and reusing water; treating storm water on-site;

(vi)Maximizing the use of local materials;

(vii)Optimizing energy performance by installing energy efficient equipment and systems;

(viii) Optimizing climatic conditions through site orientation and design;

(ix) Integrating natural day-lighting and ventilation;

(x) Minimizing the use of mined rare metals and persistent synthetic compounds and volatile organic compounds;

(xi) Minimizing construction waste by reducing, reusing and recycling materials during all phases of construction and deconstruction.

5(b) Creation of green-space in cities, planning for creation of city green zones includes:

(i) Greening Commercial Corridors - This focus on landscape enhancements along strategic streets that can serve as a neighbourhood's economic lifeline

(ii) City Parks Revitalization-This focus on maintaining and beautification of existing parks in a city

(iii) Setting-up of New Community Gardens

(iv) Street Beautification Projects-creation of "Garden Blocks"

(v) Education and Training Opportunities – Courses and workshops help city dwellers beautify their communities through horticulture.

5(c) Apart from setting up green buildings, green covers, strategy for strict implementation of local emission control codes through green energy planning.

(i) Utilize sites to capture environmental benefits and preserve or create new open space;

(ii) Develop programs and policy to conserve potable water use, improve storm water management and "green" the city sewage waste water system;

(iii) Address city and regional transportation issues by encouraging transit-oriented development, improve public transit services and reduce dependency on individual automobile use;

(iv) Implement citywide energy conservation programs and incentives, encourage use of renewable, non-fossil fuel energy sources and improve city performance on meeting regional clean air standards;

(v) Promote the development of local, green manufacturing industries and the use of recycled content materials or renewable materials for building, operations, and supplies for city work.

(vi)Establish more extensive recycling program to include construction and demolition waste recycling;

(vii)Maintain city's sustainable development by integrating programs, such as in workforce development, economic redevelopment, and the public school system.

6. CONCLUSION

Since over 50 per cent of the world's population now lives in cities, the time to take the concept of "green cities" seriously has arrived in developing Asian nations. Managed well, human settlements can support growing concentrations of people, limit their impact on the environment, provide improved health and living conditions. Eco-welfare involves reference to the principles of distributive justice, sustainability and ultimately pivoted with green energy momentum towards green growth and sustainable development. Numerous constrains/initiatives that can be undertaken to make Green Cities a reality, which describes the dynamism of the cities that are currently undertaking such initiatives. A review of this work of intervention described in this paper, that cities may undertake to move toward environmental sustainability. How we live in cities is one of the biggest challenges we face. Green cities of the developed nations are the leaders as of now. The spirit of craft, innovation, community and originality has created a high-growth, low-carbon city- A Green city. The case study of Chennai Metropolitan city, India and its findings in this research work has proved beyond doubt, the need for the reduction of urban energy demand, in order to promote sustainable urban development, which will impact climate change.

Energy plays vital role in city's performance and functions towards the development of green system. For example, the human body considered as system (City) which requires clean energy through food for the efficient performance in the system. The apparent function of Vitamin-G in the system (human body) are (a) Necessary to growth and development, (b) Necessary to cell respiration, (c) Necessary in blood regeneration, (d) As growth stimulus, promotes normal repair processes and thereby delays senility and (e) Helps to lower blood pressure. Likewise, for making green cities, the authors' perception, research work and lessons learnt from world's green cities, led to the conclusion that green energy planning and its catalytic actions for eco-welfare, act as Vitamin-G for attaining sustainable urban development in the system.

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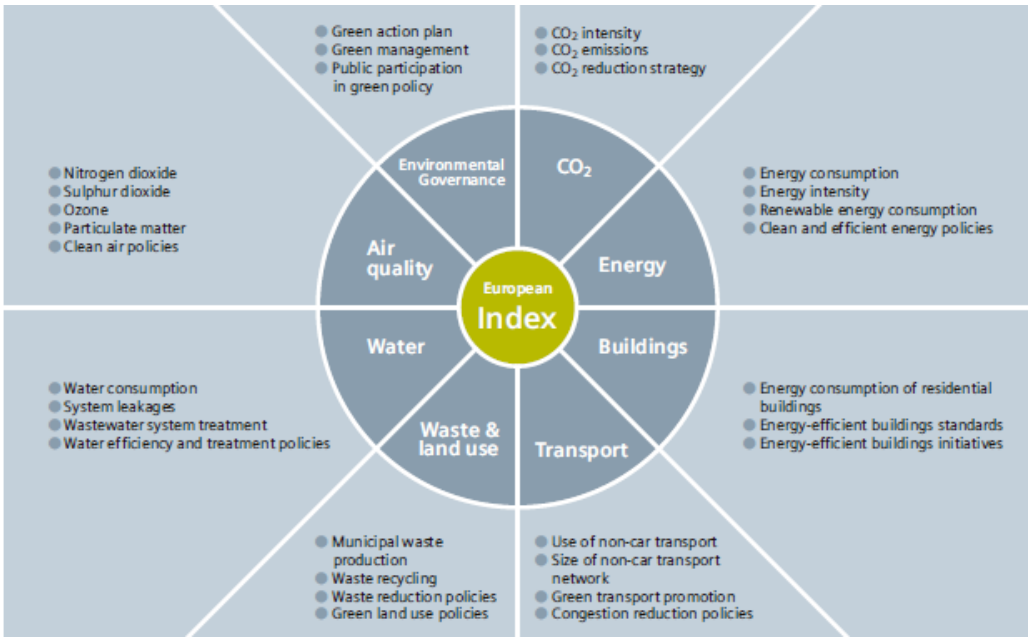

Figure 01: Green City Index methodology

Source: Report on Green City Index, Siemens AG, 2012

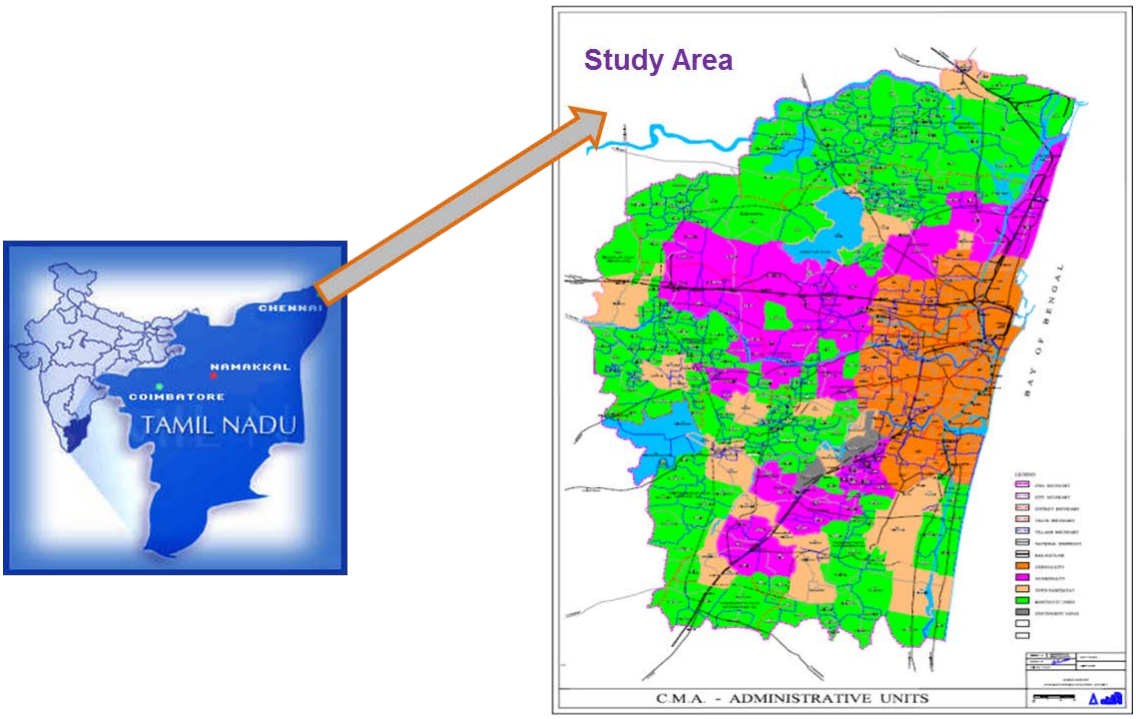

Figure 02: Geographical location of Chennai Metropolitan City, India

Note: The extent of Chennai Metropolitan Area (CMA) is 1189 Sq.km. CMA covering of Chennai City and its Urban Agglomeration, comprising of administrative divisions such as, Chennai city, 16 Municipalities, 20 Town Panchayats and 214 Village Panchayats in 10 Panchayat Unions.

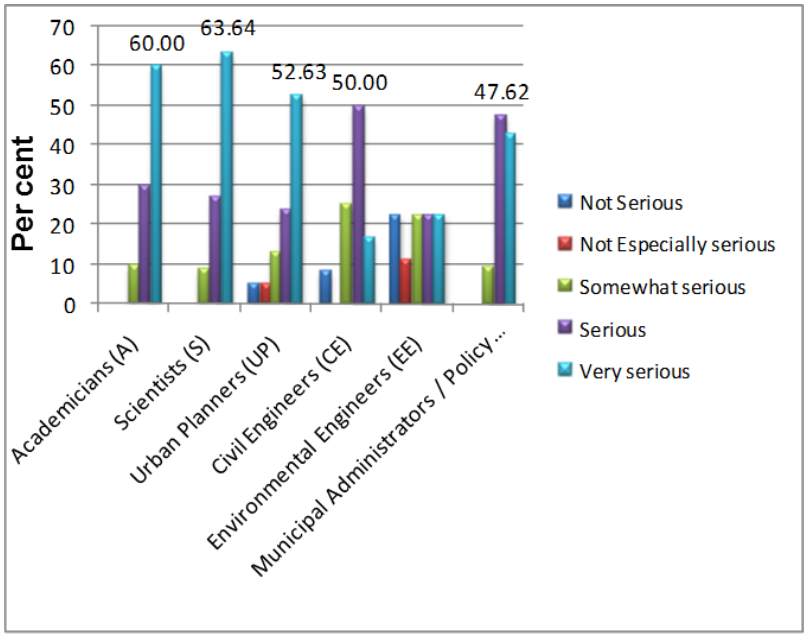

Figure 03: Respondents opinion on the local agricultural economy

Source: Compiled by the Authors based on the Primary Survey, 2013

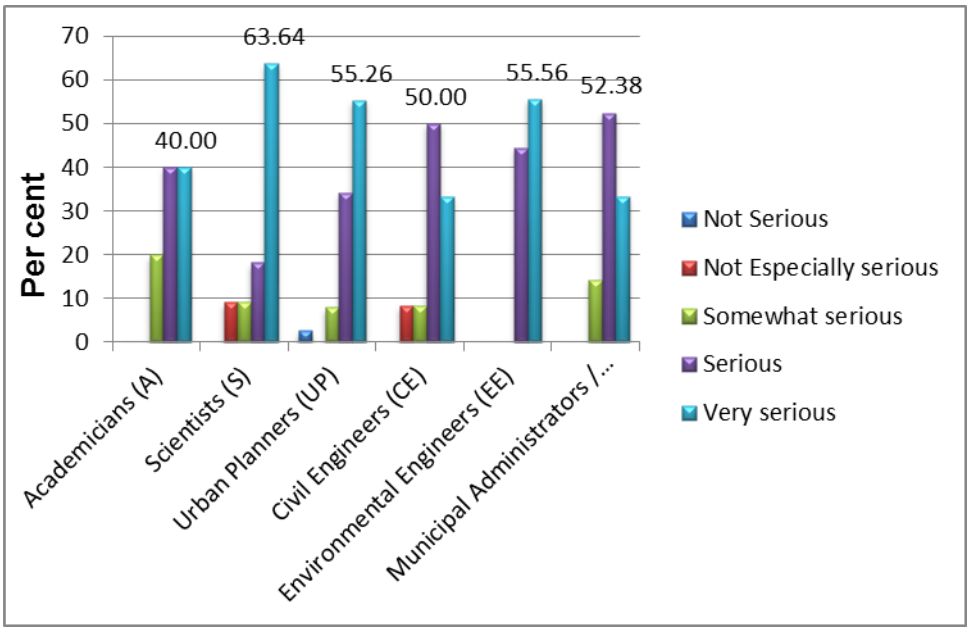

Figure 04: Respondents opinion on Reducing Traffic congestion
Source: Compiled by the Authors based on the Primary Survey, 2013

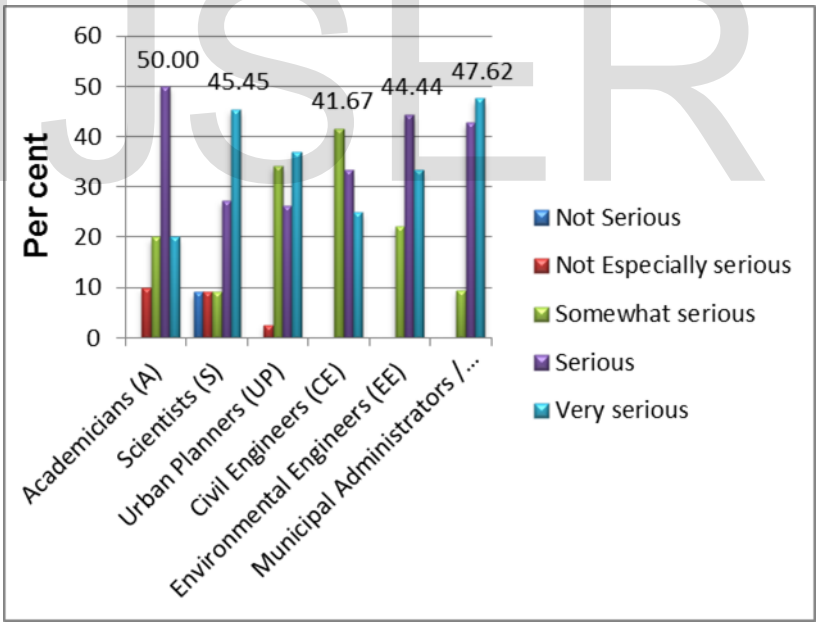

Figure 05: Respondents opinion on Creating "Green" Economy
Source: Compiled by the Authors based on the Primary Survey, 2013

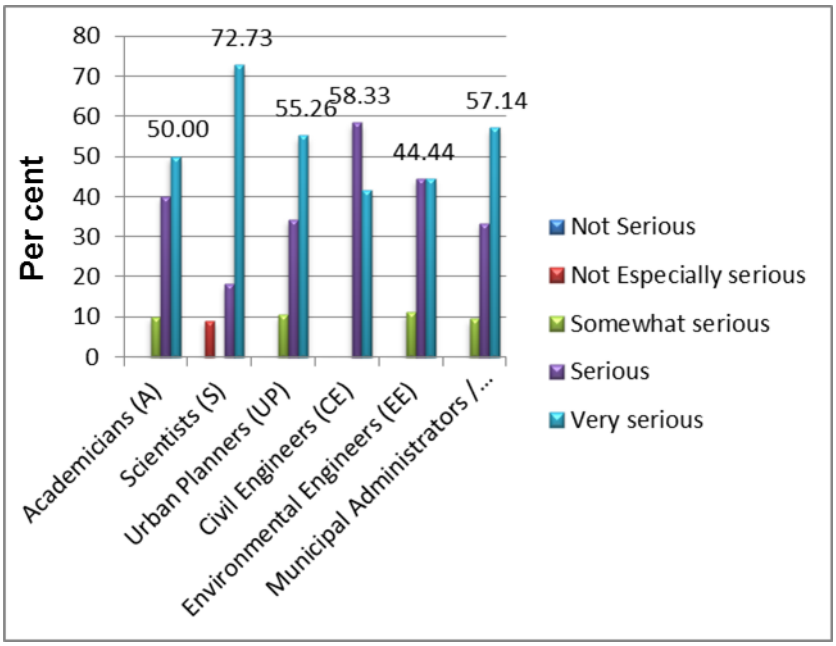

Figure 06: Respondents opinion on protecting the local, natural and Environmental resource base

Source: Compiled by the Authors based on the Primary Survey, 2013

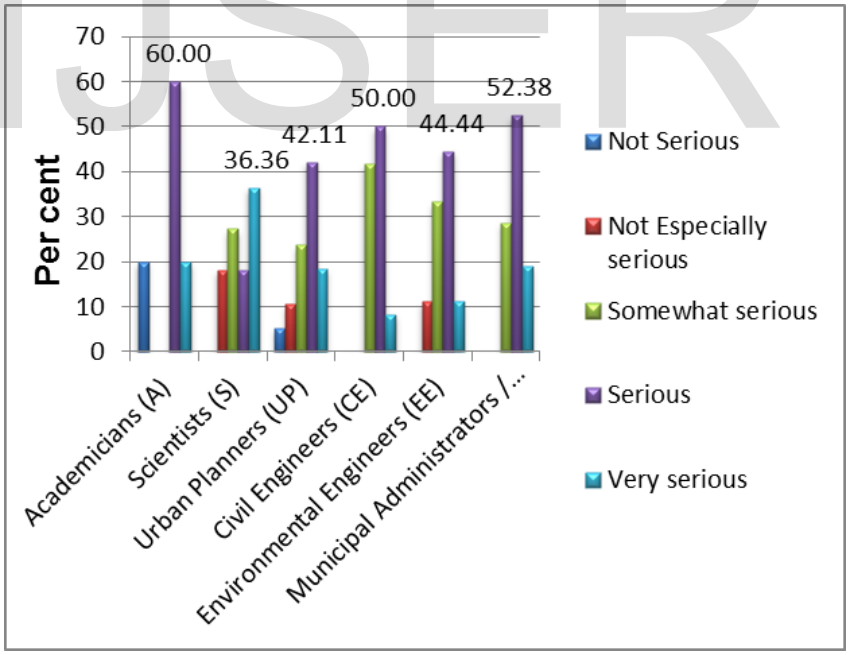

Figure 07: Respondents opinion on reducing sprawl

Source: Compiled by the Authors based on the Primary Survey, 2013

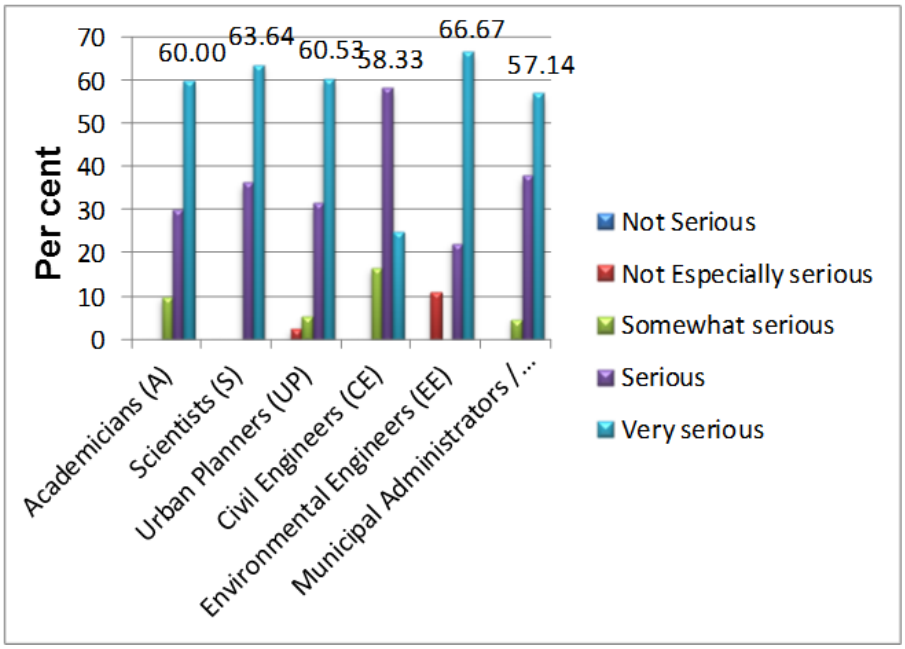

Figure 08: Respondents opinion on reducing air pollution
Source: Compiled by the Authors based on the Primary Survey, 2013

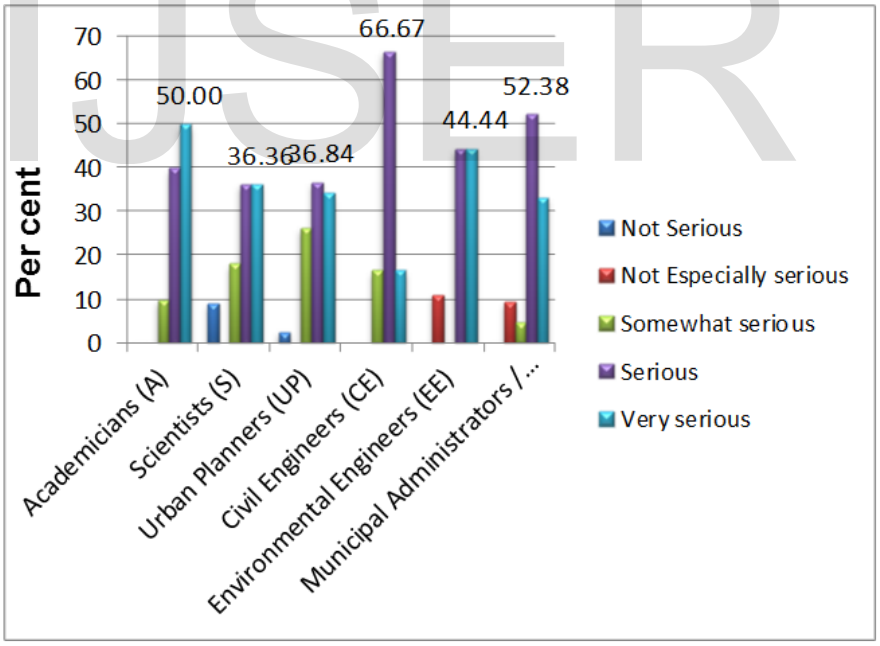

Figure 09: Respondents opinion on reducing dependency over fossil fuels
Source: Compiled by the Authors based on the Primary Survey, 2013

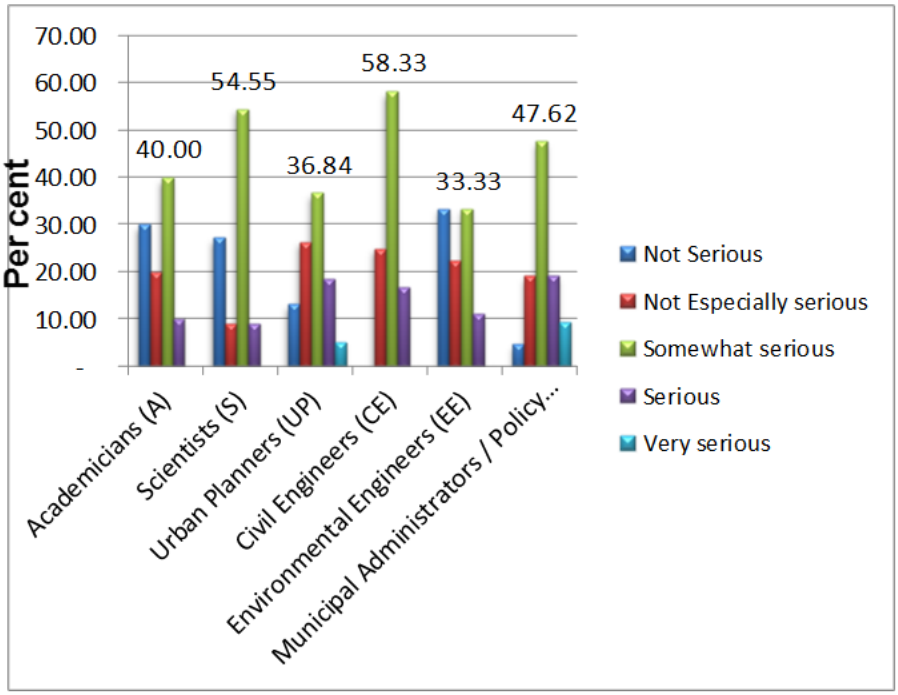

Figure 10: Respondents opinion on the involvement non-profit organizations in public planning process

Source: Compiled by the Authors based on the Primary Survey, 2013

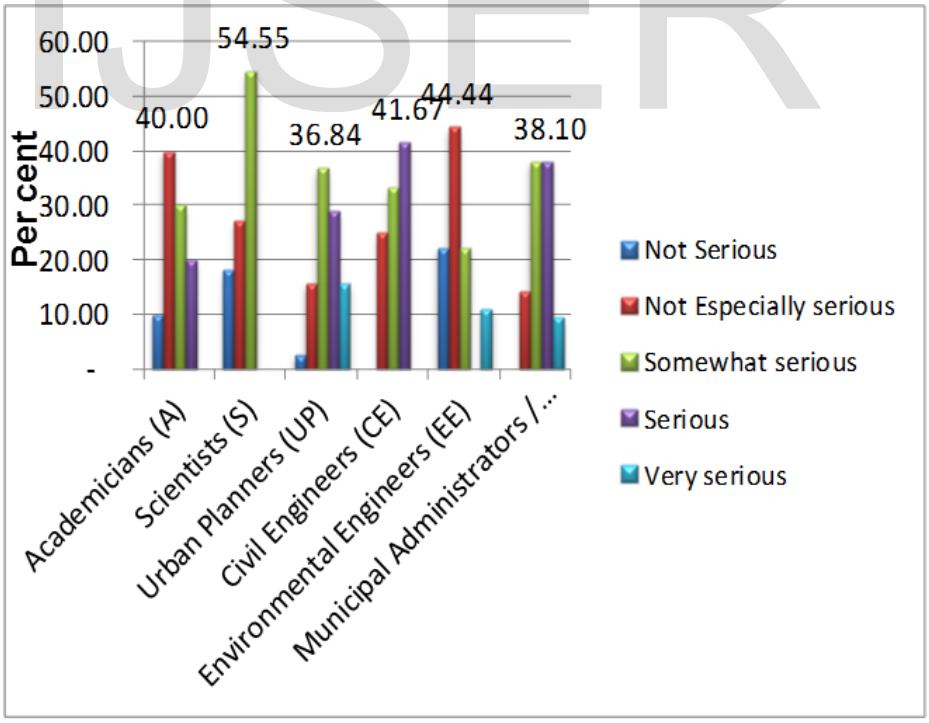

Figure 11: Respondents opinion about the guidance of study region's requirements by the local planning efforts

Source: Compiled by the Authors based on the Primary Survey, 2013

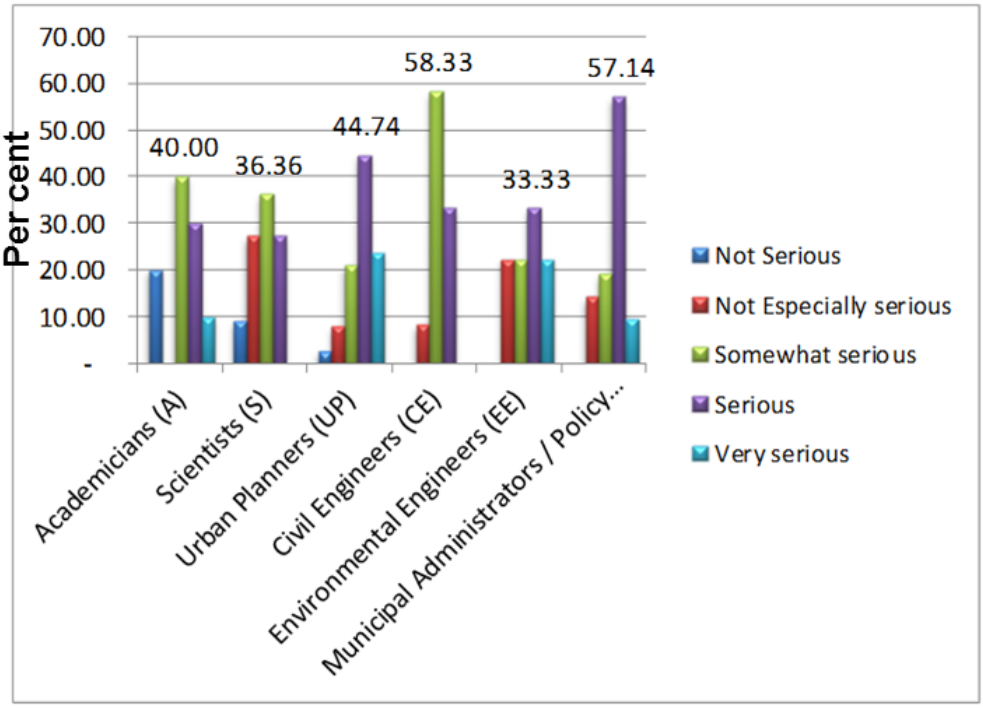

Figure 12: Respondents opinion about new urban development on compact and mixed use

Source: Compiled by the Authors based on the Primary Survey, 2013

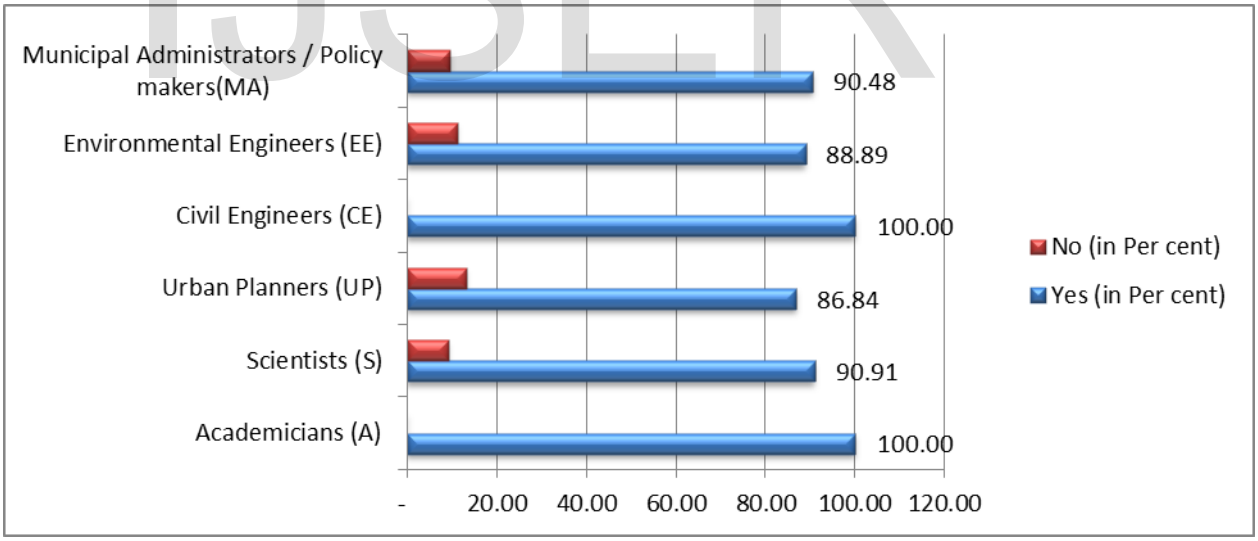

Figure 13: Respondents opinion on the awareness of fuel poverty

Source: Compiled by the Authors based on the Primary Survey, 2013

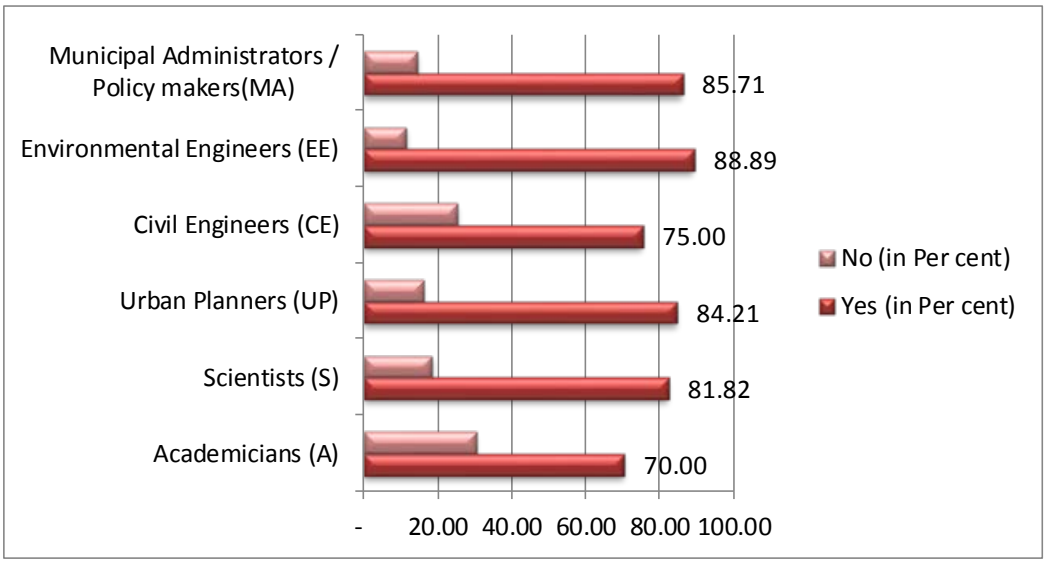

Figure 14: Respondents opinion on Enactment of comprehensive legislation for reductions in GHG emissions

Source: Compiled by the Authors based on the Primary Survey, 2013

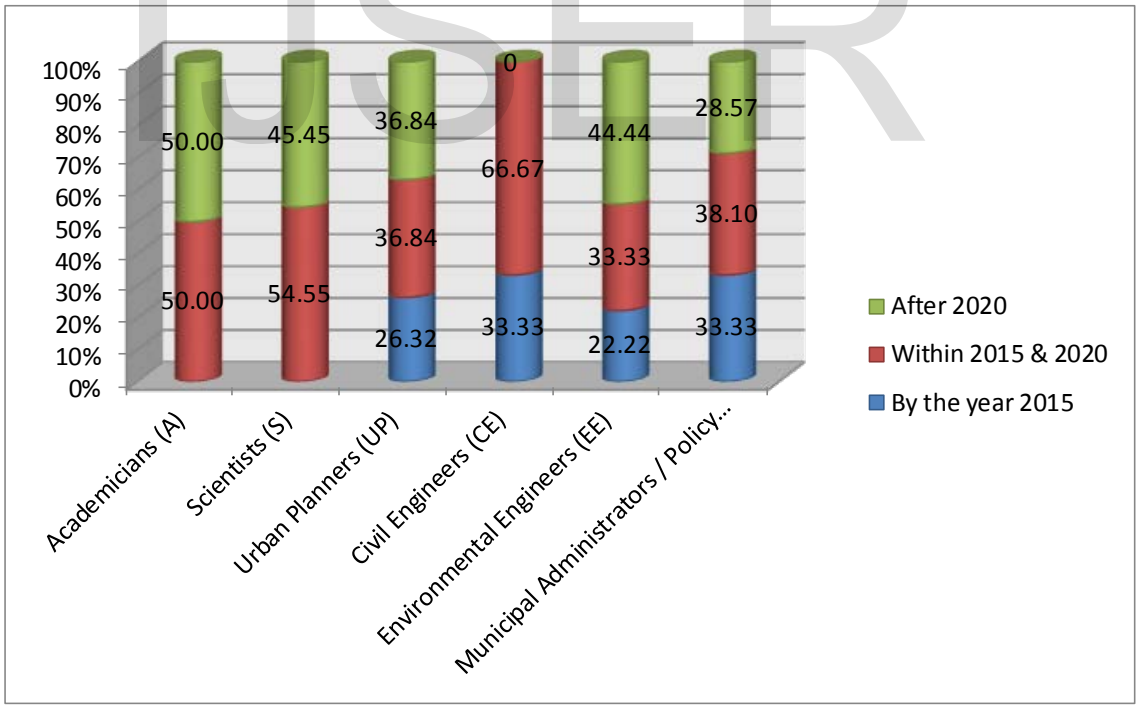

Figure 15: Respondents opinion about the enactment of comprehensive legislation for GHG emissions

Source: Compiled by the Authors based on the Primary Survey, 2013

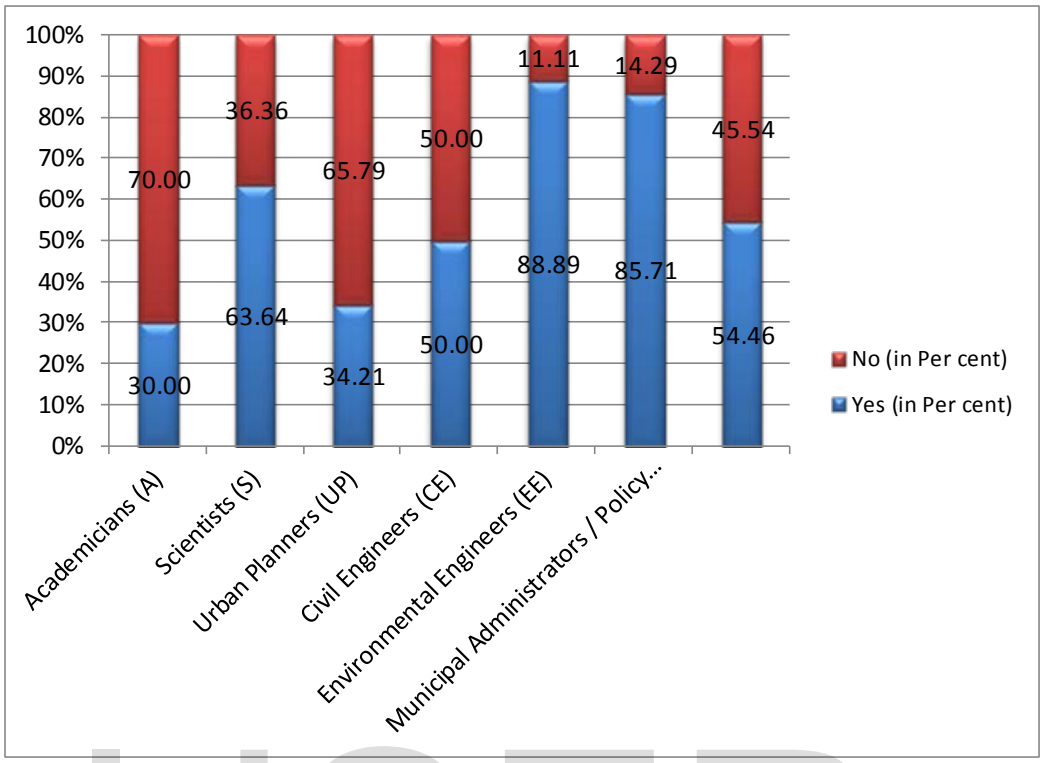

Figure 16: Respondents opinion on removal of restriction of Floor Space Index

Source: Compiled by the Authors based on the Primary Survey, 2013

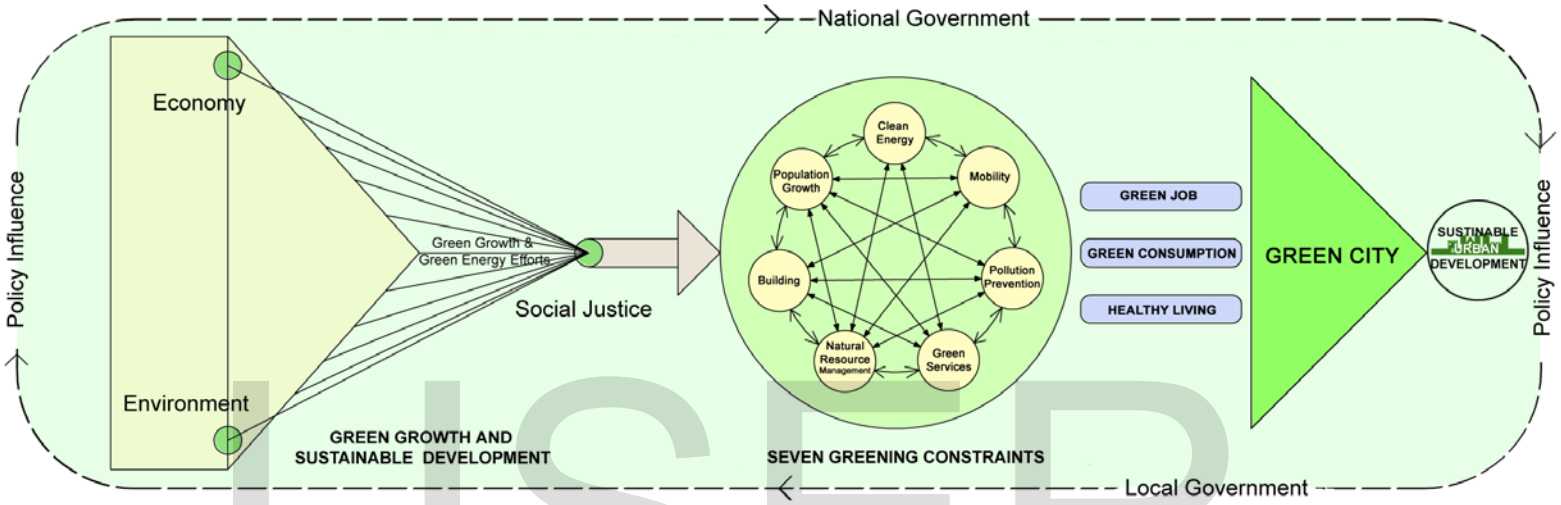

Figure 17: A Model of Eco-welfare for Green Growth and Sustainable Development along with their Greening Constraints of an Urban System

Source: Compiled by the authors based on the report on Green City Index, Siemens AG and Economic Intelligence Unit, Global Sherpa, 2012

Table 01: Estimated motor vehicle pollutant on road

S.No.	Pollutant	Amount
1	Carbon Dioxide(CO2)	3 Kilograms/Liter of Petrol
2	Carbon Monoxide (CO)	2.1 Gram / Kilometer
3	Hydrocarbons(HC)	0.26 Gram / Kilometer
4	Oxides of Nitrogen (Nox)	0.63 Gram / kilometer

Source: Energy Information File – Petroleum - Energy Victoria, Melbourne

Table 02: Distribution of Survey respondents based on specialization/occupation

S. No.	Specialization / Occupation	Respondents(Nos.)	Per cent
1	Academicians (A)	10	9.90
2	Scientists (S)	11	10.89
3	Urban Planners (UP)	38	37.62
4	Civil Engineers (CE)	12	11.88
5	Environmental Engineers (EE)	09	8.91
6	Municipal Administrators / Policy makers	21	20.79
Total		**101**	**100**

Source: Compiled by the Authors based on the Primary Survey, 2013

Table 03: Most influential parameters for energy efficient urban development by removal of FSI restrictions													
S. No.	**Influential parameters for energy efficient urban development**	**Rating**											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	Distance from the CBD area and the Housing Area						**5**						
2	Limiting the FSI restriction within the Carrying Capacity	**3**											
3	Transportation demand and transportation capacity		**2**	5									
4	Providing adequate Physical and Social infrastructures in the system				**0**		0						
5	Resulting loss of facilities of existing residents is considered										**2**		
6	Choice of Individual preference - too high or too low density											5	**3**
7	Transport lines (regular bus/rail routes)alter the directions of city growth									**0**			
8	Encouraging mixed land use development		1	**6**									
9	Distance from the work area to the housing area							**2**					
10	Discouraging private transport by introducing congestion charges										1	**4**	3
11	Increase the share of residents Who Walk, Cycle or take Public Transportation to Work w.r.to minimum standards (time)								**6**				
12	Relationship with FSI and Road width for limitation of FSI									**6**			

Source: Compiled by the Authors based on the Primary Survey, 2013

Table 04: Most compelling motivations for your energy efficiency strategies in Urban Development

Sl. No.	Strategies	Choice			
		Yes	Per cent	No	Per cent
1	Rising energy prices/need for more aggressive cost control	46	45.54	5	54.46
2	Local Governments involved in Energy Planning and Conservation	**67**	**66.34**	4	33.66
3	Corporates involved in Energy Planning and Conservation	11	10.89	0	89.11
4	Property Owners -Residential, Commercial, and Business	10	9.90	1	90.10
5	Understanding Solar and Other Renewable Energy Incentive Programs by the Government	**84**	**83.17**	7	16.83
6	Understanding Solar and Other Renewable Energy Incentive Programs by the Private sector	**57**	**56.44**	4	43.56
7	Part of a larger Local government commitment to reduce carbon footprint	18	17.82	3	82.18
8	Part of a larger Corporate commitment to reduce carbon footprint	9	8.91	**2**	91.09
9	Anticipation of carbon emission regulations in the near future	23	22.77	8	77.23
10	Improving energy performance as a way of demonstrating Corporate social responsibility	25	24.75	6	75.25
11	Developing new, more energy-efficient products and services	**82**	**81.19**	9	18.81
12	Technology advancement-efficiency efforts as gateway to wider productivity, innovation, and future growth	**69**	**68.32**	2	31.68

Source: Compiled by the Authors based on the Primary Survey, 2013

Table 05: Formulation of planning policies in the community

Sl. No.	Policies	Rating			
		1	2	3	4
1	On the basis of a planning document that was the result of an extensive, bottom-up collaborative visioning process by the Government	24	**55**	20	2
2	On the basis of a planning document that was the result of a plan development process that included citizen involvement	**63**	24	12	2
3	On the basis of a planning document that was principally the result of a technical and political plan development process	14	16	**62**	9
4	On the basis of ad hoc responses arising out of the situations	0	6	7	**88**
Total		**101**	**101**	**101**	**101**

Source: Compiled by the Authors based on the Primary Survey, 2013