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Original Paper

Efficient Utilization of Urban Fringe Area for Smart Urban Growth with Proposed Compact Township Design: A Case Study in Pabna District, Bangladesh

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Abstract

In last few decades Bangladesh has been facing major urbanization throughout different cities. Also, the urban growth of this cities will not follow any planning standard and increases haphazardly which causes serious urban sprawl. The Compact Township (CT) Design is considered one of the best planning strategies that can control the haphazard growth of urban sprawl and develop more sustainable cities which will benefit Bangladesh in the environmental, social and economic dimensions. Pabna district, Bangladesh faces major urbanization problem in last few decades because of its large amount of existing resources and opportunities. Ishwardi Thana in Pabna district has been selected as the study area for CT design. The aim of this study is to estimate the decadal urban growth of study area using Landsat images from 1996-2016 as well as Proposed an effective CT Design to control haphazard urban growth in the fringe area. From the image analysis using Arc GIS 10.4 and Erdas Imagine software, it's clearly noticeable that Ishwardi Thana has been facing more urban growth from any other Thana in Pabna District. Also, the study area consists of a significant amount of urban fringe area which is suitable for the development of CT. The proposed CT design in "Majdia site" situated in selected study area where Zoning techniques have been used in 245 acres area. To make the design production and transport-oriented the location is divided into high-class residential zone, middle-class residential zone, lower class residential zone and Mix use zone, etc. According to the design and estimation, the 245 acres area can provide accommodations about 25200 population with easy

accessibility of work and basic amenities. Considering all the condition, planning strategies of the CT is meant to guarantee a good accessibility and integrate collective transports, services and attractive public spaces to avoid the increase of the urban sprawl.

Keywords

urbanization, compact township, urban sprawl, sustainable city, Pabna district

1. Introduction

Urbanization refers to the process of economic, social and physical growth of towns and cities often at the expense of rural area (Aguilar, 2008; Michaels, Rauch, & Redding, 2012). This growth finds expression in an outward expansion of the built-up area into land in the urban fringe. Urban fringe area means where town meets village area also known as outskirts of the urban hinterland (Yeh & Li, 2001). Land at the urban fringe is often converted to urban use without any systematic development plan (Adesina, 2008). This unsystematic development of land is called haphazard development (Ukoje, 2016).

Bangladesh is losing agricultural land, bare soil, and water body every year in urban fringe areas for horizontal growth in housing (Jenks, 2002; Roy, 2009). Faster population and industrial growth are acting as driving factors resulting in intense sprinkle urban development that has negatively impacted planned urban growth and make urban areas less livable and less productive (Hasi Bagan & Yoshiki Yamagata, 2012). This type of scattered new development on isolated tract, separated from the main urban area through the vacant land is called urban sprawl (Rahman, 2016; Yeh & Li, 2001). Urban sprawl has been criticized for inefficient use of land resources and energy and large-scale encroachment on agricultural land and vegetation (Dewan & Corner, 2014; Roy, 2009). Smart growth concept has emerged one of the widely used concepts to fight against urban sprawl (Filion, 2003; Song, 2005). It stimulates a harmonize types of building and uses, diverse housing and transportation options. The concept represents an approach to urban design that promotes compact urban development (Dewan & Corner, 2014; Filion, 2003; Song, 2005).

A Compact Town (CT) is a self-governing and self-financing town that will provide all basic services to a population of about 20,000. Compact Town is generally attributed to high-density houses, hospitals, schools, markets, rural industries and local governmental units (Burton, Jenks, & Williams, 2003; Edrish & Ferdous, 2013; Kamruzzaman, Rahman, & Rahmatullah, 2010; Rashid, 2001). The CT will be largely self-governing and self-financing. The size is small enough for traffic within the CT to be directed by non-motorized vehicles and for motorized traffic to be thus isolated from the CT itself, making it well connected and environmentally friendly (Jenks, 2002; Rashid & Quayes, 2000). The CT general describe the idea which discuss about the combination of Integrated Rural Development with the idea of a “Growth Pole”, or its spatial equivalent, a “Growth Center” (Rashid & Quayes, 2000). The importance of CT in Bangladesh will gain popularity in few years because the population growth in Bangladesh is still considered to be a major problem despite enormous success in the area of family

planning (Kamruzzaman et al., 2010; Roy, 2009). Our land is limited and over the last few decades the population growth in rural areas has been almost quiet not because insufficient natural reproduction but as a result of large migration to the cities and the lacks urban infrastructure facilities in rural areas to support even the prevailing rural citizens (M. Z. Hossain, 2001; Kamruzzaman et al., 2010; Rashid & Quayes, 2000). At the same time, no major development and expansion activities of existing urban centers have been happened to accommodate for increasing population (Rashid, 2001). We need to develop the existing town centers either we can either allow the country to gradually move towards an impossible situation (Edrish & Ferdous, 2013; Rashid & Quayes, 2000). Instead of allowing the existing urban centers to bear the pressure of migration we could develop small urban centers in the form of compact townships that would not only absorb willing migrants but also inspire other rural households to move to these compact towns (Burton et al., 2003; Kamruzzaman et al., 2010; Rashid, 2001; Rashid & Quayes, 2000).

To ensure effective utilization of urban fringe area and to promote sustainable urban development municipalities required accurate information on the extent and direction of urban growth (Dewan & Corner, 2014; Hai-long, 2005). As the population is increasing day by day the concerned authority should provide more time, attention and effort to manage urban sprawl to prevent the haphazard growth of city (Jat, Garg, & Khare, 2008). But the habit of practicing effective policies to manage rapid and large-scale urban sprawl in Bangladesh is absent. In this context, the object of this content to estimate the urban growth of Pabna district in last few decades to understand urban expansion dynamics and proposed an efficient Compact township design to ensure smart urban growth in Pabna District. The convergence of GIS and Remote sensing techniques has helped in quantifying and monitoring the urban sprawl phenomenon (Hai-long, 2005; Rahman, 2016). Characterizing urban sprawl pattern involves detection and quantification with appropriate scales and statistical summarization (Ahmed & Ahmed, 2012; Jat et al., 2008; Weng, 2002; Yeh & Li, 2001). The concept of Compact Township is relatively new in Bangladesh and the proposed design will can be apply for smart urban growth in any part of Bangladesh which ensure production and transportation oriented compact township design.

2. Literature Review

Edgar E. Ramirez in his article seeks how local government of Florida engage in smart growth related land use regulations. The study established that in Florida regional competition and cooperation have negative influence to adopt land use regulation that promote compact development (Lubell, Feiock, La Cruz, & Ramirez, 2009; Ramirez de la Cruz, 2009).

Due to the rapid urbanization at Randstad Holland in Europe occurred between the mid-1960s and the end of the 1970s urban sprawl started to the threatened green heart of the city (Dieleman & Wegener, 2004; Van Der Burg & Dieleman, 2004). Policy was designed to mitigate urban sprawl and the main focus of it was to establish growth centers. After the decay of old growth centers in 2000, Researchers thinks about new solution. They proposed compact city design which will be facilitated with both

residence and employment opportunities. This compact city is provided with strong and vibrant central city, walking and bicycle facilities, and public transport facilities, open space for recreation, environmental space and guaranteeing affordable housing for all. To provide affordable housing for all the design area was divided into three categories. High, medium and low-density area (Dieleman & Wegener, 2004).

Chris Couch and Jay Karecha studies about measures of controlling urban sprawl in Liverpool. They developed policies for controlling urban sprawl within the British planning system. And tried to evaluate the effectiveness of that policy in that region (Couch & Karecha, 2006). They proposed compact city and a city can be compact in three ways. By limiting growth through green belt, regulation on density and type of new buildings. Compact city design comprises both employment opportunities and residence for all classes of people. They understand the importance of the compact city to control urban sprawl and regulate market forces to produce more compact city. Study accept that there is a prima facie relationship between compact cities and sustainable development (Couch & Karecha, 2006).

Michael Neuman recognizes the problem creates by urban sprawl. The response to sprawl has been in the different form of compact city design. But the compact city is overcrowding. This paradox remains unsolved (Neuman, 2005). Neuman studies the intellectual origins of sustainability and studies whether compact city supports sustainability or not. And after analyzing from different dimension the studies reach a conclusion that compact city is more sustainable than sprawl (Innes, Gruber, Neuman, & Thompson, 1994; Neuman, 2005).

3. Method

3.1 Description of Study Area

Ishwardi Thana is considered for the study area which situated at the western part of the Pabna district in the northern part of Bangladesh. Ishwardi Thana was formed in 1949 and it was turned into an upazila in 1983 (Khan, Sakauchi, Sonoda, Washio, & Mori, 2003). Ishwardi Upazila (Pabna District) area 246.90 sq. km, located in between 24°03’ and 24°15’ north latitudes and in between 89°00’ and 89°11’ east longitudes (G. Hossain, Howladar, Nessa, Ahmed, & Quamruzzaman, 2010). It has 1 Municipality, 9 Wards, 26 Mahallas, 7 Unions, and 128 Mouzas and 124 Villages. Main water body includes Padma (Ganges), Kamala; and Pati Beel (Islam & Rashid, 2012; A. Kafy et al., 2015). Economically, Ishwardi Thana is the largest area of industrial concentration in Pabna district. It has been regarded as a model for regional development as the largest railway junction of Bangladesh is situated in this Thana. Due to this fact the study area is experiencing huge urban growth. But new development is disperse in nature. A lot of fringe area is available in this area that is suitable for compact township program. About 200-300 acres of land can be acquired without destructing any important structures. Only seven houses are standing within 200-300 acres of land (Field survey, February 2015). River erosion is not a problem in this area because of presence of proper crevasse.

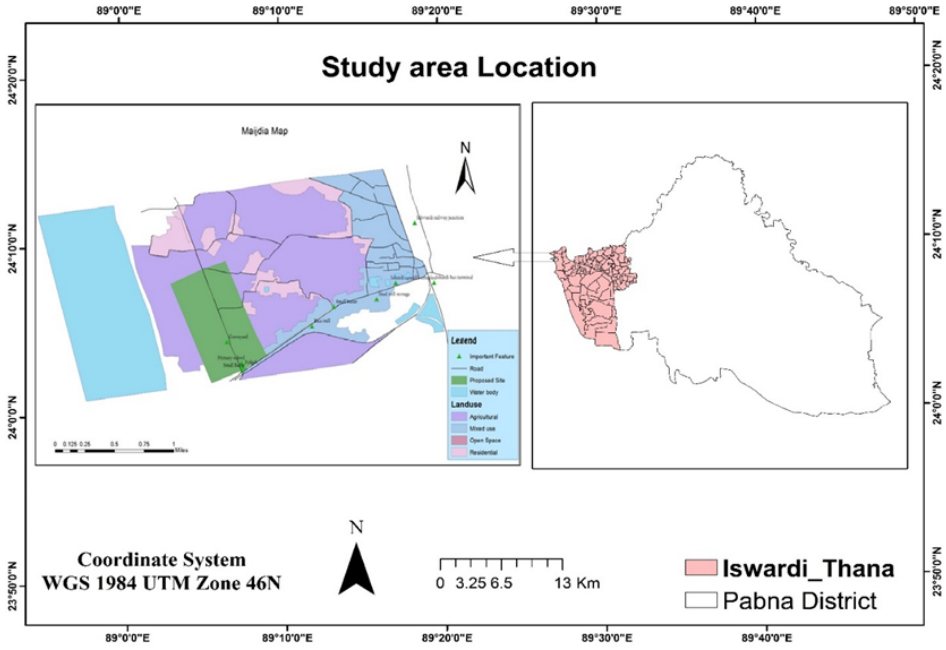


Figure 1. Study Area Map Showing both the Location and Existing Land Use

Figure 1 showing proposed site location for Compact Township and surrounding land use. Area in green color indicates the specific proposed area which is 245 acre. This site area is well connected with Ishwardi upazila through well-constructed road network. Location of important features (Small bazar, Rice mill and steel mill storage, etc.) and water body sighted in the map. The labor-intensive industries, in association with cash crop production increased the suitability of this area for production oriented compact township program.

3.2 Satellite Data Processing

Remotely sensed data and GIS techniques have been widely used to understand the dynamic phenomenon, such as urban sprawl/growth and analysis of land use change (Faisal, Kafy, & Roy, 2018; A.-A. Kafy, Rahman, & Ferdous, 2017). Because these techniques provide consistent and continuous imagery on either regional or global scale (H. Bagan & Y. Yamagata, 2012). The satellite imagery technique has the huge potentiality to provide accurate information to detect land use change pattern and urban sprawl (Rahman, 2016; Weng, 2002). In this study, to attain first objectives land use and land cover patterns for 1996 and 2006 were mapped by the use of Landsat Thematic Mapper data, which have a 30-m ground resolution (except for band 6 (the thermal IR band), which has a 120-m resolution) and OLI data is used for mapping land use and land cover patterns of 2016. ERDAS imagine and ArcGIS software (ESRI) have been used for image analysis. Image extraction, rectification, restoration, and classification of three satellite images (1996, 2006 & 2016) was done to find land use changes. To classify the Landsat images supervised signature extraction method is employed along with the maximum likelihood algorithm. The most effective bands in thematic mapper data for discriminating

classes are bands 2 (green), 3 (red), and 4 (near infrared). Along with that band 5 (Shortwave Infrared 1), band 6 (Thermal) and band 7 (Shortwave Infrared 2) is used for classification. During the process of classification of OLI data in the year of 2016, band 1 and band 2 are left out. 20 signature have been established to classify three years satellite image. By using the ERDAS Imagines' accuracy assessment utility Kappa coefficient have been generated. From the accuracy assessment the accuracy of the supervised image classification is estimated 87%, 92% and 93% for year 1996, 2006 and 2016 respectively. The land use is categorized into four categories for the purpose of understanding urban sprawl. The category includes (1) Water body, (2) Urban or built-up land, (3) Bare soil, (4) Vegetation (Faisal et al., 2018). In order to analyze the nature, rate, and location of urban sprawl/growth, both the statistical and graphical scenario are analyzed of the three satellite images.

3.3 Preparation of Detail Compact Township Design

To ensure an effective Compact Township Design to control haphazard urban growth in fringe area of Pabna District, authors proposed a sustainable compact township design which will create a holistic and sustainable human settlements. Disciplines of spatial planning, architecture, landscape architecture, road and street design and environmental design have been incorporate in this township design (Burton et al., 2003; Gibberd, 1970; Jenks, 2002). Sketch up and GIS software's have been used for accomplishment of compact township design. Plotting of various types of land uses have been done using Arc GIS tool "Create Fishnet". The design have been prepared for 245 acre area in Maijdia site which is situated in fringe area of the study area. Land uses have been allocated for different types of facilities on the basis of private residential land development rules 2004 (Table 1). 3-D visualization have been done for different zoning sites like higher class residential Zone, Middle class residential zone, Lower class residential zone and Mix use zone using Sketch up 15 software .

Table 1. Space Allocation of Various Amenity Facilities in CT Design

Community Services	Area In acres for 25200 thousand population
Education	
Nursery	1.6
Primary school	1.6
Secondary school	2.0
College	1.6
Health	
Small clinic	0.8
Utility & community services	
Religious services	0.8
Recreation	
Play-ground	1.6

Park	2.4
Commercial	
Market/kutcha bazar	0.8
Roads	
Residential roads	6.8

Source: Private Residential Land Development Rules, 2004.

4. Result and Discussion

4.1 Land Use Change Analysis for Pabna District

Figure 2 describe a spatial land use and land cover change map of Pabna district between 1996, 2006 and 2016. In Figure 2, a significant expansion of buildup Area (the red area) can be detected during the time period. In 1996, the buildup area was 8%, water body was 17%, bare soil 44% and vegetation 31%. In 2006 buildup area increased up to 18%, more than doubled. Vegetation area increased up to 36%. However, on the opposite, the area of water body and of bare soil decreased. The area of water body in 2006 is about 16%. Not a significant decrement in this type of land use. And bare soil decreases up to 30%. In 2016, buildup area again increased in respect to 2006. The buildup area increased up to 20 percent. That's indicating increase in buildup area is a continuous process. The area of buildup land use is increasing from decade to decade. And water body decreases up to 12 percent. Bare soil increases up to 37 percent and Vegetation dropped by 31 percent.

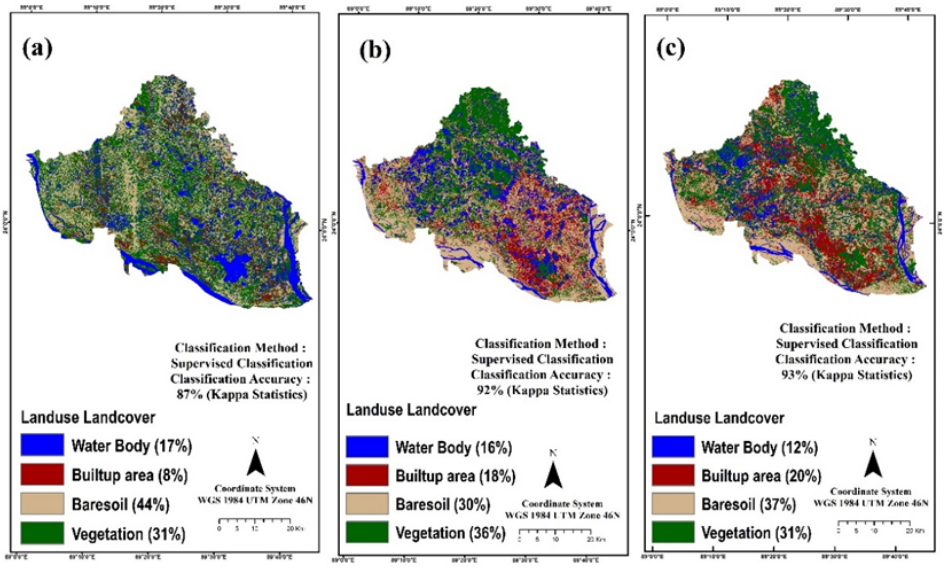


Figure 2. Land Use Map of Pabna District in 1990 (a) and in 2006 (b) and in 2016(c)

Figure 2 demonstrates that Pabna district has experienced dramatic urban expansion over the time period. The buildup area significantly expanded in such a short time might relate to increase in population. In 2000, the overall population of Pabna district was 2,176,270 (BBS, 2001), while the population increased up to 2,818,000 in 2016. Industrial setup can also be related to urban sprawl. The economic situation of Pabna district is boosted up due to the establishment of different industry like cottage industries of Jamdani (Chowdhury, 2011).

The Figure 2 clearly shows that the distribution of buildup area changes to multinuclear in 2016 from mononuclear in 2006. Outward expansion of buildup area of new development went almost in every direction and created several nuclei. This indicates the built-up area grows much dispersed in 2016 than in 2006. Which means the degree of sprawl became higher over the time period.

Paban district have been experienced rapid urban growth in last few decades. From the Table 1 it's noticeable that urban area expand more than double compare with year 2006. Waterbody and Agricultural & Vegetation land decrease gradually with every decades (Table 1). This situation very alarming for Pabna district and this district need smart urban growth city planning. To fulfill the smart growth we propose a transportation and production oriented compact township design in most urbanization happened part of Pabna district. After reconnaissance survey the suitable location was found in Ishwardi thana fringe area. The land use pattern and design of compact city will be discuss in the following sections of the paper.

Table 2. Area of Different Land Use in Pabna District

Land use	1996 (km^2)	2006 (km^2)	2016 (km^2)
Waterbody	413	382	287
Urban Area	193	434	479
Agricultural & Vegetation land	1047	834	761
Bare Soil	727	730	853
Total	2380	2380	2380

4.2 Land Use Change Analysis for Ishwardi Thana

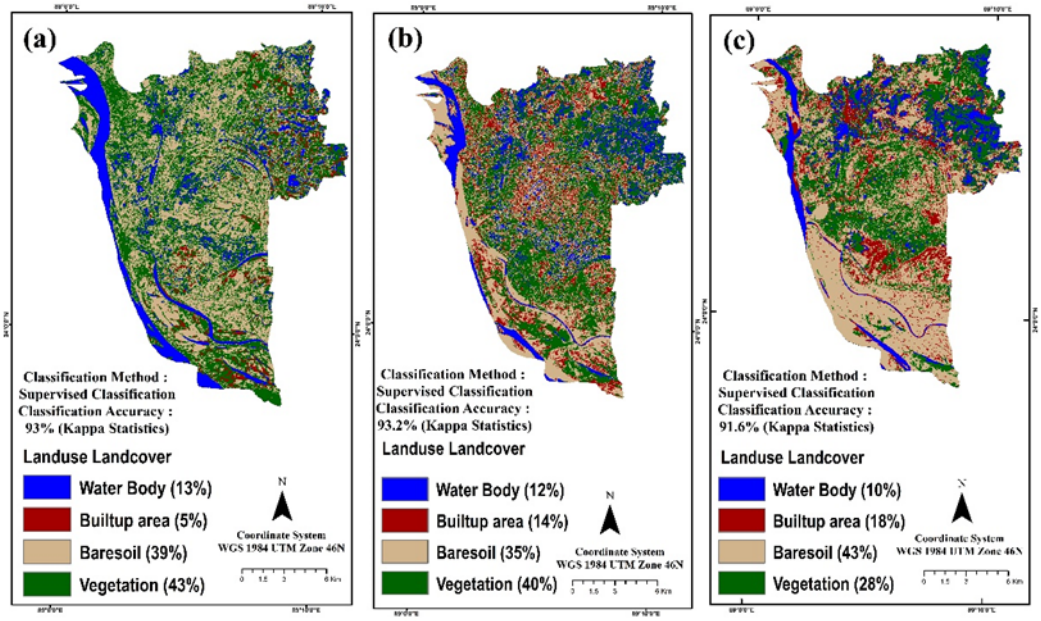


Figure 3. Land Use Map of Ishwardi Thana in 1990 (a) and in 2006 (b) and in 2016 (c)

Figure 3 is a spatial land use and land cover change map of Ishwardi Thana between 1996, 2006 and 2016. Figure 3 also showing significant expansion of buildup Area (the red area) during the time period. In 1996, the buildup area was only 5%, water body was 13%. In 2016 buildup area increased up to 18%, more than three times. To control haphazard growth of this district Ishwardi Thana is selected to design compact city. This Thana significantly experienced urban growth over the period. From the Table 2, it's clearly noticeable that urban area expand rapidly in space of 20 years in Ishwardi thana. Urban area expansion is 4 times compare with year 1996. With the expansion of urban area the Agricultural & Vegetation land decrease rapidly and area of Bare Soil increase respectively. People start to fill the Agricultural & Vegetation land and water bodies for the purpose of their residential or commercial activities.

Table 3. Area of Different Land Use in Ishwardi Thana

Land use	1996(km^2)	2006(km^2)	2016(km^2)
Waterbody	34	30	27
Urban Area	12	37	48
Agricultural & Vegetation land	113	103	74
Bare Soil	101	90	111
Total	260	260	260

4.3 Compact Township Zoning Approach in Maijdia Site

Land use zoning is very effective method to identify the best fitted design for any area. The zoning technique have been applied for the compact township design in Maijdia, Ishwardi. Total area of land of the study area is 245 acres.

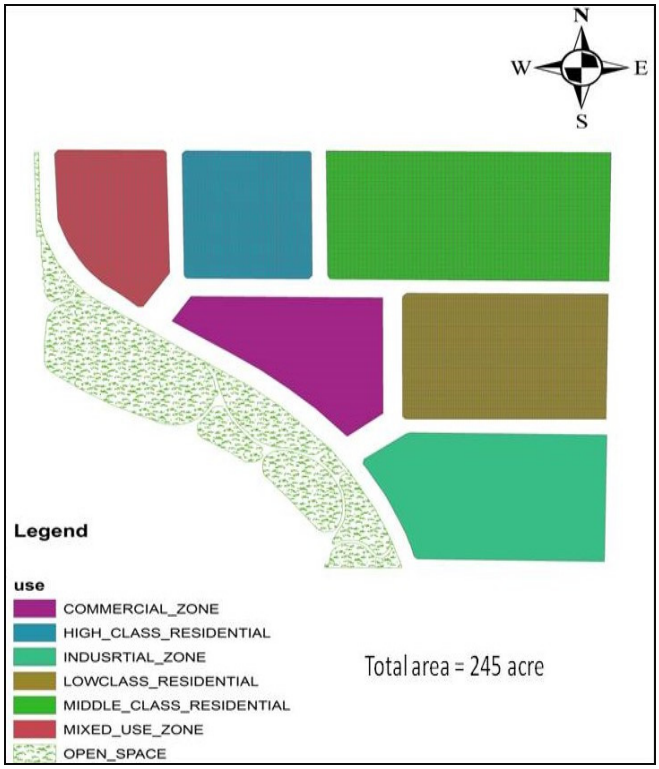


Figure 4. Zoning of Study Area for Compact Township Design

The total area is categorized by on the basis of different types of land uses like higher class residential Zone, Middle class residential zone, Lower class residential zone and Mix use zone, etc., to make the compact city sustainable in future, the design also incorporate industrial zone. Open space is a very crucial part and maintain the ecological balance of environment. The design also proposed a sufficient amount of open space which will make the proposed compact township design more sustainable and effective in future (Figure 4).

Among the different types of land use, Commercial land use is dominant than other types of land uses. The area of land for higher class residential Zone, Middle class residential zone, Lower class residential zone and Mix use zone are nearly the same amount. Open space is occupied 4.12% of land (Table 3).

Table 4. Land Use % in Proposed Compact Township Design

Zone	Area in Acre (%)	Population
Higher class residential Zone	30 acre (12.24%)	4500
Middle class residential zone	35acre (14.28%)	7200
Lower class residential zone	35acre (14.28%)	10500
Mix use zone	35 acre (14.28%)	2200
Industrial zone	30 acre (12.24%)	800
Commercial zone	40 acre (16.32%)	-
Open space	10 acre (4.12%)	-
Road	30 acre (12.24%)	-

4.4 Design Description of Compact Township

4.4.1 Description of 2-D Layout Design

Figure 5 describe the 2-D layout design for the *Maijdia Site* area. The design serves more than 25 thousand population in 245 acres area. The figure shows the incorporation of various land uses which make the design more sustainable for the future. The design will support the smart growth of increased urban growth in Ishwardi Thana.

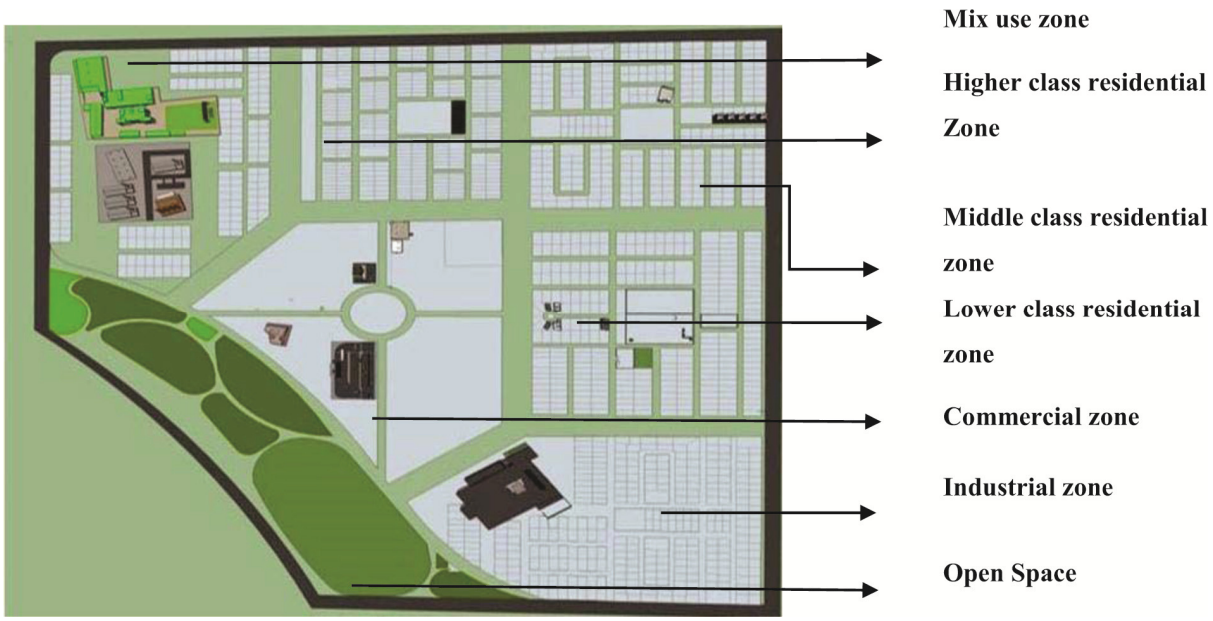


Figure 5. 2-D Layout Design of the Proposed Compact Township in Maijdia, Ishwardi

4.4.2 Description of Higher Class Residential (HCR) Zone Design

Higher class residential zone has covered 30 acre (12.24%) area among the total amount of 245 acre area. In this zone, there are different types of facilities which are Primary and secondary school, collage,

hospital, community center, Neighborhood Park, mosque, post office, etc. (Figure 5 and Table 4). 4 story (5 katha) super category building with ground floor parking. Number of plots occupied by resident: 150. Each floor is 326.5 square meters. Population = 150*30 = 4500 (5 person in a family). This area can be used for Public Open Spaces, Detached/Duplex/Compound Houses, Corner Shops, clinics, pharmacies (less than 250 m²) and Educational and Childcare facilities. This area cannot be used for Transportation for haulage, Commercial Development over 250m² and Crematorium or Cemetery (Figure 6).

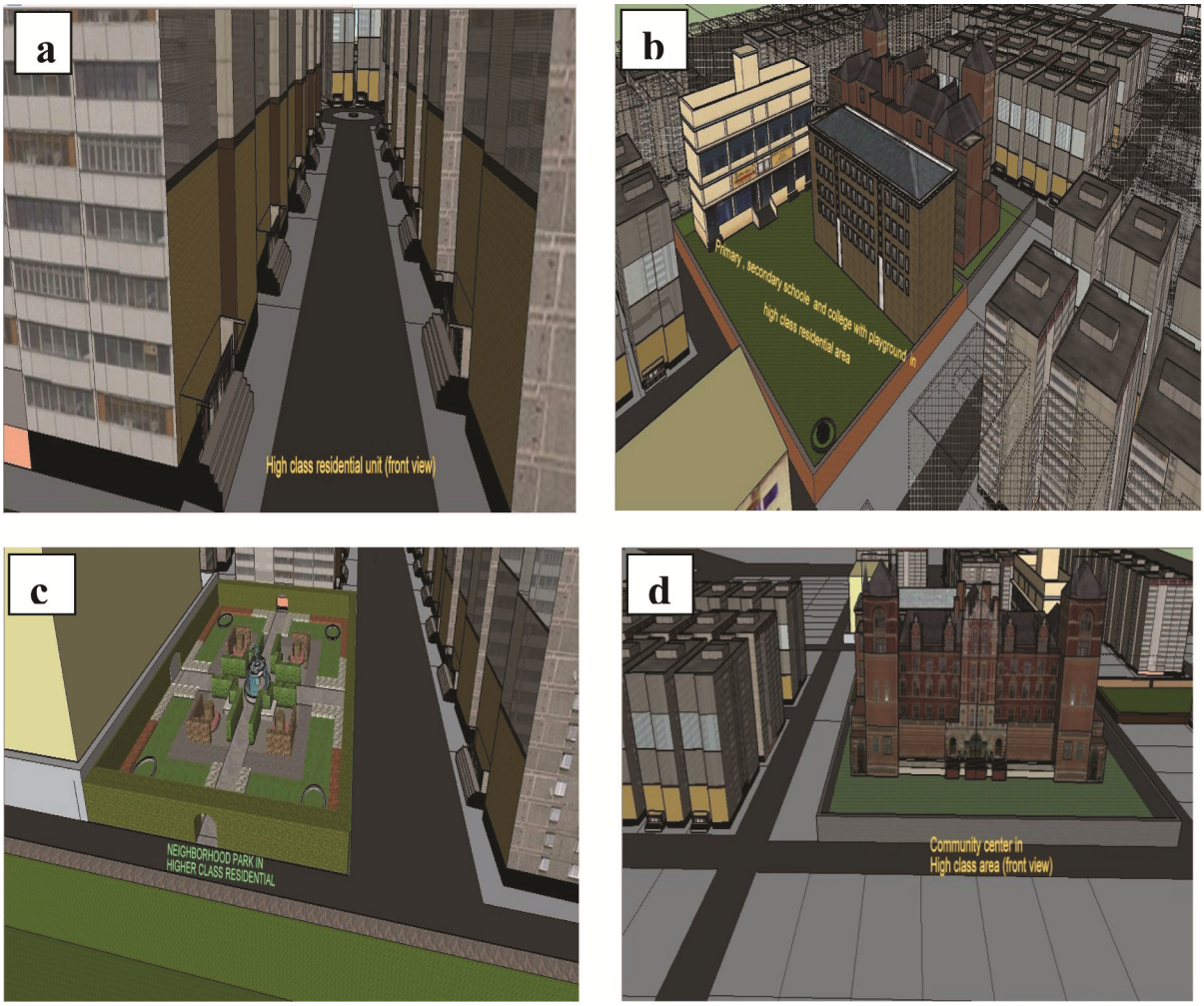


Figure 6. Design of Higher Class Residential Zone: a) Front View of HCR Unit; b) Scholl and College in HCR Unit; c) Recreational Spaces in HCR Unit; d) Community Centre in HCR Unit

4.4.3 Description of Middle Class Residential (MCR) Zone Design

Middle class residential zone has covered 35 acre (14.28%) area among the total amount of 245 acre area. In this zone, there are different types of facilities which are Nursery, Primary and secondary school, collage, hospital, community center, Neighborhood Park, mosque, post office, etc. (Figure 5 and Table 4). 5 story (4 katha) super category building with ground floor parking. Number of plots

occupied by resident: 180. Each floor is 267.56 square meters. Population = 180*40 = 7200 (5 person in a family). This area can be used for Public Open Spaces, Detached/Duplex/Compound Houses, Corner Shops, clinics, pharmacies (less than 250 m²) and Educational and Childcare facilities. This area cannot be used for Transportation for haulage, Commercial Development over 250 m² and Crematorium or Cemetery (Figure 7).

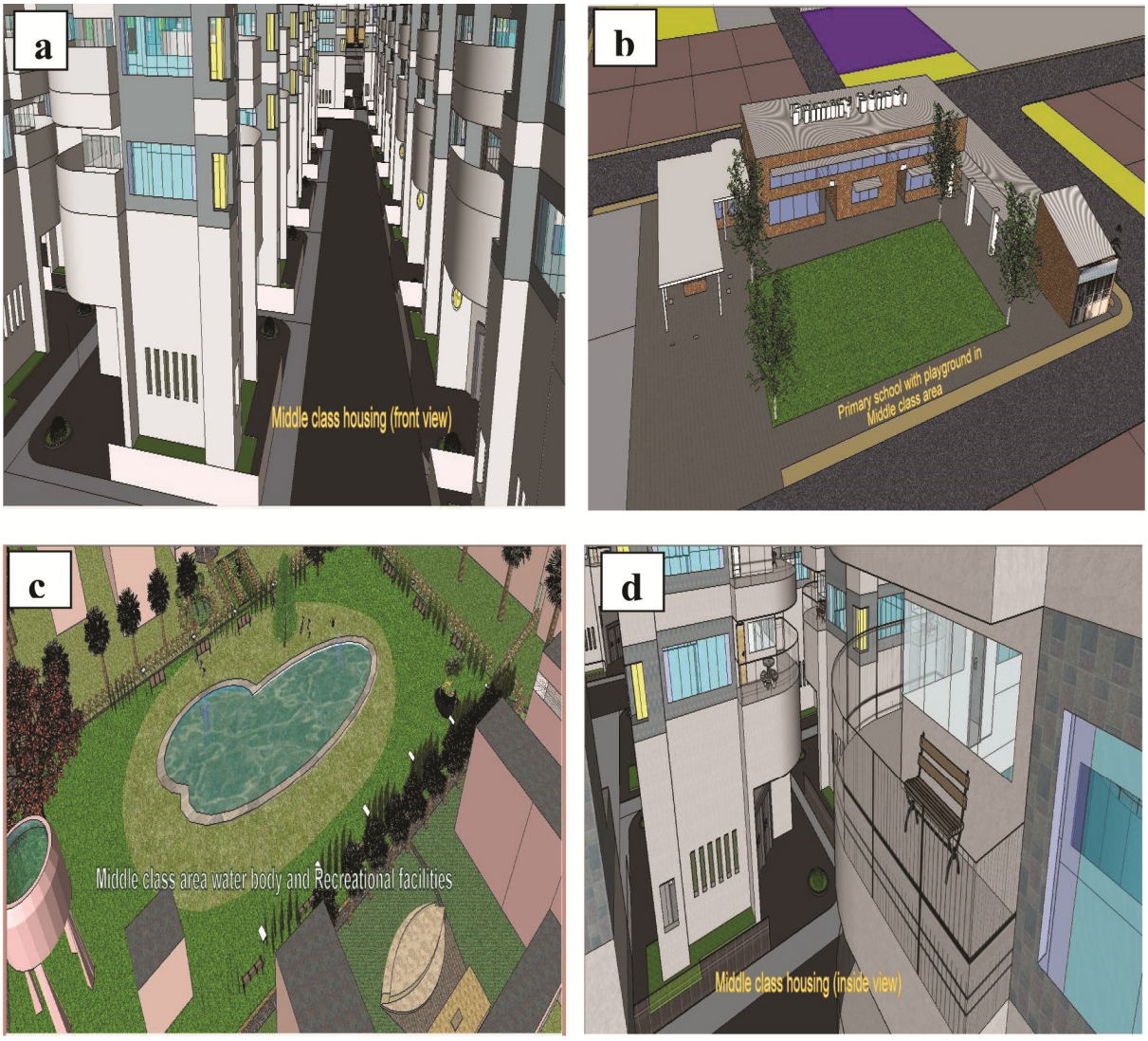


Figure 7. Design of Middle Class Residential (MCR) Zone: a) Front View of MCR Unit; b) Scholl and College in MCR Unit; c) Recreational Facilities in MCR Unit; d) Inside View of MCR Unit

4.4.4 Description of Lower Class Residential (LCR) Zone Design

Total area of lower class residential zone is 35 acre which is 14.28% of the total area. There are different types of facilities in the zone which are Nursery, Primary and secondary school, clinic, mosque, post office, market, etc. (Figure 5 and Table 4). 6 story (3 katha) standard category building. Number of plots occupied by resident: 210. Each floor is 200.67 square meters. Population = 210*50 =

10500 (5 person in a family) (BBS, 2011). This area can be used for Detached, Semidetached, Row & compound housing, Home business, Parks & Playground, Places of public worship, Clinic, Outdoor/Indoor Recreational Facilities, Primary, Junior High Schools, Public transport facilities and Market. This area cannot be used for Major commercial premises, Animal Husbandry, Cemetery or crematorium (Figure 8).

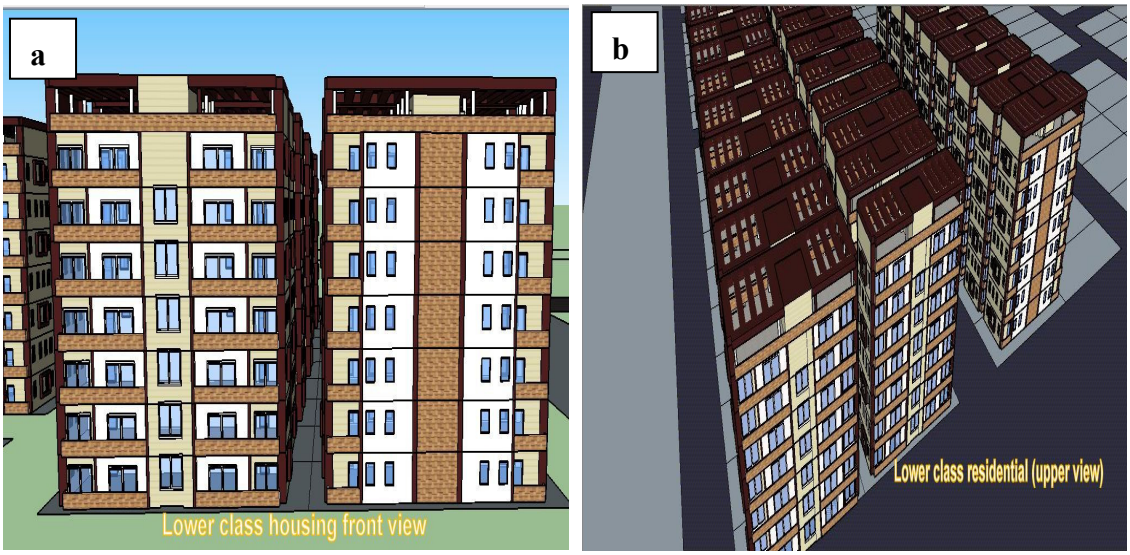
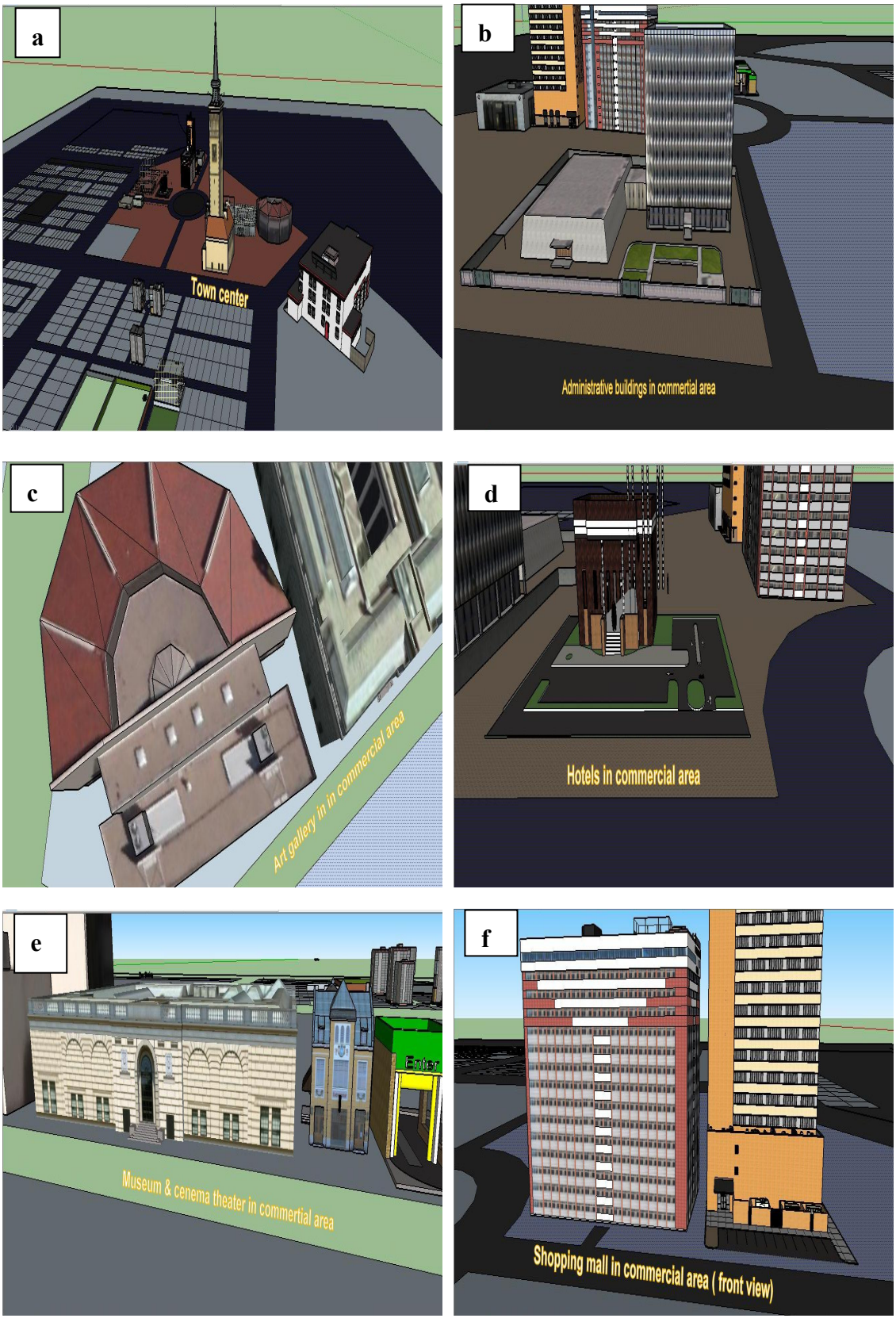


Figure 8. Design of Lower Class Residential (LCR) Zone: a) Front View of LCR Unit; b) Top View of LCR Unit

4.4.5 Description of Commercial Unit (CU) Design

Commercial zone is one of the most important zones because of the economic benefit. It has covered 40 acre (16.32%) area among the total amount of 245 acre area (Figure 5 and Table 4). In this zone, there are different types of facilities which are Hospital and pharmacies, Town center, Hotels and restaurants, Market, shopping mall, parking area, government office and Commercial office development. The town center is development in such way that creates the conditions which attract people, provide opportunity, ensure variety and choice and allow for transformation (Figure 9).


a
Town center
b
Administrative buildings in commertial area
c
Art gallery in in commercial area
d
Hotels in commercial area
e
Enter
Museum & cenema theater in commertial area
f
Shopping mall in commercial area (front view)

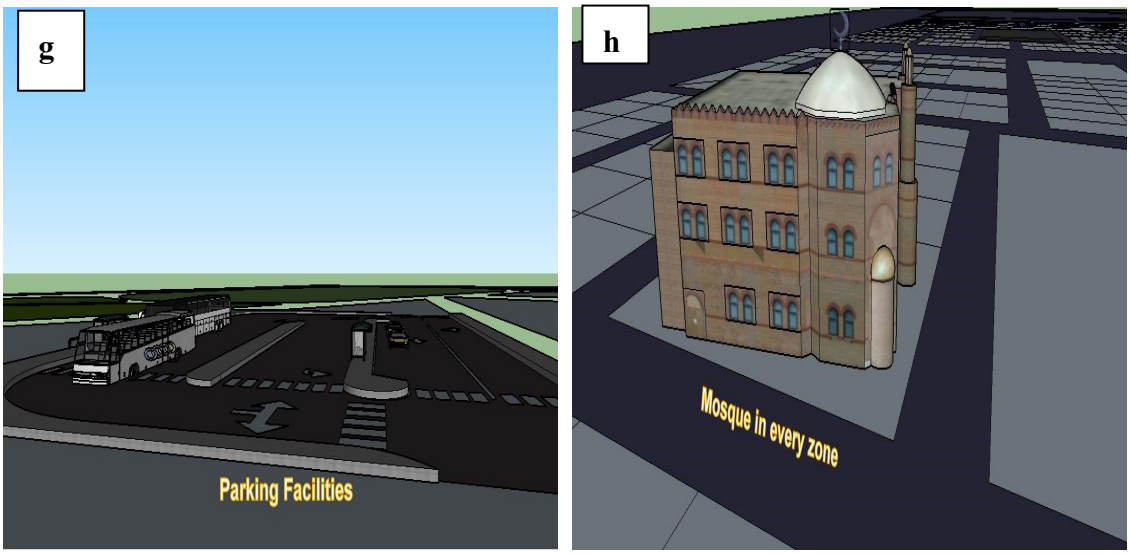


Figure 9. Design of Commercial Unit (CU) in Commercial Zone: a) Town Centre in CU; b) Administrative Building in CU; c) Art Gallery in CU; d) Hotels and Resturents in CU; e) Cinema Theater and Museum in CU; f) Multi Storied Shopping Mall in CU; g) Parking Zone in CU; h) Religious Structures in CU

4.4.6 Description of Industrial Unit (IU) Design

Industrial zone has covered 30 acre (12.24%) area among the total amount of 245 acre area (Figure 5 and Table 4). Land included in a Heavy Industrial zone is intended to accommodate a wide a range of industrial and related development including manufacturing, food processing, assembly of machinery, and heavy equipment, vehicles and appliances. It has located close to major roads and infrastructure to ensure that services are provided to a high standard and reliability. A limited range of retail, commercial office and warehousing will be permitted in the zone. Parking is provided in accordance with parking standards for the zone. Landscaping is provided along the frontage and adjacent to any development abutting a public open space area. Land in a Light Industrial Zone is intended for light industrial activities, particularly those using clean, low technologies to restrict air and noise offence. The sorts of industries that may be found in a light industrial zone might include those producing high value but low weight and volume goods, such as specialized electronic firms, IT based industries, jewelry, medical products, etc. In industrial zone there is some residential apartment also. People work in the area stay there. The industrial zone provides all the opportunities so that no one needs to go outside of the compact city for work (Figure 11).

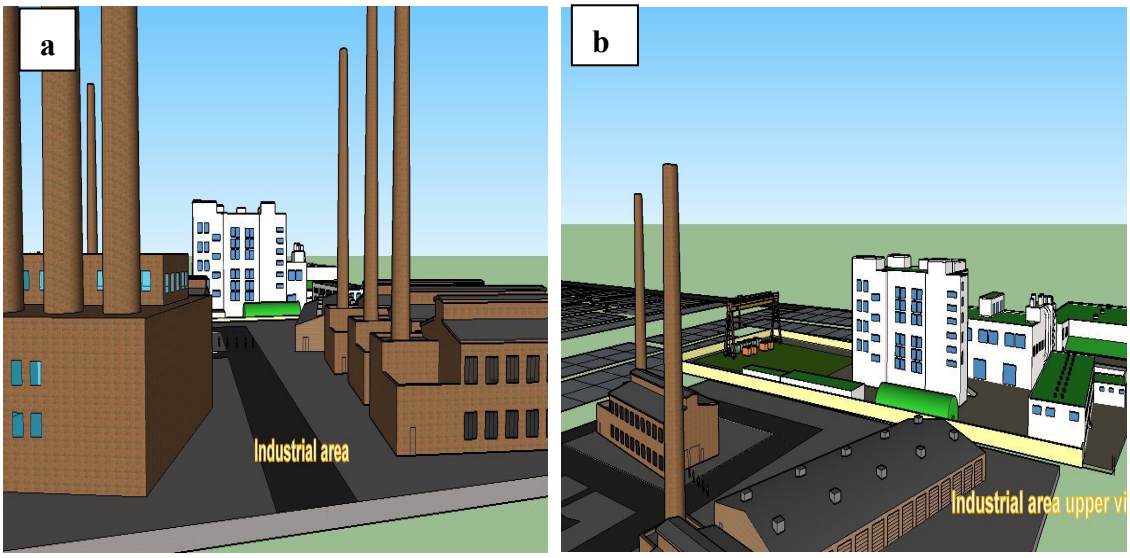


Figure 10. a) Front View; and b) Upper View of Industrial Unit (IU) in Proposed Compact Township Design in Maijdia Site

4.4.7 Description of Mixed Used (MU) Unit Design

The area of the mix use zone is 35 acre (14.28%) of the total area. In this zone, there are different types of facilities which are educational facilities, recreational facilities, hospital, administrative & commercial offices, post office and fire station etc (Figure 5 and Table 4).

5 story (4 katha) standard category building. Number of plots occupied by resident: 55. Each floor is 267.56 square meters. Population = 55*40 = 2200 (5 person in a family). This area can be used for administrative & commercial offices, markets, educational centre, car park, local market, local shops, service agencies, light industries, restaurant, libraries, government places of assemblies, post office. This area cannot be used for industrial development, repair works, dwelling at ground level, market over.

4.4.8 Description of Open Space Design

The quality of the public realm is determined by how well the public space is designed, built and maintained. In this design, open space covered 10 acre (4.12%) areas among the total amount of 245 acre area (Figure 5 and Table 4). Open spaces are created intentionally and scaled and configured to suit the functions for which it is planned. A major park will be provided to offer a full range of recreational opportunities. The park will offer areas of surface water management systems, and a significant component of community gardens. Native plants and non-native plants used in landscape which support native species of insects, birds and other wildlife (Figure11).

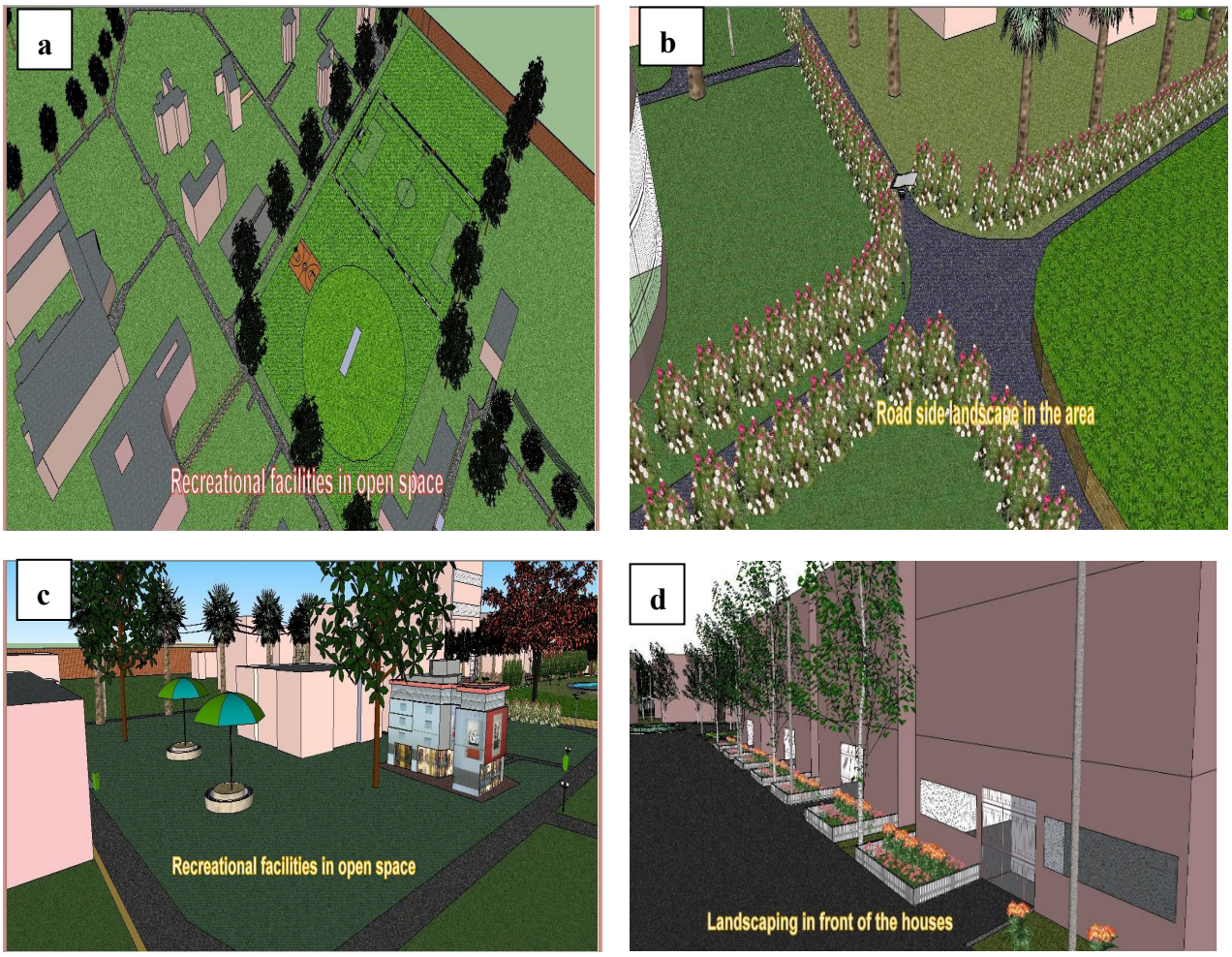


Figure 11. Design of Open Space in Compact City: a) Recreational Facilities in Community Open Space; b) Road Side Landscaping in Open Space; c) Recreational Facilities in Public Open Space; d) Landscaping for Open Space in Front Side of Residential Buildin

4.4.9 Design Description of Transportation System

Fine and accessible network of pedestrian and bicycle paths throughout, connecting to nearby neighborhoods and shopping/employment areas. Routes have simple straightforward geometries and simple designs that do not create blind spots in the area. Encourage slower traffic speeds where appropriate and ensure that people can safely cross busy roads and railway lines. It also provides ample car parking facilities must be located so that they offer convenient access, but not compromise pedestrian safety and convenience (Figure 12).

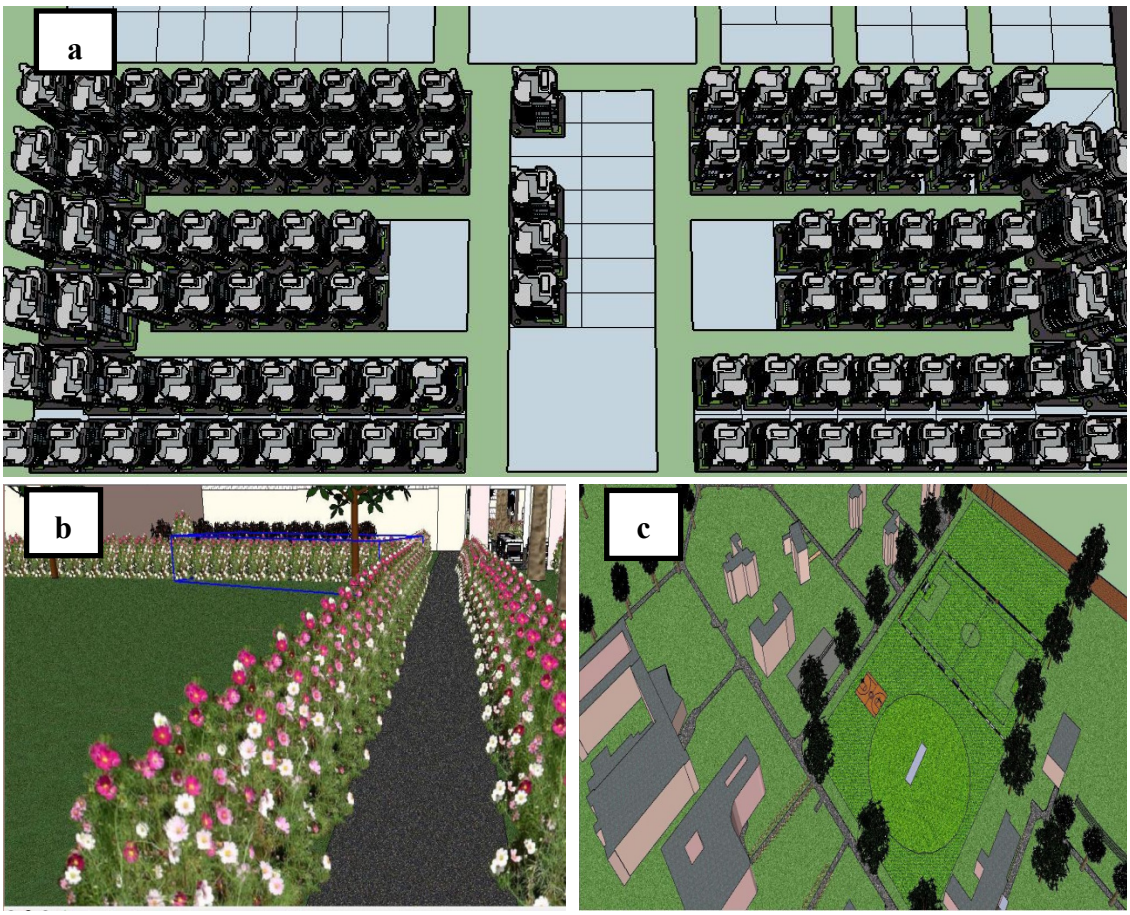


Figure 12. Design of Road Network in Compact City: a) Loop Street Pattern Road in Compact City; b) Road Side Landscaping in Compact City; c) Road Connectivity within Recreational Facilities in Public Open Space in Compact City

5. Conclusion

In Bangladesh urban growth is the most visible reflection of urbanization and the cities in Bangladesh have a tendency to grow in haphazard way. This study identifies the amount of urban expansion in Pabna district as well as direction and intensity of growth in Ishwardi Thana. In doing so, it also discussed some principal aspects of urbanization reviewing the relative literature. Ishwardi Thana has experienced rapid urban growth during 1996-2016. To control this haphazard urban growth this study proposed a compact city design. Maijdia Site is selected for designing compact town. The labor-intensive industries, in association with cash crop production increased the suitability of this area for production oriented compact township program. Zoning techniques is used and area of 245 acres is divided into high class residential zone, middle class residential zone, lower class residential zone and Mix use zone, etc. To make the city production oriented the city is also provided with industrial zone. School, college, markets, hospitals and other facilities are facilitated according to the standard. The city can accommodate about 25200 population within 245 acre of land along with availability of work and basic facilities. With the existing regulatory system of the country, it may not possible to control the

growth of the country. This type of city design can provided an incentive for the policy maker to solve the problem of housing scarcity and control urban sprawl. Focus of this compact city design is on promoting sustainable human development through provision of economic activity and reducing environmental stresses.

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Author Contributions

Abdulla-Al Kafy give the idea to prepare a paper on this topic, Write abstract , Some part of methodology and Analysis, Prepare map, Organize and Review the paper. Muhaiminul Islam Asif design the proposed Comapct Township in Skatch Up, Write the Introduction, Conclusion and some part of Methodology and Analysis. Dulal Sarker write some part of analysis, organize the analysis part for 2nd objective initially and review the paper. S. M. Abdullah Al-Fatin and Md. Mehedi Hasan give extensive support in reconnaissance survey and Site selection.

Conflicts of Interest

The authors declare no conflict of interest.

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