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Changing Brown Cities to Smart and Sustainable ones: Proposed Applicable Strategies and Indicators for Omid-e-Sabz Township in Kabul City

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Abstract

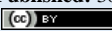
The two world-wide challenges, the population growth and the climate change, have forced everyone to think differently and seek new approaches to revive cities to be sustainable for centuries to come. Therefore, transforming the cities to the green and smart city are inevitable. The first step towards green and smart city is the recognition of applicable indicators for an existing city. In the next stage, introducing the most sustainable strategies to implement and realize the introduced indicators are of key importance. Omid-e-Sabz is a crowded city in the south-west of Kabul, hosts more than 27,000 inhabitants. Thus, a study through modifying this city to a sustainable and smart city is crucial for future urban development in Afghanistan. The indicators of green and smart city have been analyzed for Omid-e-Sabz Town in this paper. Moreover, some key guidance's and plans for transforming an ordinary city to sustainable and smart city have been introduced and suggested. This paper is the first of its kind that discusses this important topic for Afghanistan. It will help the urban planning sector of Afghanistan to learn and continue this discourse to make sure the future cities in Afghanistan are smart and sustainable.

Keywords: Smart City, Kabul City, Climate Change, Energy and Environment.

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Ethical: This study follows all ethical practices during writing.

1. Introduction

Afghanistan doesn't have a centralized grid network. Therefore, it has three major grid islands, which are North East Power System (NEPS), South East Power System (SEPS), and West Power System (WPS). NEPS demand

power is 900 MW, while the supply power is 600 MW. Furthermore, the SEPS and WPS demand powers are 100 and 220 MW, yet the supply powers are 45 and 180 MW [2]. At the beginning of 2021, Kabul city peak demand reached 750 MW, whereas the supply power was 477 MW [3]. Therefore, Kabul inhabitants use dirty sources of energy for energy usage during winter due to lack of access to clean energy and poverty. This problem forces us to investigate on the alternative solution for Kabul city, which sustainable and smart city is one of them. We have taken a town as a sample for studying the smart and sustainable cities in the Kabul. For this reason, we picked Omid-e-Sabz Township for this study. Omid-e-Sabz map has been shown in the [Figure 1](#).

Omid-e-Sabz Town pla

ced south-west of Kabul City at 3 km of Darla-man palace. It has an area of around 3 square kilometers. 50% of the land is used for residential areas, and the other 50% used to construct roads, fields, green spaces, and public access. This town is house for 27,500 inhabitants [1]. In this town, four transformers had installed that every transformer has 800 kVA capacity, which makes the total installed capacity of 3,200 kVA of electricity. According to Dabs, the peak demand of this town was 2.392 MVA in 2015. and the electricity consumption from the grid was 795.914 MWh/2-month in 2015 for 1,180 consumers [4].

2. Literature Review

Sustainable and smart cities are distinctive and massive concepts; however, each has similarities. If they both mix, it will give a clean and high intelligent city once. The cities like Singapore carry out each sustainable and smart city separately. More than half of the world's population now lives in cities, and this proportion is going to grow to seventy-five percentages by 2050 [5]. In recent times, the most urbanized regions are Northern America (82 %), Latin America and the Caribbean (80 %), and Europe (73 %) [5]. The green city has the subsequent objectives: clean air and water, the risk of main infectious disease outbreaks in such cities is low, low chemical and physical hazards, exceptional streets and parks, and green cities are resilient within the face of natural disasters [5]. Green cities additionally encourage green behavior, along with the usage of public transit, decrease transfers of environmental expenses to areas outside the city, make certain development towards sustainable consumption, and their ecological influences are notably small [5].



Figure-1.
Omid-e-Sabz Town Map. [1]

On the other hand, Smart city is looking to discuss public problems through information and communications technology (ICT) based solutions on the base of multi-stakeholder and municipality-based partnership [6]. It makes integrating the physical, social, IT, and business infrastructures into one framework, therefore, as to leverage the collective intelligence of a city [6]. The smart city monitors and integrates conditions of all its crucial infrastructure – consisting of roads, bridges, tunnels, rails, subways, airports, seaports, communications, water, electricity, even major buildings [7]. It can better optimize its resources, plan its preventive maintenance activities, and check security aspects while maximizing services to its residents. The smart city makes use of ICT to enhance its livability, workability, and sustainability [7].

Smart city has six dimensions, which are being built at the smart combination of endowments and activities of self-decisive, independent, and conscious citizens [8]. The smart economy, smart government, smart environment, smart living, smart mobility, and smart people are smart city wheels. A worldwide and European agreement on smart city indicators has not been determined because smartness is not always easily measurable [8]. The indicators, which stated at the international papers or used in cities for projects have existed greater than four hundred that smart environment has 86 indicators, smart Living has 72 indicators, smart people have 68 indicators, smart mobility has 77 indicators, the smart economy has 55 indicators, and the smart government has 69 indicators [9]. Sustainable city indicators are equipment, which allows city planners, city managers, and policymakers to decide the socio-economic and environmental impact like current urban designs, infrastructures, policies, waste disposal systems, pollution, and access to services by citizens. These indicators measure how much a city is a greenness [10]. The green city indicators particularly divide into two-part; quantitative and qualitative indicators. Quantitative indicators are getting used to explain the three Green City dimensions, which the environmental quality dimension has the largest number of indicators. Qualitative indicators specifically are being used to evaluate the city's environmental policies [5]. The thirteen categories of indicators play an essential function in evaluating the greenness of a city, which are transport, air quality & CO₂, energy, water, green spaces, building, acoustic environment, education, equity, safety, health, and participation [5].

3. Methodology

As a sample for study, the Omid-e-Sabz Town has been taken a typical town for study. This research focus on the selection of indicators, suggested strategies, and environmental impact. The first methodology was to identify the indicators that studied in the other research paper. After identifying, the indicators are selected based on political, economic, ecological, and other situations. Besides, some new indicators have been created by author for better illustration of some categories. Secondly, we have suggested some applicable strategies that will have important effect on the smart and sustainable cities indicators. We proposed the strategies based on the political, social, cultural, and economic situation which cost of some strategies are estimated. Moreover, we have measured the environmental impact of the strategies.

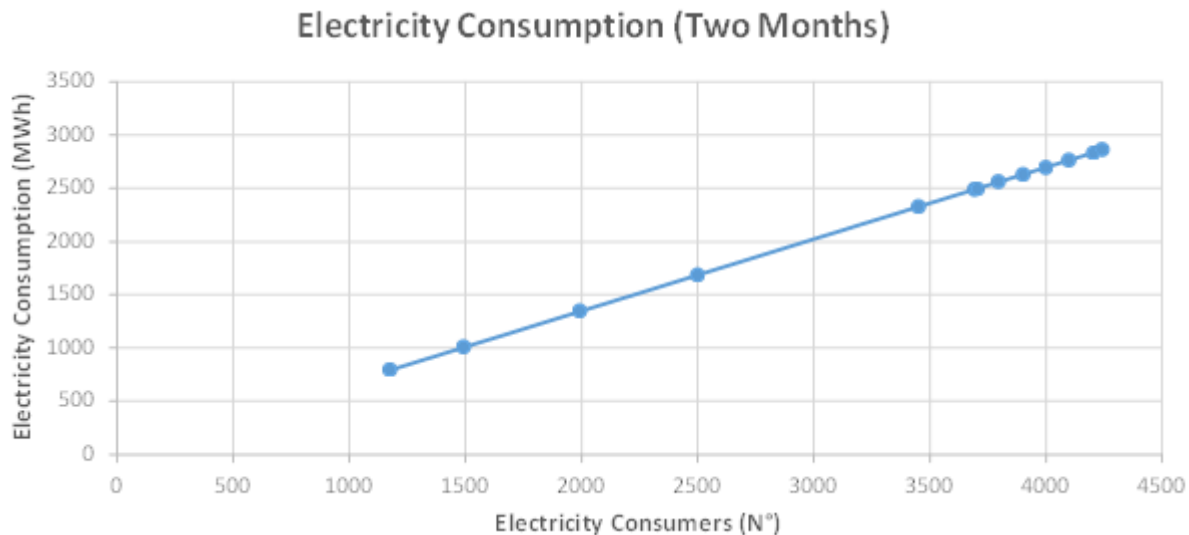


Figure-2.
Linear model electricity consumption relative to consumers.

In recent years, Kabul city has sort of challenges. These challenges can be solved by one procedure that is sustainable and smart cities. Water has emerged as a hot topic from a few years ago. The dearth of potable water is a critical task for Kabul residents. According to the Afghanistan National Environmental Protection Agency (NEPA), 70% of groundwater had been contaminated in Kabul city [11]. It means that 70% of Kabul population does not have access to clean potable water. Electricity shortage can be seen every year during winter. DABS does promise to solve this problem every year, but they could not. Pollution that is being caused by emissions of CO₂, NO_x, and SO_x from transport, stove, crowded, and the uncompleted combustion of conventional energy has placed resident's life to a vital health threat. Therefore, we have studied smart and sustainable cities as a solution to these problems. In this study, the combined methods of research (quantitative, qualitative) had been used. The accumulating of data is being accomplished by two approaches. First, a couple of information that was being needed about Omid-e-Sabz Town gathers from Kabul municipality (KM) and the

office of Omid-e-Sabz Town. Furthermore, the statistics about electricity consumption and electricity load of Omid-e-Sabz Town collected from DABS. Second, some data accrued from Articles, e-books, Conference papers, Reports, and Environmental Protection Agency (EPA).

We had electrical data of Omid-e-Sabz from DABS for 2015 but we need an update data that we could not find it. Therefore, we used a linear model for estimating the power consumption of 4,250 consumers of Omid-e-Sabz Town. In figure, we can see that the power consumption is 2,866 MWh/2-months for 4,250 consumers. We estimated that we will have 4,250 consumers in 2020. [Figure 2](#) shows the linear model of electricity consumption relative to consumers.

4. Result and Discussion

The result illustrates three crucial findings: first, there are hundreds of indicators of the sustainable and smart city that has been used around the world. In this study, 106 indicators were selected or created to apply in the Omid-e-Sabz Town. These Indicators also can be applicable for Kabul City because Omid-e-Sabz town was a trail. Second, applicable strategies had been proposed if we transform the township into smart and sustainable cities. Finally, the effect of this transformation on environment has been measured.

4.1. Indicators

Indicators are the characteristics that define sustainable and smart cities. The indicators are the base for transformation to sustainable and smart cities. In this research, we have collected and studied more than 400 indicators. From 400 indicators, the 115 indicators were the sustainable indicators while the remaining were the smart city indicators. We have studied each indicator one after the other which 106 applicable and suitable indicators have been selected and created based on culture, weather, society, and political condition at Kabul city. We have divided the indicators into three-part. First, the indicators that are perceived as they are existing in the city. Second, the indicators that we believed they did not use before in this town. Furthermore, these indicators are retrieved from other journal papers or reports. Finally, the indicators that we have prepared because are not found in journal papers or reports.

The 55 indicators are perceived to existing in the town. In [Table 1](#), we can see the 55 indicators that are perceived they existing in this town. The second column states the indicators name while the third and fourth column represent the sustainable city categories and smart city dimensions that describe an indicator has effect on which categories. The unit for each indicator is shown at the last column.

Table-1.

Smart Sustainable Cities Indicators that have been used in the Omid-e-Sabz Town [\[5, 12-16\]](#).

No	Indicators Name	Sustainable	Smart	Unit
1	Average annual concentration of PM _{2.5}	Air Quality	Smart Environment	µg/m ³
2	Average annual concentration of PM ₁₀	Air Quality	Smart Environment	µg/m ³
3	Average annual concentration of SO _x	Air Quality	Smart Environment	µg/m ³
4	Average annual concentration of NO _x	Air Quality	Smart Environment	µg/m ³
5	average annual concentration of O ₃	Air Quality	Smart Environment	µg/m ³
6	CO ₂ Intensity	CO ₂	Smart Environment	Grams/ GDP
7	CO ₂ Emissions per capita	CO ₂	Smart Environment	t CO ₂ Emissions/ person
8	Total CO ₂ emissions per KWh electricity Consumed	CO ₂	Smart Environment	t CO ₂ / KWh
9	Tons of CO ₂ emissions from transportation	CO ₂	Smart Environment	t CO ₂ / vehicle
10	Tons of CO ₂ emissions from waste	CO ₂	Smart Environment	t CO ₂ / t Solid waste
11	Share of population exposed to noise pollution	Acoustic	Smart Environment	%
12	Average Annual Electricity consumption	Energy	Smart Environment	MWh/ year
13	KWh of electricity use by residential sector	Energy	Smart Environment	kWh
14	KWh of electricity use by commercial sector	Energy	Smart Environment	kWh
15	KWh of electricity use by city facilities	Energy	Smart Environment	kWh
16	Annual average number of electrical interruptions per year, per customer	Energy	Smart Environment	N°
17	Daily water consumption per capita	Water	Smart Living	lit/day
18	Population with Access to potable water	Water	Smart Living	%
19	Annual wastewater generated	Water	Smart Living	liters

20	Number of sewer spills	Water	Smart Living	N°
21	Percent of Water system leakages	Water	Smart Living	%
22	Percentage of city's wastewater receiving treatment	Water	Smart Living	%
23	Total Municipal Waste production	Waste	Smart Environment	ton/yr
24	Total solid waste generation per capita	Waste	Smart Environment	ton/ capita
25	Share of the population with municipal solid waste (MSW) collection	Waste	Smart Environment	%
26	Hazardous waste generation per capita	Waste	Smart Environment	ton/ capita
27	Amount of Household Waste generated per capita	Waste	Smart Environment	ton/yr
28	Percent of households within 1 km of a park or recreational open space	Green Areas	Smart Environment	%
29	Percent of green space added	Green Areas	Smart Environment	%
30	Percentage of population with access to improved sanitation	Health and Safety	Smart Living	%
31	Suicide rate	Health and Safety	Smart People	N°
32	Number of murders	Health and Safety	Smart People	N°
33	Number of deaths related fire	Health and Safety	Smart Living	N°
34	Response time for emergency response services from initial call	Health and Safety	Smart People	min
35	Response time for fire department from initial call	Health and Safety	Smart Living	min
36	Response time for police department from initial call	Health and Safety	Smart Living	min
37	Violent crime rate	Health and Safety	Smart People	%
38	Share of peoples connected to the internet by any access method	Education	Smart Living	%
39	Percent of inhabitants travelling on public transport	Transport	Smart Mobility	%
40	Average number of vehicles (cars and motorbikes) per household	Transport	Smart Mobility	N°
41	CO ₂ equivalent production from transport	Transport	Smart Mobility	ton/yr
42	Percent of population Foreign language skills	Education	Smart People	%
43	Participation in voluntary work	Participation	Smart People	%
44	Percentage of young		Smart People	%
45	Fertility rate		Smart Governance	%
46	Number of business		Smart Economy	N°
47	Employment rate		Smart Economy	%
48	Unemployment rate		Smart Economy	%
49	Percentage of city population Living in poverty		Smart Economy	%
50	Tax collected as a percentage of tax billed		Smart Economy	%
51	Life expectancy	Health and Safety	Smart Living	years
52	Percentage of female school-aged population enrolled in schools	Education	Smart Living	%
53	Percentage of students completing primary education	Education	Smart Living	%
54	Percentage of students completing secondary education	Education	Smart Living	%
55	Percentage of higher education's degrees	Education	Smart Living	%

We believed that 29 indicators are not used before in this town. Besides, their existence is also not perceived in the town. These indicators have been added for the better implementation of smart and sustainable cities. These indicators are shown in the [Table 2](#).

Table-2.

Smart Sustainable Cities Indicators that are not used in the Omid-e-Sabz Town [5, 12-15, 17, 18].

No	Indicators Name	Sustainable	Smart	Unit
1	Percentage of citizens living within 300m of quiet areas	Acoustic	Smart Environment	%
2	Average annual Renewable Energy Consumption	Energy	Smart Environment	MJ/ year
3	KWh energy savings from energy efficiency	Energy	Smart Environment	kWh
4	kW peak energy reduction from energy efficiency	Energy	Smart Environment	kW
5	Energy Intensity	Energy	Smart Environment	MJ/ GDP
6	Annual total electricity consumption per capita	Energy	Smart Environment	kWh/ person/yr
7	Numbers of registered cars	Transport	Smart Mobility	N°
8	Kilometers of cycle paths and lanes	Transport	Smart Mobility	km
9	Average age of car (total and by type)	Transport	Smart Mobility	years
10	Satisfaction with access to public transport	Transport	Smart Mobility	%
11	Satisfaction with quality of public transport	Transport	Smart Mobility	%
12	Number of Electrical Vehicle (EV) charging stations	Transport	Smart Mobility	N°
13	Number of rechargers at EV charging stations	Transport	Smart Mobility	N°
14	kWh recharged in the EV charging stations	Transport	Smart Mobility	kWH
15	Proportion of public parking connected to the parking management system	Transport	Smart Mobility	%
16	Proportion of traffic lights connected to the traffic management system	Transport	Smart Mobility	%
17	Satisfaction with quality of e-governance service		Smart Governance	
18	Number of web visitors per year	Education	Smart Governance	N°
19	Information services for residents	Education	Smart Governance	
20	Satisfaction with quality of health system	Health and Safety	Smart Living	
21	Satisfaction with access to educational system	Education	Smart Living	
22	Satisfaction with quality of educational system	Education	Smart Living	
23	Improved cyber security		Smart Living	%
24	Improved data privacy		Smart Living	%
25	Increased environmental awareness	Education	Smart Living	%
26	Satisfaction with fight against corruption		Smart Governance	
27	Percentage of population having a Master /Ph.D. degree	Education	Smart People	%
28	Mortality of underage five	Health and Safety	Smart Living	N°
29	Proportion of municipal solid waste (MSW) that is sorted and recycled (total and by type of waste e.g. paper, glass, batteries, PVC, bottles, metals)	Waste	Smart Environment	%

We have prepared a few indicators of smart and sustainable cities to show the contribution of important categories that do not exist in the journals and reports. We have prepared 22 indicators based on economic, political, cultural, and weather conditions in Afghanistan. Furthermore, these indicators are only applicable in Afghanistan. The 22 indicators have been shown in [Table 3](#).

Table-3.

Smart and Sustainable Cities Indicators that are prepared for the Omid-e-Sabz Town.

No	Indicators Name	Sustainable	Smart	Unit
1	Transferred building into green buildings	Buildings	Smart Environment	N°
2	Annual number of trees planted	Green Areas	Smart Environment	N°
3	Number of total trees	Green Areas	Smart Environment	N°
4	Number of Green building	Buildings	Smart Environment	N°
5	Number of electric vehicles in city	Transport	Smart Mobility	N°
6	Percentage of diesel cars in total vehicles cars	Transport	Smart Mobility	%
7	Total number of cars run by hybrid	Transport	Smart Mobility	N°
8	Number of Pharmacies	Health and Safety	Smart Living	N°
9	Annual Total gas consumption	Energy	Smart Environment	kg/yr
10	Annual total wood use for Heating	Energy	Smart Environment	kg/yr
11	Annual total Coal use for heating	Energy	Smart Environment	kg/yr
12	Annual total gas use for heating	Energy	Smart Environment	kg/yr
13	Annual total electricity use for heating	Energy	Smart Environment	kWh/ yr
14	Annual total electricity use for cooling	Energy	Smart Environment	kWh/ yr
15	Annual total wood use	Energy	Smart Environment	kg/yr
16	Annual total other type of energy use	Energy	Smart Environment	kg or lit/yr
17	Liters of water purchased per capita	Water	Smart Living	lit/day/person
18	Number of hospitals	Health and Safety	Smart Living	N°
19	Number of fuel station for cars	Transport	Smart Mobility	N°
20	Percentage of population without income		Smart Economy	%
21	Female employment	Equity	Smart Economy	N°
22	Percent inhabitant have access to education system	Education	Smart Living	%

4.2. Strategies

We have suggested some strategies for implementation in this town. Moreover, we calculated the environmental effect in section 4.3. These strategies would affect directly into indicators that shows the change towards the sustainable and smart city. In this section, we estimate some data of strategies along with suggesting of these strategies. The primary proposed strategy is the Photovoltaic (PV) system. PV system has been proposed for energy utilization because it is clean energy. We have taken some assumption for estimation of PV system. The assumptions are cost of equipment's and number of consumer in 2020. Furthermore, we assume that all PV system will be on-grid system. We suggest 8 MW on-grid rooftop PV system because the energy consumption will reduce after implementation of energy efficiency strategy. Moreover, the solar heat collector has been recommended for heating, while energy efficiency also has been suggested to apply because it will control the heat gain and heat loss. We have taken two assumptions for solar heat collector and energy efficiency. We assumed that every house need 3 solar heat collector with 300-liter capacity and the cost is about \$650. Besides, we assumed all buildings of this town is three floor building because it will take lots of time to estimate insulation for all types of buildings. Energy Efficiency cost of a typical three floor building is around 18,350 USD and it will save up to 46% of energy [19]. Thus, we take assumption that all buildings of this town will cost the same price and will save the same percentage for energy efficiency. We have shown the details of these three strategies in the [Table 4](#).

Table-4.

Details of Energy Strategies for Smart Sustainable Cities.

Strategy Name	No Households	Size	Area	Total Cost (\$)
PV System	4,250	8 MW	40 jerib	6.12 Million
Solar Collector	4,250	3,825,000 L	25.5 jerib	8.3 Million
Energy Efficiency	4,250	Three Floor		78 Million

We have suggested two strategies for waste because we have huge amounts of waste in Kabul. Hence, we suggested anaerobic biogas digester and waste collection and recycling for waste management system. Kabul city generate 0.71 kg/day/person waste that 0.43 is reusable, 0.28 is recyclable, and 0.29 is the landfilling waste [20]. In this town, we assumed the max waste generation that is about 19.5 ton per day, which 8.4 ton/day is reusable in the biogas digesters, 5.5 ton/day is recyclable in the waste recycling plant, and 5.7 ton/day is the landfilling waste. We have suggested three strategies for water management system. The rainwater storage well, Decentralized Wastewater System (DEWATS), and Potable water piping system are the suggested strategies. The rainwater storage well strategy is to make a well with depth of 6 to 10 m and with diameter of 1m in every 400 to 700 m² or at least 4,500 wells in this town. We assumed that 15% of

rainwater will be caught in these wells. We suggested that water piping system must install for every house in this town to use from water because drilling well will bring drought in this town and Kabul. We assumed that 95% households will use from potable water piping system because maybe some household don't use from this strategy. The wastewater management is very crucial for a city because it will decrease the water usage up to 50 percent. Therefore, we suggested the DEWATS system for wastewater treatment of this town. The assumption has been taken that every person generates 20 liters of sewage. The DEWATS capacity that required for this town is about 16,500 m³. Moreover, we assumed that DEWATS will treat 30% of wastewater. In [Table 5](#), the description and size of these strategies are represented.

Table-5.
Waste and Water Strategies for Smart Sustainable Cities.

Strategy Name	Description	Size
Anaerobic Biogas Digester	From 0.71 kg/day/inhabitant waste generation, the 0.43 kg/day/inhabitant is reusable in the biogas digester. We suggested 2 biogas digester.	8.4 ton/day
Waste Collection and Recycling	From 0.71 kg/day/inhabitant waste generation, the 0.28 kg/day/inhabitant is recyclable in the waste recycling plant.	5.5 ton/day
Rainwater Storage Well	A well with depth of 6 to 10 m and diameter of 1 m will be drilled in every 400 to 700 m ² . It will catch up to 15% of rainwater during a year.	4500 wells
Potable Water Piping System	A drinking water piping system from once central drill well to every household for drinking water, cooking, and other usage.	95%
DEWATS	The DEWATS strategy will treat wastewater for irrigation and usage in bathroom. It will treat 30% of wastewater.	16,500 m ³

We have suggested four strategies for transportation system. These strategies are public electric bus, electric vehicle (EV), on-grid solar charging station, and bike path. We have suggested electric bus for public transportation. It will decrease the traffic in the town. We assumed that 12 electric bus will be sufficient for public transportation in this town. Furthermore, we assumed that average cost of each electric bus is \$750,000. Thus, the total cost of this strategy will be around 9 million USD. We assumed that one person from every 30 persons has car in this town. Therefore, the total private car is 916 in this town. We assumed that 25% of those who have cars will change their vehicle to electrical vehicle because the high cost of electrical vehicle. Besides, we assumed that cost of an electrical vehicle be around 45,000 USD. We have suggested the on-grid solar charging station for charging the electric vehicle. We proposed 8 on-grid solar charging station. We take assumption that every on-grid solar charging station will cost 30,000 USD. The people from 14 – 45 ages will have been encouraged to use from the bike for transportation in this town. The bike path has assumed to construct 40 km around the town. Besides, we assumed that the construction cost of 1 km bike path will be around 50,000 USD. [Table 6](#) shows the quantity, unit cost, and total cost of these strategies.

Table-6.
Transportation Strategies of Smart Sustainable Cities.

Strategy Name	QTY	Unit Cost	Total Cost
Public Electric Bus	12	\$750,000	\$9 Million
Electric Vehicle	230	\$45,000	\$10.35 Million
On-grid Solar Charging Station	8	\$30,000	\$240,000
Bike path	40 km	\$50,000	\$2 million

We have suggested two strategies for green areas. The green building and vertical garden are the proposed strategies. Green building strategy can reduce the pollution and bring aesthetic to the environment. Besides, it is a solution for climate change and global warming. Vertical Garden is a new idea that comes in the world. It constructs the vertical building that can produce a few times more food than the food product in the same amount of land. These two strategies are more helpful when we transform Kabul city to a smart sustainable city. Therefore, we suggested these strategies first in this town like a prototype strategy. In table, you can see these strategies along with description. In [Table 7](#), we have described these strategies in some detail.

Table-7.
Green Areas Strategies for Smart Sustainable Cities.

Strategy Name	Description
Green Building	The cost of green building is a little bit high relative to conventional buildings but it can save energy and absorb the GHG that have value more than it is cost. We suggested that at least 16% buildings change to green building in this town.
Vertical Garden	The vertical garden will produce vegetables and fruits for inhabitants of this town. We proposed that 4 vertical garden built at an area of 2,400 m ² in the town.

The last three suggested strategies are closed-circuit television (CCTV) security camera, internet of things (IoT), and ICT. These strategies are very crucial for a smart city. These are the base for transformation to a smart city. The ICT

strategy is helpful for smart education system because the world goes faster on innovation of new technologies. Therefore, it is important to learn and work with these technologies. On the other hand, IoT strategy is the base of all smart sustainable cities because the town will not be a smart city without this strategy. It connects all systems on one control system. Besides, it will transfer data from one system to another for a command. The description of these strategies have been shown in [Table 8](#).

Table-8.
Smart Strategies for Smart Sustainable Cities.

Strategy Name	Description
CCTV Security Camera	The CCTV has been suggested to install all over town. It will provide the monitoring for security purpose.
ICT	We suggested to provide ICT for every student. Thus, they can learn modern and smart technologies.
IoT	IoT have been proposed to provide for all inhabitants. Besides, IoT will be connected to all technologies.

4.3. Environmental Impact

The sustainable and smart city is the mixture of several solutions for the reduction within the GHG emissions. The transforming of this town into a green and smart town will cut GHG emissions and other pollutions that will affect the climate change and global warming in a small scale. We have measured the environmental impact of some strategies but we have taken some assumptions for data. The first assumption is the CO₂ emission for all strategies based on the fuel consumption type or carbon dioxide absorption per area like in column 4 table 9. We also assumed that 75 wh is needed to heat 1 liter of water. Besides, we calculated the biogas production and CO₂ emission from an online calculator in the RENERGON website [21]. Furthermore, we assumed that calculation from this website is nearly accurate for estimation of CO₂ emission. We compare electric bus and electric car to diesel bus and petrol car. We have taken assumption that bus will travel 19,300 km/year and car will travel 12,250 km/year. Besides, we assumed the fuel consumption 32 L/100 km for bus and 9 L/100 km for car. We have calculated the carbon dioxide emission for all these strategies which except biogas that emit carbon dioxide other strategies reduce these amount of carbon dioxide production in a year. The total annual CO₂ emission from all strategies with description have been shown in [Table 9](#).

Table-9.
Annual CO₂ Emission from Strategies.

Strategy Name	Description	Energy Consumption	CO ₂ Emission	Total Annual Tonne of CO ₂ emission
PV System	8 MW of On-grid PV Panel	13,705,830 kwh	0.22 kg/kwh	-3,015.28
Solar Collector	12,750 Solar Collector of 300 liters for 4,250 Consumers.	97,728,750 kwh	0.22 kg/kwh	-21,500.33
Energy Efficiency	46% of energy saving	7,910,160 kwh	0.35 kg/kwh	-2,768.56
Anaerobic Biogas Digester	Two biogas digester for 8.4 ton of waste per day.	82,782,000 liter of biogas	0.002 kg/l	+165.56
Public Electric Bus	12 electrical bus that is alternative for diesel bus.	74,112 liter of diesel	2.68 kg/l	-198.62
Electric Vehicle	230 electric car which is alternative for petrol car.	253,575 liter of petrol	2.31 kg/l	-585.76
Green Building	680 green building with area of at least 400 m ² .		5.9 kg/m ³	-1,604.8
Vertical Garden	4 vertical garden with area of 600 m ² .		4.95 kg/m ³	-11.88

We can see the annual CO₂ emissions from all strategies in column five of [Table 9](#). The minus sign represents the reduction amount of CO₂ by these strategies. The plus sign shows the carbon emission from biogas burning as gas in the households. As we can see from [Figure 3](#), the solar collector contributes mostly on CO₂ reduction which is followed by PV system, energy efficiency, and green building. [Figure 4](#) shows the annual predication of CO₂ emissions till 2050.

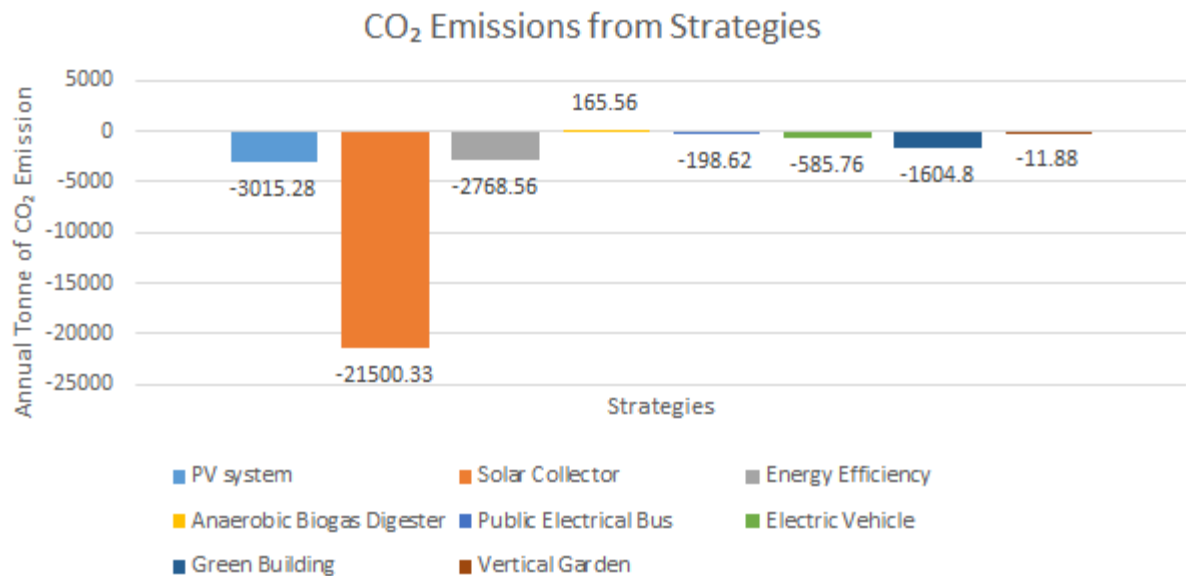


Figure-3.
Contribution chart of carbon dioxide emission from different strategies.

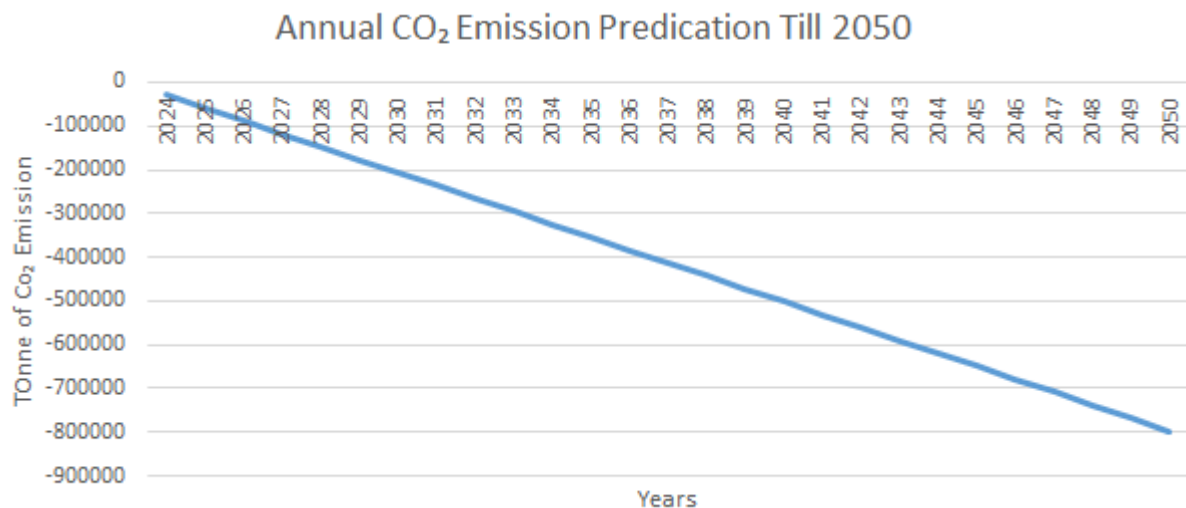


Figure-4.
Annual Carbon Dioxide Predication Till 2050.

5. Conclusion

In this research, the study has been completed on transforming the Omid-e-Sabz Town into a sustainable and smart town. Omid-e-Sabz town that is located inside Kabul city has the capacity 27,500 inhabitants. The research has been carried out on indicators selection, suggested strategies, and environmental impacts of strategies of the smart sustainable city, which from more than 400 indicators 106 indicators have been selected and created. On the other hand, 17 applicable and feasible strategies have been proposed for this transforming. Furthermore, the environmental impact of strategies has been measured. As a result, 29,519.67 tons of carbon dioxide have been reduced by implementation of this project.

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