COLLEGE OF DEVELOPMENT STUDIES

CENTER FOR ENVIRONMENT & SUSTAINABLE DEVELOPMENT

ASSESSING URBAN SMART ENVIRONMENT PRACTICES IN AKAKI KALITY SUB-CITY, ADDIS ABABA CITY ADMINISTRATION

By

Henok Tekie Tezazu

November, 2021

Addis Ababa, Ethiopia

ADDIS ABABA UNIVERSITY
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This is to certify that the thesis entitled **"Assessing Urban Smart Environment Practices in Akaki Kality Sub-City, Addis Ababa City Administration"** is submitted in partial fulfillment of the requirements for the degree of Master of Art in Environment and Sustainable Development Studies at Addis Ababa University, and is a record of original research carried out by Henok Tekie Tezazu, ID. No GSE/6740/11 under my supervision and no part of the thesis has been submitted for any other Degree. Therefore, I recommend it to be accepted as fulfilling the thesis requirement.

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COLLEGE OF DEVELOPMENT STUDIES OFADDISABABA UNIVERSITY FOR THE DEGREE OF MASTER OF ARTS IN ENVIRONMET AND SUSTAINABLE DEVELOPMENT STUDIES

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DECLARATION

I, Henok Tekie, declare that this work entitled **"Assessing Urban Smart Environment Practices in Akaki Kality Sub-City, Addis Ababa City Administration"** is the outcome of my effort and study and that all sources of materials used for the study have been duly acknowledged. I have produced it independently except for the guidance and suggestion of the research advisor. This study has not been submitted for any degree in this University or elsewhere.

By: Henok Tekie

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This thesis has been submitted for examination with my approval as a University advisor.

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ABSTRACT

This study aimed to assessing urban smart environment practices in Akaki Kality Sub-City, Addis Ababa City Administration. The concept of Smart Environment was introduced as one of the efforts to improve urban environmental quality. Smart Environment (SE) relies on communication and cooperation between a variety of technology devices, including sensor networks implanted in the environment, and servers in a permanent infrastructure. All of these devices combine computer, networking, and physical processes, and monitor and control the environment; making them a very efficient and cost-effective way to improve people's quality of life and security. This study used a mixed approach research method. The tools for data collection were key informant interviews and survey questionnaires. Totally, 98 (Experts) samples were drawn from all 13 Woredas of Akaki-Kality Sub-city Environmental Protection and Green Development Office using the judgmental sampling method. Thematic analysis, descriptive analysis, and binary logistic regression model were used for analyzing the data. Based on the results, there is no urban smart environment practice and environmental problem was not solved in Akaki Kality. This resulted from the lack attention from the government, and lack of community awareness and poor understanding of the importance of stakeholder collaboration in Akaki Kality. To implement smart environment, the government should recognize the benefits of a smart environment, and seek to implement it for environmental protection.

Keywords: *Smart Environment, Smart City, Environmental Protection, Pollution Addis Ababa, Ethiopia*

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ABBREVIATIONS AND ACRONYMS

ASCIMER	Assessing Smart City Initiatives for the Mediterranean Region
CGR	Collaborative Governance Regime
ESIA	Environmental and Social Impact Assessment
FDRE	Federal Democratic Republic of Ethiopia
GDP	Gross Domestic Product
GIS	Geographic Information System
GPS	Global Positioning System
HSEI	Human-Smart Environment Interactions
ICT	Information and Communications Technology
IOT	Internet of Things
IT	Information Technology
OGD	Open Government Data
SBISC	Smart Building in a Smart City
SC	Smart City
SDGs	Sustainable Development Goals
SE	Smart Environment
SPSS	Statistical Package for the Social Science
SUD	Sustainable Urban Development
UGI	Urban Green Infrastructure
USA	United State of America

GLOSSARY FOR LOCAL TERMS

Woreda- a sub division under sub-city which is the smallest administrative unit in Addis Ababa, Ethiopia

CHAPTER ONE – INTRODUCTION

1.1 BACKGROUND OF THE STUDY

1.1.1 CAUSES AND CHALLENGES OF URBAN ENVIRONMENTS

Environmental problems may result from functioning of various spheres of vital activity of the city, for example, inefficient management of urban economy, housing and public utilities, transport system, low level of industrial safety in industrial facilities in the city and low level of responsibility and awareness towards environmental protection from the citizen's lining in urban areas (Turgel et al., 2019).

Cities in developing countries are characterized by economic, social and environmental imbalances. Many of them are dealing with challenges such as pollution and environmental degradation, saturation of transport, population growth (attraction of rural migrants, attraction of the middle and upper classes, etc.), illiterate populations, tough living conditions and lack of business opportunities (Barro et al., 2018).

Generally speaking, the main reasons for the water, sanitation and hygiene crisis in urban Africa include: a lack of planning at the country level, poor ownership, governance and a lack of political will for action; a lack of knowledge and poor maintenance as well as inefficient usage of existing systems; an unclear distribution of roles and responsibilities between the public and private sectors; and a lack of capacity to deal with these issues (Güneralp et al., 2017)

Ethiopia is one of the least urbanized nations, but among the fastest growing city even in the African context (Mohamed et al., 2020). Addis Ababa city has always suffered from serious water shortage problems and thus considerable parts of the city gets water supply just once a week and sometimes once in 2 weeks. The population growth is one of the major factors affecting the public health and socioeconomic development of urban communities (Alemu & Dioha, 2020).

Addis Ababa city's rivers have become heavily polluted. River bank erosion has resulted from the widespread occupation of river banks by informal community's settlements, along with a lack of sufficient sanitation, transforming the city's rivers into open sewers. This poses a

significant danger to ecosystems, is a threat to future water supply, and has serious health implications, as urban agriculture is commonly practiced along these river banks (Mazhindu et al., 2012).

1.1.2 URBAN SMART ENVIRONMENT

The Smart City concept can be seen as an adjusted combination of human, social, financial, and natural energy, commonly coordinates for the same reason, pointing to overcome the most challenges of urban living. Smart Cities can be seen in a broader approach, utilizing of innovations encouraging the interaction between distinctive utilities, frameworks, administrations, and systems, with the main purpose of supporting the sustainable use of resources and increasing city administration efficiency, benefiting inhabitants, governance, and economic growth (Patrão et al., 2020).

According to Phadtare & IndajeetJadhav, (2017) Sustainable development of smart city is nothing but sustainable development that's profoundly responsive technologically to resource conservation and climate change. The urban multi-level governance structures and operations may facilitate the empowerment of the local built-up capacity.

Investments in technology, population, and institutions aimed at the smart city concept generate sustainable development and quality of life, promote responsible management of natural resources, and enable institutions to contribute with innovation and better services for citizens, strengthening debates and political participation (Trindade et al., 2017). According to Ortega-Fernández et al., (2020) innovation is the key to achieving sustainable cities. Sustainable development may be a pressing issue that requires prompt activity and change from governments, industry, and society as whole. Learning may be a pivotal component in these entities' interest of feasible development, which progresses their sustainability and enables sustainable performance. Presently more than ever, it is vital to contribute in development to create cities able of strength through arranged and feasible measures, such as encouragement of advanced technological change.

Smart city growth/ the city of tomorrow's idea are highly associated headway of advanced innovation, asset utilization, and put citizen's involvement as main role player. Smart development is characterized as an advancement that serves the economy, community, and the

environment and gives a system for communities to create an informed decision around how and where they develop. Recently, smart city growth has been strongly linked to modern regionalisms, or the spread of urban area with multiple local governments (Mohamed et al., 2020).

Guido Perbol & Mariangela Rosano, (2020) argue that policymakers nowadays understand smart cities as the next stage in urbanization, developing the quality of life for residents of the cities, expanding the effectiveness and engaging quality, whereas minimizing the environmental problems. Understanding the key characteristics and trends of smart cities become the crucial agendas for the sustainable development and inclusive growth of urban areas, in different countries.

Modern societies face tremendous sustainability challenges ranging from environmental (climate change, air quality issues, waste accumulation), economic (unemployment, economic inequality) to social (food insecurity, water scarcity, and poverty) challenges. Addressing sustainability challenges is of paramount importance. Smart city strategies and initiatives with an eye for SUD (Sustainable Urban Development) needs to be promoted to combat these challenges. The SUD perspective needs to consider factors such as economic development, ecological conservation, and democratic equity. Smart city projects support information and communication technology (ICT)-based innovations and tech-driven opportunities to assure cities' long-term viability and brings sustainable development (Kutty et al., 2020)

The Smart Environment concept is one of the 6 Smart City indicators, namely Smart Governance, Smart Economy, Smart People, Smart Mobility, and Smart Living. The Smart Environment concept is one of the efforts to improve urban environmental quality (Rahmayanti et al., 2018). A Smart Environment (SE) relies on communication and cooperation between varieties of technology devices, including sensor networks implanted in the environment, and servers in a permanent infrastructure. All of these devices combine computer, networking, and physical processes, and monitor and control the environment; making them a very efficient and cost-effective way to improve people's quality of life and security (Barsocchi et al., 2018).

African cities can use smart technological applications to solve their problems and catch up to other countries in terms of growth. For African cities to be competitive in the global market, smart city technology must be used. African countries are encouraged to use digital technology

to address essential development concerns while ensuring that residents' security and privacy are protected (Echendu & Okafor, 2021)

The definition of the Smart City in Addis Ababa includes the development and administration of urban green areas such as cooperative housing green areas and street trees. This is because the construction of multi-functional cooperative housing green areas and street trees contributes towards the smart city's goals in terms of improving the quality of life and environment for the city's residents (Kefelew & Megento, 2015).

Ethiopia is dominantly pursuing top-down approach in implementing smart city 50 projects. However, encouraging attempt is currently underway in implementing smart city initiatives under a public-private partnership (PPP) model and combination of both approaches (top-down, bottom-up) while involving both local and international ICT firms (Bayu, 2020)

To be smart is not only to use new technology. To be smart is to do things in a better way, to employ system-wide thinking for a good outcome, to deal tactfully with problems we face in this world in our daily activities, when planning each of our tasks and working hard for a brighter future; not only for the benefit of the current generation but also for the benefit of the next generation. This can lead to a better future and to create something new for humanity.

According to Winkowska, Szpilko and Pejić, (2019) a city cannot be called “smart” if it does not engage in environmental protection or resource management initiatives. The necessity of maintaining the natural environment's quality is paramount, as seen by efforts to reduce emissions, pollution, and the use of renewable energy resources. Consequently, because the smart environment is one of the components under the concept of Smart City, the concepts mentioned in this study about Smart City are also applicable to smart environment. As a result, the researcher believes that the practices and implementation of Smart City will be used in this study to discuss about smart environment.

However, only a few studies in the academic literature on urban smart environment initiatives in Addis Ababa context. This study tries to examine if urban smart environment implementation could be a solution for the urban environmental problems in Addis Ababa as a case study Akaki Kality Sub-city.

1.2 STATEMENT OF THE PROBLEM

Despite rapid and consistent economic growth over the last two decades, Addis Ababa is facing a number of shocks and stresses that could prevent it from meeting its development objectives. Shocks include flooding, urban fire, and disease outbreak; stresses include rapid and uncontrolled urbanization, water scarcity, and high unemployment (Teshome, 2020).

According Paul Pierce & Bo Andersson, (2017) Addis Ababa is consuming an increasing amount of natural resources while producing an increasing amount of waste and emissions. This causes air and water pollution, and the consequences are felt on a daily basis. Waste management, air pollution, traffic congestion, and resource scarcity are all major health and environmental challenges for city dwellers. Furthermore, the city's outdated technical and physical infrastructure is insufficient to accommodate the expected population expansion.

Additionally, Addis Ababa still does not have a modern solid waste disposal system especially considering when the city was established. There are only a few modern waste collection vehicles. There are currently 119 vehicles assigned to solid waste transportation. The vehicles' primary challenge is their age, as well as maintenance issues, driver irresponsibility, and frequent accidents. The vehicles only transport one container at a time to the disposal site, with a maximum capacity of $8m^3$ for front loaders and $10m^3$ for side loaders (Gelan, 2021). In most cases, the waste collected from the household is transported to the final landfill, Reppi, through open body trucks. This shows that there is still a backward garbage disposal system in Addis Ababa. An example of this can be seen in the photo below:

FIGURE 1: Transportation of Collected Waste through Open Body Trucks

Source: *Photo Taken by the Researcher, 2021*

According to Mohammed & Elias, (2017) only 65% of Addis Ababa's solid trash is collected and disposed of each day, 5% is recycled, and 5% is composted, while the remaining 25% is uncollected and deposited in unapproved locations, posing a serious environmental hazard. Domestic wastes account for the majority of municipal trash, hence their management and associated environmental implications are important to consider. The rate of solid waste generation per capita is 0.45 kilogram per day, while residential activities alone produce roughly 100,000m^3 waste water per day. Inadequate household trash management leads to a slew of environmental issues. The absence of sewage networks and treatment facilities complicates the collection and treatment of waste water, as sewer network coverage accounts for only 7.5% of the built-up area.

Akaki-Kality Sub-city is one of 11 sub-cities found in Addis Ababa. Addis Ababa hosts about 65% industries of the country and more than 90% of the industries discharge their waste to nearby rivers without proper treatment. Akaki River is the most polluted river in Ethiopia (Yohannes & Elias, 2017). Currently, there are more than 300 industries in Addis Ababa with an estimated labor force of 80,000. Akaki-Kality Sub-city is an industrial zone where 60% of metal, paints, garment and food processing industries of Addis Ababa are found (Hailemichael, 2018).

> *"One of the major emerging environmental problems in the tanning industry is the disposal of chromium contaminated sludge produced as a by-product of wastewater treatment. Tannery effluents severely affect the mitotic process and reduce seed germination in extensively cultivated pulse crops."* (Engida *et al.*, 2020)

Furthermore, Gile, (2018) emphasizes that despite the viability of smart solutions, neither the quality nor the quantity of smart solutions available in Addis Ababa have yielded optimal results. Currently, a lot of good work is being done by Addis Ababa City Administration through various environmental protection strategy implementations, including building parks and encouraging initiatives in the development of green areas. Teshome, (2020) reported the following:

> "*The multimillion dollar project "Beautifying Sheger" intended to decorate Addis Ababa. This 29 billion birr (about $1.028 billion), rivers and riversides development, project is slowly making the city green as works for developing and rehabilitating the two rivers in the city launched in February 2019 progress."*

While these efforts are encouraged, however, beautifying Addis Ababa with parks alone cannot be the answer to environmental problems. Furthermore, there has been a lot of work on green development in the past, but it has not generated significant results in solving environmental problems. Despite these efforts, the environmental problem is getting worse from time to time.

It is known that, various researches have been done on Addis Ababa. Some of more current, researches that have been conducted related to the environment were: by Abebe Amare (2019); Sileshi Azagew and Hailu Worku, (2020); By Tebarek Lika Megento and Gebrye Kefelew, (2015); Sileshi Azagew and Hailu Worku, (2020); Hamere Yohannes and Eyasu Elias (2017) the case of Nifas Silk Lafto Sub-city and Akaki-Kality Sub-city (Akaki River Basin) in Addis Ababa. The major findings focused on the causes of environmental problems; which are fast population growth, uncontrolled urbanization and industrialization, poor waste management practices, a lack of awareness on the part of the public and of government employees, weak institutional capacities, a lack of coordination among stakeholders, lack of financial and human resources, weak enforcement of development plans, built up area expansion, and lack of priority for Urban Green Infrastructure (UGI), by analyzing the key challenges and the solutions of the main source of environmental problems for the future in Addis Ababa. Based on these, various recommendations have been made, and it has been implemented for Addis Ababa's environmental protection.

However, the works of the researchers did not address a very broad scope and the new perspective of smart environments; to answer the fundamental question, "Is smart environment hard to implement in Addis Ababa?" Moreover, there are limited researches related to evaluating

if Addis Ababa is implementing smart environment, efforts carried out toward making Addis Ababa a smart environment and in explaining with enough evidence, to understand the challenges to implement smart environment in Akaki Kality, Addis Ababa. It is safe to say that, to-date there are no straightforward studies of urban smart environment implementation practices and research that examines smart environment as a solution for Akaki-Kality Sub-city's environmental problems.

The researcher chose Akaki-Kality Sub-city because it is known for its industries and as a result, pollution is more prevalent in Akaki-Kality than in the other sub-cities of Addis Ababa. Akaki-Kality Sub-city provides a broad answer to the issue of the relationship and significance of implementing a smart environment to environmental pollution problems in the Sub-city. Hence the gap of the study was trying to fill by assessing urban smart environment practices in Akaki-Kality Sub-city, by studying the role of government, the attitudes of environmental experts, the challenges on implementing of smart environment in Akaki-Kality Sub-city.

1.3 RESEARCH QUESTIONS

The research questions were focused on studying Assessing Urban Smart Environment Practices in Akaki Kality Sub-City, Addis Ababa City Administration. The research questions were:

1. Is there any smart environment practice so far in Addis Ababa?
2. What are the roles of government in creating urban smart environment practices in Akaki Kality Sub-city, Addis Ababa?

1.4 OBJECTIVES

The overall objective of this research study was to assess urban smart environment practices in Akaki-Kality Sub-city, Addis Ababa. Under this, the specific objectives were:

1. To investigate the main benefits of implementing urban smart environment to Akaki-Kality Sub-city, Addis Ababa
2. To assess the attitudes of environmental experts on creating urban smart environment practices in Addis Ababa
3. To identify the challenges of creating urban smart environment in the Addis Ababa context

1.5 SIGNIFICANCE OF THE STUDY

The main implication of this study would be a starting point to assess urban smart environment practices in Akaki-Kality Sub-city, Addis Ababa. This study has significance for the different actors listed below:

For the government: This study clearly indicates, environmental issues, the gaps and challenges of green development. Also, this study clearly indicates the government's role in the successful implementation of a smart environment. Using the evidence presented in this study, the government can potentially make practical decision-making changes to achieve sustainable green development.

For other stakeholders (e.g. Industries, Private Business, Community or community-based organizations, and voluntary groups (NGOs), Academic Institutions etc…): in this study, the lack of coordination among stakeholders is one of the reasons that environmental problems are not solved. In this regard, it is important to note that stakeholders have a significant role to play in the future of smart environmental implementation. This study shows possible ways for these stakeholders to work together and contribute their share to successful urban smart environmental implementation.

For Environmental Protection and Green Development sector: this study can provide tangible evidence for the sector to understand environmental experts' attitudes in Akaki Kality Sub-city, Addis Ababa, their understanding and need to give a clear view on what their main idea is in terms of technology and innovation. By recognizing their knowledge of technology and using it as a starting point for future plans and operations, it can be especially helpful as a guide to how to get started in the implementation of a smart environment.

For policy makers: this study tries to find out what the current state of smart environment implementation in Addis Ababa. It aims to answer the question, "How can we take advantage of the existing situation in Addis Ababa by applying Smart Environment as a new concept?" Smart environment is believed to be a good starting point in order to create a better environment condition in Addis Ababa City. By recognizing, the vast benefits of a smart environment to make more accurate decisions and to develop policies to enable the use of smart environment strategies as a solution to environmental problems in the future.

For researchers: this study identifies the gaps for researchers who want to do further research related with smart environment. This research can be utilized as a starting point for researchers and other academic institutions to dig deeper into a new concept called Smart Environment, which could be the new way to solve the numerous environmental problems of Addis Ababa.

1.6 SCOPE OF THE STUDY

Spatial scope: geographically the study was limited to Akaki-Kality Sub-city, one of the 11 sub cities, found in the southern part of Addis Ababa. Akaki-Kality Sub-city is located at 8.895831 latitude and 38.789162 longitudes in Addis Ababa, Ethiopia It has GPS coordinates of 8° 53' 44.9916" N and 38° 47' 20.9832" E and it is located 2,140m above sea level (Hailemichael, 2018)

Thematic scope: thematically it focused on assessing urban smart environment practices in Akaki-Kality Sub-city, found in the southern part of Addis Ababa City.

Target group: the target groups of the study were experts working in 13 Woredas and Akaki Sub-city Environmental Protection and Green Development Offices.

Unit of analysis: the researcher selected mixed research approach that enables the researcher to use both qualitative and quantitative analysis. The main focus of the study was assessing urban smart environment practices in Akaki-Kality Sub-city, Addis Ababa by studying the role of government, the attitudes of environmental experts, the challenges and the importance of collaboration and engagement of different stakeholders on the implementation of smart environment in Akaki-Kality Sub-city.

Temporal scope: the data gathering has been conducted on different days; from Akaki-Kality Sub-city Environmental Protection and Green Development Office, 4 key informants were interviewed on May 14, 2021. In addition, the research questionnaires were distributed to all 13 Woredas and Akaki-Kality Sub-city Environmental Protection and Green Development Offices from May10, 2021 to May 14, 2021 for 4 days and the required responses data was gathered.

1.7 LIMITATION OF THE STUDY

The findings of this study have to be seen in light of some limitations. The sample size and research method of this study only focused primarily information obtained from experts and their perspectives of Akaki-Kality Sub-city Environmental Protection and Green Development Office. This researcher not able to cover the community and different stakeholders, as well as the government's top-down approach perspectives in Akaki Kality Sub-city, Addis Ababa.

CHAPTER TWO

2 REVIEW OF CONCEPTUAL AND RELATED LITERATURE

This chapter provides review of the related literature on the concepts of urban smart environment practices. It also provides theoretical, empirical and conceptual approaches of Smart Environment. Accordingly, available related studies have been critically reviewed in this chapter.

2.1 CONCEPT AND DEFINITION OF SMART ENVIRONMENT

According to Oke et al., (2020) multi-functional devices can be implemented to monitor the causes contributing to climate change. These devices used to monitor resource; one of these multi-functional devices is called "smart meters" which has "flow meters and pressure sensors" that measures the level of consumption electricity, water, and gas usage and energy outputs. Similar to this, Cominola *et al.,* (2015) emphasis that a growing number of cities around the globe are testing smart waste management solutions to create higher effectiveness in terms of resources and costs related with keeping their cities clean.

According to Roggema (2020), the interlinked development of sustainability awareness, urban growth, and technological development have recently converged under what is labeled 'smart sustainable cities'. Smart sustainable cities can be defined as a human composed of a complex network of relationships between various synergistic clusters of urban substances that, through an all-encompassing and systemic approach, meet on a common approach to using and applying smart technologies that enable to create mainstream solutions that help provide a fertile environment conducive to improving the contribution to the goals of sustainable development.

There is no doubt that technology plays a major role in shaping the modern urban landscape and there is a wide range of technologies that drive urban innovation and sustainability, from renewable energy to electric cars and internet-based solutions. The global technological advancement which is pushing ICTs and their integration in urban environments, enabling the construction of smart cities, should be aligned with local urban dynamics and local needs (Komninos & Mora, 2018).

Similarly, benefits of applying advance sensors in cities presented by Ramírez-Moreno et al., (2021) emphasis that regarding smart water monitoring, sensors are used to measure water quantity and quality data continuously and consistently. The obtained data can be processed and visualized in real-time to the end-users, or forecasts can be developed for the water agencies. These technologies allow minimization of the risks associated to poor water quality and deficiencies in water supply. Regarding with solid waste management, currently sensors can identify wet, dry, or metal garbage; however, it would be optimal to develop sensors that allow identifying waste in greater detail. Because of their adaptability, ICT-based innovations in energy consumption monitoring in buildings, public lighting systems, and urban settings are a great alternative. Intelligent lighting systems with sensors adaptable to weather conditions, hours of use and presence of people or vehicles where the street lamps serve as Wi-Fi connection points, allowing interconnected networks over the entire urban area monitoring the quality of the environment, noise levels, and surveillance, among others.

Investments in high-speed fiber networks and smart city innovations to improve service delivery, a strategy for how data will be shared, managed, and secured, and a smart city master plan to guide decision-making and investments are all required to become a smart city. However, most importantly, becoming a smart city requires adopting new technology that meets the needs of its citizens, ensuring that cities do not lose sight of being inclusive, equitable and sustainable as they strive to be smart (Johnston, 2019).

Sustainable city should enhance resource management while maintaining a high standard of living. Applications of smart cities in the context of economic growth, social interactions, and leadership issues focused on developing a model related to municipal and governmental cooperation. Smart cities, should invest resources by providing capital and contentment, as well as enabling corporations. In addition, smart citizens should bring their intelligence and innovative concepts to the city (Kirimtat et al., 2020).

According Barro et al. (2018), using the current generation of smart city technologies, cities might achieve tremendous progress toward the Sustainable Development Goals. Similarly, Africa has been urbanizing fore few decades at an exceptionally fast pace, It is now more important than ever to plan for the sustainable development of cities and to employ advanced technology components while adopting what is being done in developed countries and by adding Africa personal peculiarities (Johnson, 2018).

Good experience from Africa’s cities, Cape Town's government has initiated a four-pillar strategy to make the city a Smart City. Cape Town's Smart City Pillars Graphic of a digital smart city Cape Town has been hailed as one of Africa's smartest cities, thanks to its open data portal, which makes public all data collected from its citizens, and digital inclusion through free Wi-Fi enabled on city buses. The availability of city data is only one small step in the external data revolution. The city is already using real-time data to improve emergency response, such as fire and rescue, law enforcement, and disaster risk management (Sokolowski, 2018).

In a digital innovation ecosystem, this information ecology theory identifies several key functions that digital technologies serve in providing the information needed to support the interactions and tasks for innovation in ecosystems of varying scales in a digital innovation ecosystem by synthesizing ecological and information perspectives (Wang, 2021).

According to Jesus, Claro and Rios, (2021) the Internet of Things (IoT) connects multiple devices in the same area on a daily basis. A set of rules from a static environment may be followed by each device. A static environment is usually managed by an expert who is familiar with all of the rules that govern it. When two or more devices interact to create instability in an environment, this is known as a feature interaction. The inclusion and exclusion of devices in a dynamic environment like to makes it impossible for an expert to keep all of these rules up to date. To avoid violating these rules and maintaining the environment's good performance, an automatic solution must be provided.

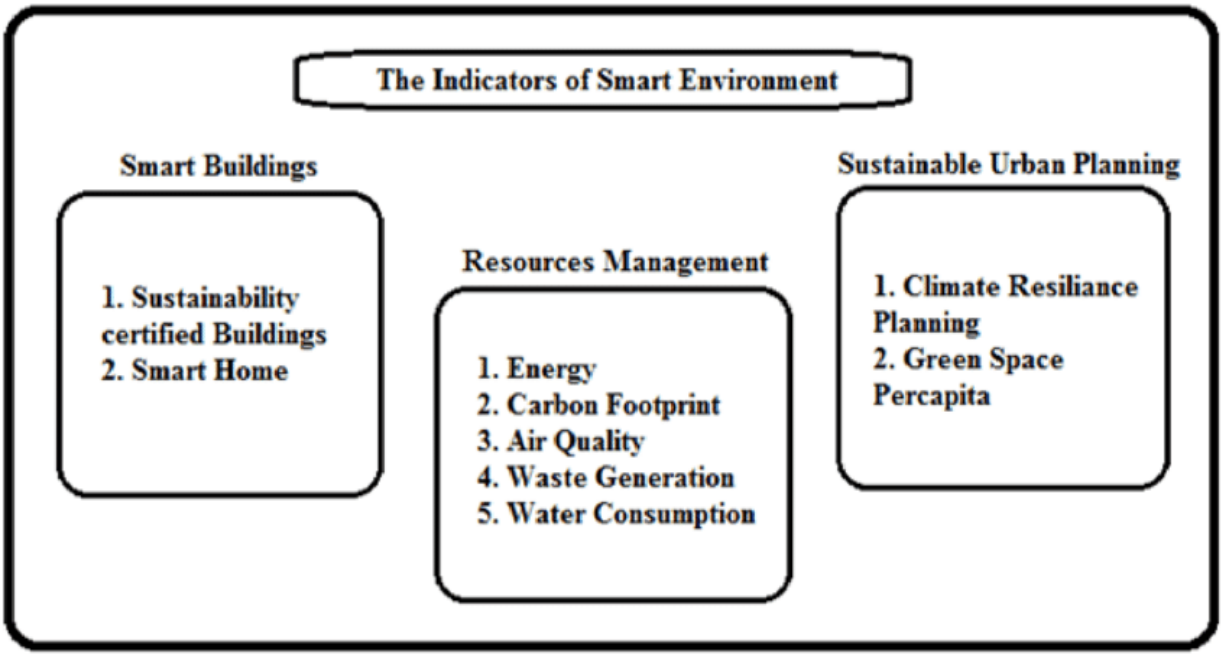
Techno-stakeholders ‘perspective by considering data driven initiatives for smart city development are being considered by techno-stakeholders. The model is based on data-driven initiatives that influence the perspectives of techno-stakeholders in order to promote smart city development (Jnr, 2021).

The human-smart environment interactions (HSEI) framework in smart cities is worked in taking people and their experiences and assessments more meaningfully into consideration. As such, a key contribution of this work is the development of a conceptual framework for smartness and human-smart environment interactions (HSEI) and dimensional relationships in smart cities, with implications for urban interactions and associated intervention potentials for innovation and learning (McKenna, 2020).

New Technologies has effectiveness and delivered a sustainable future for city development. Green innovation which involves creating a green city in terms of urban form, transportation

system, and energy and resources is an important approach for achieving sustainable city development(Goi, 2017)

Figure 2: The Indicators of Smart Environment



Source: Purnomo *et al.*, 2020

2.1.1 THE ROLE OF GOVERNMENT ON SMART INITIATIVES IMPLEMENTATION

According to Alaverdyan et al., (2018) Governance is the fundamental actors of Smart City initiatives. The main role of governance is to bring these initiatives closer to communities and allow them to participate in their implementation, monitoring, and evaluation. List "smart" actions: that support in the formation of Smart City governance, such as collaboration, cooperation, partnership, citizen involvement, and participation.

Similarly, Schaffers et al., (2012) agreed that governments set challenge of competitiveness, inclusion and sustainability, and develop and implement policies for urban development and orchestrate the planning and decision process. Pre-commercial procurement, for example, is one policy tool that helps to encourage innovation.

Ilyas et al., (2020) suggested that the government facilitates the adoption of green practices that can consequently contribute to SDGs. Likewise, Cao et al., (2019) also suggested that governments should make prudent use of investment in research and technology, as well as the oversight system. Governments should make more scientific and technological investments in pollution management and emission reduction, as well as improve the scientific execution of administrative measures by raising resource and environmental performance metrics. Meijer & Bolívar, (2016) emphasis that Smart city governance is about fostering new kinds of human collaboration via the use of information and communication technologies (ICTs) in order to achieve better outcomes and more transparent government procedures.

Hashemi *et al.*, (2020) by explaining from experience obtained from the cities Amsterdam, Barcelona and New York in implanting smart city successfully; emphasis that, the appropriate policies and participation of citizens are the key to the success of smart city initiatives. Similarly, AR *et al.*, (2021) argued that smart Cities the principles of good governance include community participation, upholding the rule of law, transparency, care and stakeholders, oriented towards consensus, equality for all citizens, effectiveness and efficiency, accountability, and strategic vision.

According to Myeong et al., (2018) administrative manpower requires in the form of smart talent with the ability to predict, create, and communicate. Saraih et al., (2020) suggested that some activities which can be channeled to the management to continue the existence of perceived justice are: 1) The management needs to fairly rewarded employees by considering the responsibilities they have; 2) The management needs to fairly rewarded employees by considering the education and training they have; and 3) Management must fairly reward employees by taking into account the stresses or strains they faced in completing their job.

Pratama & Imawan, (2019) governments should consider four dimensions of readiness in its programme of smart implementation. First, establishing bureaucratic preparation requires the commitment of the higher echelons, including the mayor and senior civil servants. In strategic policy decisions and planning, the support of the higher echelons is extremely beneficial. Second, clear and thorough regulations for smart city initiatives may provide smart city implementation with significant legal power. Because the bureaucracy must be backed up by legal and written laws, a regulatory framework is seen as crucial for putting smart city policies into effect. Third, because smart cities are so heavily reliant on technology, IT resources – the

extent to which the bureaucracy is capable of designing, implementing, and maintaining IT infrastructure, as well as the skills required to facilitate a smart city program – must be considered. Fourth, the bureaucracy's ability to conceive, develops, and sustains smart city policy-supporting strategies, decisions, and structures may influence the bureaucracy's readiness to undertake a smart city program.

The government's commitment could be measured according to Tomor et al., (2019) encompasses a wide range of aspects, including motivation, vision, and strategies, attitudes, decision-making, process coordination, and roles and responsibilities, as well as the provision of financial, regulatory, technological, and human resources, knowledge management, and organizational culture, among others The first organizational feature is commitment, which refers to how driven local governments are to participate in sustainable development through ICT-supported urban collaboration. Similarly, Pratama & Imawan, (2019) illustrated that the commitment of government could measure by timescale, implementation scale, and background of the management programme.

According to Tan & Taeihagh, (2020) technology-enabled smart cities in developing countries can only be realized when concurrent socioeconomic, human, legal, and regulatory reforms are instituted. Governments need to step up their efforts to fulfill the basic infrastructure needs of citizens, raise more revenue, develop human capital, assure digital inclusion, and promote environmental sustainability by establishing clear regulatory frameworks to prevent technological threats. A supportive ecosystem that encourages citizen participation, nurtures start-ups, and promotes public–private partnerships needs to be created to realize their smart city vision

According to François, (2019) revisiting city governance implies a culture of innovation that incentivizes experimentation and risk taking but also dedicated goals, strategies, staff, and budget. It is also important to reinforce strategic management and innovation capabilities of local public officials to design and implement integrated urban strategies that match the complexity of current and future challenges. New and broader forms of citizen engagement that put local residents at the center of policy planning, design, implementation and decision-making regarding public spaces and infrastructure choice are also spreading out through citizen councils, use of technology, citizen monitoring and public innovation labs. Open government initiatives

also contribute to expanding and facilitating access to public information, increased transparency and accountability of decision-makers, as well as instances of co-creation of public policies

The Collaborative Governance Regime (CGR) is a specific, systemic approach to making public decisions in which cross-sectional cooperation is the preferred mode of behavior and activity. Simultaneously, the model examines a viewpoint on the political, tangible, socioeconomic, and environmental contexts and functions as a preliminary analysis of opportunities and constraints taken into account when talking about collaboration (Gavriloaia, 2019)
Open government Data (OGD) has enormous potential to improve transparency, accountability, and participation while also improving operational efficiency, data-driven and evidence-based policymaking, and trust in government institutions (Khurshid et al., 2020).

2.1.2 The Collaboration, Participation and Engagement of the Community and Various Stakeholders on Smart Environment Implementation

> *"Stakeholder engagement can take place in different ways, ranging from basic communication and stakeholders participation and feedback, to full co-production, co-delivery and co-evaluation, which implies a balanced sharing of powers among stakeholders. Digital innovation and technologies can also facilitate new forms of engagement with a broader range of urban residents and other stakeholders, and co-production throughout the policy design and implementation process"* (Aline, 2020).

Multiple actors include formal and informal, governmental and non-governmental, public and private. For these actors to effectively and achieve collective goals, institutionalized arrangements establishing structures and systems have to be put in place, and these will emerge out of the stakeholders' diverse interests through consensus building and/or contestation. Ideally, urban governance as a process facilitates persuasion, contestation, bargaining and, finally, consensus building among actors during urban policy development (Bekker et al., 2021).

Citizens and urban planners can benefit from understanding and considering stakeholders' desires for green areas development and involving them in the planning process. Furthermore, taking into account citizens' perceptions and preferences is viewed as a first step toward encouraging and facilitating effective citizen engagement and government (Ferreira et al., 2020).

In the same way, Woldesenbet, (2020) also suggested that multi-stakeholder governance should result in the development of new and more fundamental capability to achieve a common goal, as well as the coming together of all stakeholders' unique resources to create the possibility for collaborative action. Establishing common committees, monitoring agreements, evaluating outcomes, and otherwise managing the partnership processes are all part of this stage. This promotes transparency and trust among stakeholders.

A smart city requires not only the development of advanced technological solutions, but also the empowerment of city actors to innovate in response to recent city challenges; to innovate, stakeholders must collaborate on the basis of mutual trust; and a partnership organization for a smart city is needed to connect the relevant actors, facilitate co-creation processes, coordinate the implementation of those solutions and accelerate innovations (Carmen Cantuarias-Villessuzanne et al., 2021).

The ultimate goal of smart city development is to enhance the quality of citizens through advanced ICT, rather than the development of advanced technologies themselves. Therefore, it can be said that bottom–up policy approach is required, rather than a top–down one, in the process of building smart city. Citizen participation is the most important factor in smart city development and cannot be excluded from policy alternatives for solving various urban problems. It would be preferable to design a smart city with methods for communicating with and listening to the needs of citizens and implement solutions in conjunction with policies (Myeong et al., 2018).

Pereira *et al.*, (2017) cited different authors define transparency as the ability to gain access to data or information about government activities, which aids in areas such as responsiveness and influence over government. Transparency can be seen in information sharing and integration among government organizations, as well as the accessibility of information and decision-making processes related to the provision, monitoring, and delivery of services, from both the internal and external perspectives of smart government.

2.2 EMPIRICAL LITERATURE REVIEW OF SMART ENVIRONMENT

In smart cities, air pollution can be reduced effectively using green transport; bicycle lanes, more greenbelt areas, more renewable energy, and a ban on the burning of municipal and agricultural garbage are all things that should be considered. The advantage of smart city people depends on the rapid collection of big data, modeling, analysis, and forecasts, as well as translating it to practical information (Dwevedi et al., 2018).

According to Graham, (2020) in Sub-Saharan Africa, multi-stakeholder collaborations are proven to be a viable tool for boosting climate resilience. Effectively implementing these innovative projects contributes to safeguarding the life and economic livelihoods of populations spread across some of the region's most disaster-prone landscapes. The increasingly multi-scale and multi-stakeholder arrangement of these partnerships in sub-Saharan Africa highlights their potential in building climate resilience in other regions comprising.

ICT-supported government–citizen cooperation for collectively shaping public matters rarely occurs. The reason for this lies in the lack of capacity and willingness to genuinely engage in smart governance for urban sustainability, both on the part of government and that of citizens. Old structures, patterns, and routines still dominate. Evidently, the simple availability of technological infrastructure is no guarantee that any radical attitudinal change will occur in public administration and the civil sphere regarding the development of co-creative collaboration to create more sustainable cities (Tomor et al., 2019).

According to Meijer & Bolívar, (2016) for a comprehensive perspective: smart city governance is about crafting new forms of human collaboration through the use of ICTs to obtain better out comes and more open governance processes.

Rachmawati & Pertiwi, (2017) by doing research and learn good practice from the success of Bandung City, suggested that municipal government to constitute good cooperation with other agencies within the governments and with other higher level of government (national government and other local governments), and also with third parties such as private sectors and NGOs. Further, every initiatives were characterized with the community engagement which contribute to its success

According to Novita & Supranoto, (2019) the ability of personnel to operate advanced information technologies is more important than the availability of advanced information technologies for the success of the smart city, in addition to the necessary collaboration of all stakeholders (government, public, and private) so that the city's vision can be realized through the application of smart city.

Energy management is a new concept use of energy efficiently and sustainable. Energy management benefits are multipurpose and appropriate to any smart environment (Silva et al., 2020).

Challenges of developing smart initiatives in cities are lack of budgets for deploying sensors, developing information systems at the enterprise level, integration of systems, and creating ICT infrastructure (Khan et al., 2020).

Ethiopia's Addis Ababa has showed good progress in implementing smart city initiatives and projects. However, lacks clarity in smart cities, undeveloped local governance system, poor urban planning and design practices, poor participation & the challenge of inclusion, mindset problem, lack of resources to finance urban infrastructure and undeveloped information technology system are among the numerous challenges that they are facing in smart city design and implementation (Bayu, 2020).

2.3 THEORETICAL FRAMEWORK OF SMART ENVIRONMENT

Sustainable urban development is a multidimensional theory that encompasses a wide range of activities. such as environmental protection, human development, and inhabitant wellbeing (Tang & Lee, 2016). Sustainable urban development is essential for protecting the natural environment as well as the well- being of people and the society at large, as inappropriate urban planning and development practices have the potential to adversely affect the surrounding environment (Kaur & Garg, 2019). Sustainable urban development will require changes in governance, markets, and regulations not only for cities and nations, but also for the environment's hinterlands. As these are in many instances global, it is global reforms in trade and in environmental standards that will force the shift towards sustainable urban development (Haughton, 1997).

According to Batagan, (2011) the sustainable development depends on the access to more and smarter solution. For smart and sustainable growth of a city is important to promoting a use more

efficient of resource, a competitive economy and an economy base on knowledge and innovation. In other words, sustainability model for cities development must use efficiently the smart solutions. This will determinate less consume of non-renewable resources and in the same time increases the produce of new resources like solar energy. All of this will improve the quality of life and the efficiency which are related with the definition of sustainability

With regard to Ethiopian urban development, the Addis Ababa Structure Plan was prepared to guide the development of the city for the ten years (2013-2023), keeping in mind that the city must meet the economic, social, cultural, and environmental goals outlined in Articles 89-92, and the right of the residents to "improved living standards and to sustainable development" by indicating major "development activities ... to enhance the capacity of citizens for development and to meet their basic needs" (FDRE constitution art 43(1) and (4)) (Bayu, 2020).

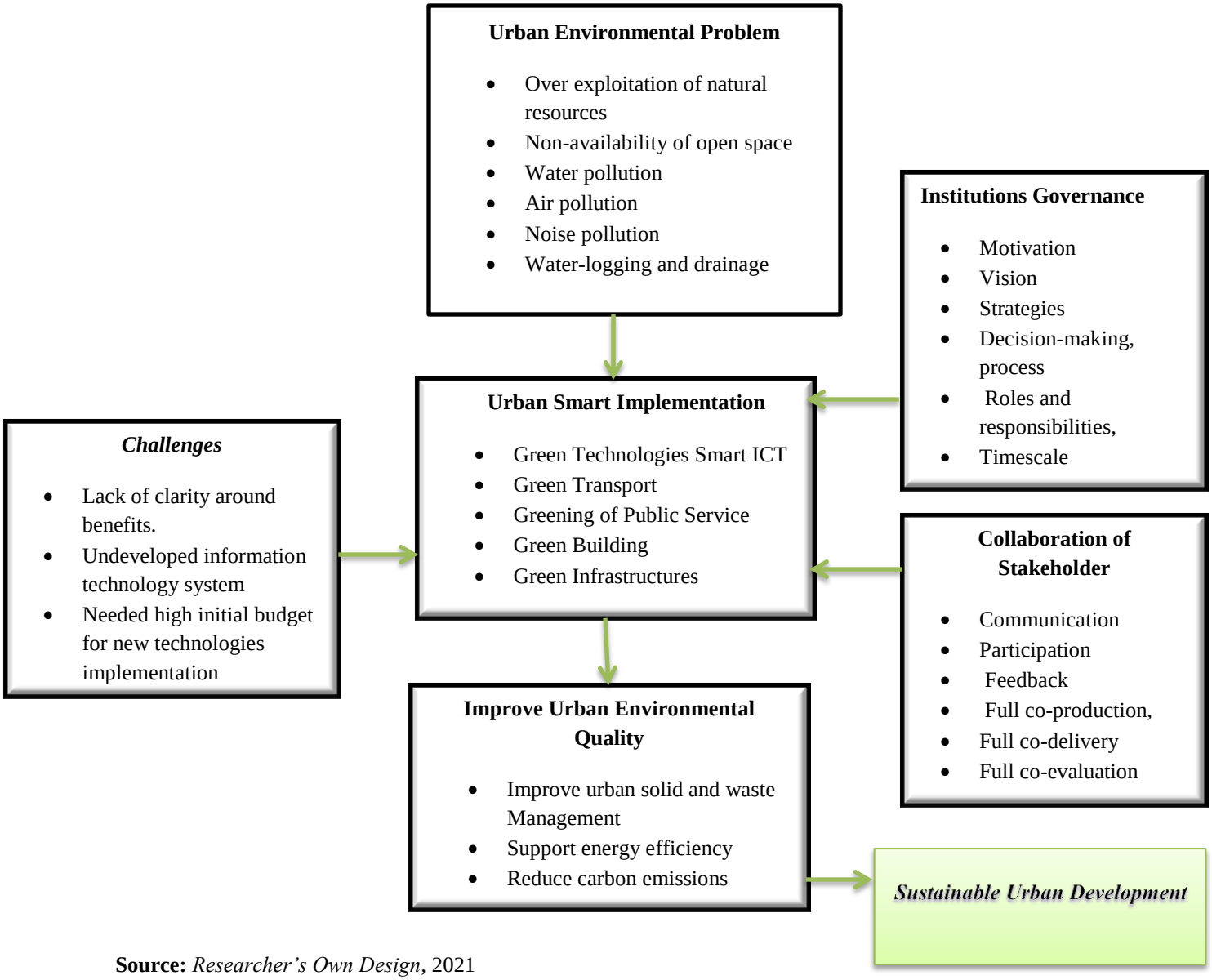
Urban environmental transition theory, suggests that cities become wealthier their environmental impacts change from localized, immediate, and health-threatening to globalized, delayed, and ecosystem-threatening. The approach is useful because it recognizes types of environmental challenges that citizens experience at different levels of development and also injects the issue of scale into the shifts in environmental burdens. As cities develop their environmental challenges increase in scale from the household and neighborhood levels to citywide regions i.e., the challenges then shift from access to water and sanitation and indoor air pollution to metro-wide air and river water pollution (Marcotullio & Lee, 2003).

The stakeholder theory concerns issues of trading, value creation, ethics of capitalism, social responsibility, and the managerial mindset. Stakeholder Theory is based on any individual (i.e. a third party) who is affected or influences the firm's actions and policies, and with whom there is a dependent relationship, ethics and businesses integrated, and then value is generated on a medium and long-term basis.. Stakeholder theory within the city context, stakeholders' engagement on planning processes and urban design promotes the urban resilience reducing activities related to disaster risks. In the long-term, the urban planning has taken into account the stakeholders' participation and collaboration on more sustainable, smarter and healthier policies, e.g. mobility, population growth, land-use planning, and smart city projects ,sustainable urban drainage system, climate change adaptation, government influence on supply chain and its competitiveness (Beck & Storopoli, 2020).

2.4 CONCEPTUAL FRAMEWORK OF THE STUDY

The study undertakes conceptual framework which is formulated the relationship between independent variables and dependent variable. The study aimed to examine the effect relationship between independent variable and dependent variable. In this conceptual framework, urban smart environment is the dependent variable, whereas collaboration of stakeholders, institutions governance and challenges are independent variables. Based on this conceptual framework, the dependent variable factor is influenced by independent variables. It moreover demonstrates that a few independent variables may be more powerful than the others depending on the setting. For this research conceptual framework formulated as follows:

Figure 3: Conceptual Framework of the Study



Source: *Researcher's Own Design*, 2021

CHAPTER THREE

3 RESEARCH METHODOLOGY

3.1 DESCRIPTION OF THE STUDY AREA

3.1.1 LOCATION

Addis Ababa is located between the latitudes of 8°50′ N and 9°5′ N, and the longitudes of 38°38′ E and 38°54′ E. With a population estimated of 3.44 million people in 2017, it is Ethiopia's capital and the largest city. Ethiopia's capital is home to 25% of the country's urban population and is one of Africa's fastest growing cities. The city's contribution to the national Gross Domestic Product is currently around 50%, showing its critical significance in the country's overall economic development (Feyissa et al., 2018). Akaki-Kality Sub-city is one of the 11 sub cities of Addis Ababa. The Sub-city is found in the city's southern part of Addis Ababa city (Kidane, 2020). Akaki-Kality Sub-city is located at 8.895831 latitude and 38.789162 longitudes in Addis Ababa, Ethiopia. With GPS coordinates of 8° 53' 44.9916" N and 38° 47' 20.9832" E. And it is located 2,140 m above sea level (Hailemichael, 2018) .

3.1.2 POPULATION SIZE

The population of Akaki-Kality Sub-city is estimated about 195,273 with 95,558 female and 99,715. the population density per sq. m is 1,653.7 (*Akaki Kaliti Sub City - Aaca*, 2021).

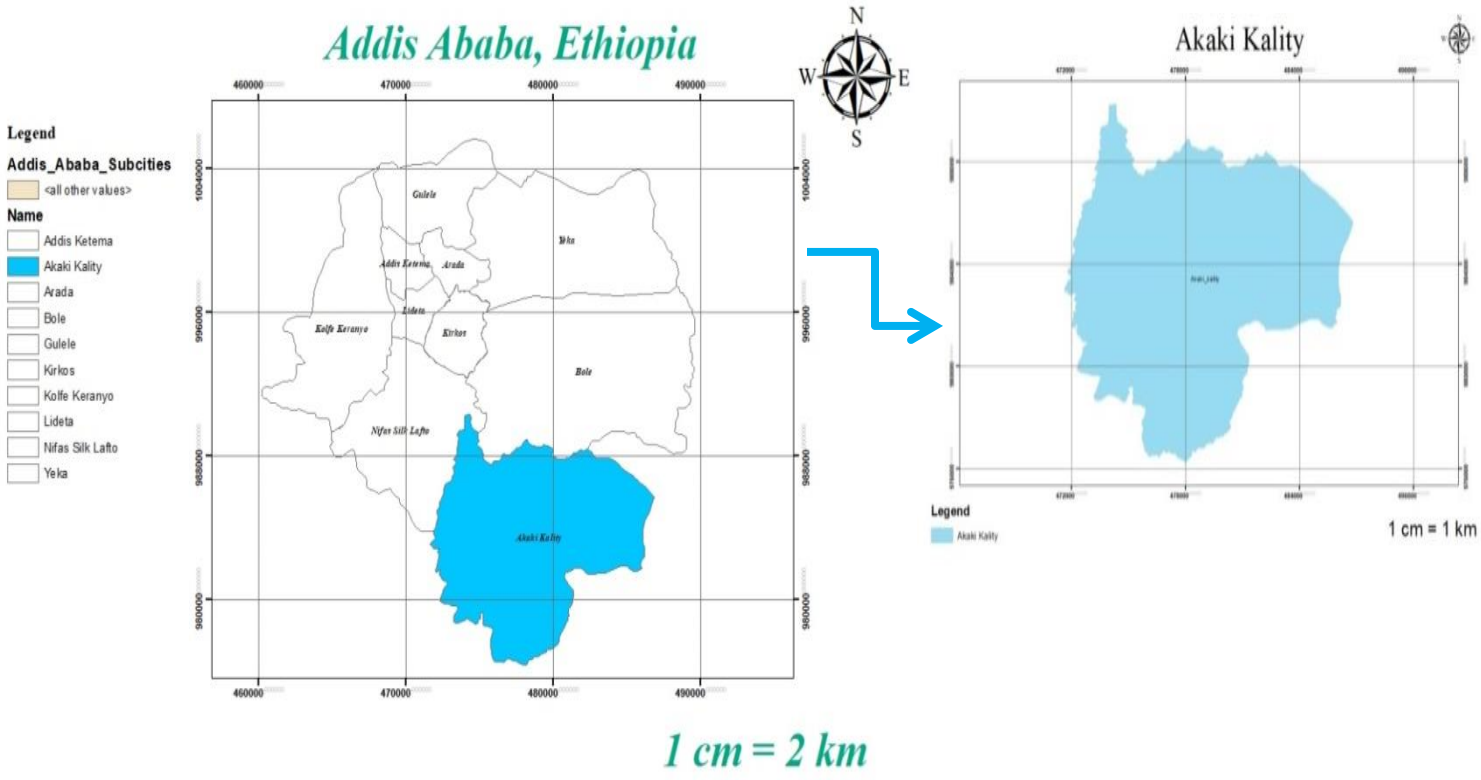
3.1.3 RAINFALL AND TEMPERATURE

Akaki Kality Sub-city area has the highest mean monthly maximum temperature found in the months of March and the lowest is in the month of July. The mean monthly minimum temperature is in December and the highest in May. Therefore the average temperature of the study area (for the period 1998-2017) is 18.4^{o}C (Kidanewald, 2018). The average annual rainfall is 1800 mm, with a bimodal pattern. In the area, there are dry and wet seasons. The long rainy season from June to September, accounts for roughly 84 % of total annual rainfall, while the dry season lasts from October to February. The rainy season lasts from March to May. The average relative humidity is 61.3%. The mean relative humidity is 61.3% (Getachew et al., 2020).

3.1.4 SOCIO-ECONOMIC CHARACTERISTICS OF AKAKI KALITY SUB-CITY

The Akaki River found in Akaki Kality Sub-city is heavily used for socioeconomic development. Urban farmers downstream use this river water to cultivate vegetables along the river's banks, supplying the city with fresh vegetables. Fishing is also done in the lower reaches of the river and at the Aba-Samuel Reservoir (Teku, 2006). Residents of the sub city include factory workers, day laborers, people working in urban agriculture, civil servants, military personnel, commercial sex workers, unemployed youth and women, and so on. The majority of this population is made up of factory workers and civil servants. Factory workers earn between $ 500 and $ 600 per year. The majority of factory workers and the rest of the population earn less than US$ 1 per day (Hailemichael, 2018).

Figure 4 : Location of Akaki-Kality Sub-City



Source: *Researcher's Own Design*, 2021

3.2 RESEARCH DESIGN

This study incorporated mixed research both quantitative and qualitative data. According to Creswell, (2013) a mixed methods design is useful to understand a research problem and the strengths of both quantitative and qualitative research (and its data) can provide sufficient and useful results for the study's overall analysis. Qualitative approach was used in order to provide an in-depth understanding about smart environment implementation practices in Akaki-Kality Sub-city. Semi-structured interviews with key informants were carried out to gather qualitative type of data. Quantitative approach was used to understand the relationship among variables and also to identify the factors of urban smart environment implementation in Akaki-Kality Sub-city.

3.3 SOURCE OF THE DATA

3.3.1 PRIMARY DATA

Primary sources of information include in this research survey questionnaires (data collected from targeted groups of people about their opinions, behavior or knowledge). The population of this study was the experts of Akaki-Kality Sub-city 13 Woredas who were working on Environmental Protection and Green Development Office.

Primary data sources were collected by using self-administered questionnaire. The survey tool questionnaires were developed from previous studies theories and concepts related with smart environment implementation, in accordance with the situation in Akaki Kality, Addis Ababa and modified to fit the study. The questionnaires were comprised of questions related to environmental protection activities and smart environment. Questionnaires typically contain multiple choice questions, attitude scales, closed questions and open-ended questions. The questionnaires was first prepared in English and translated to local language (Amharic) to help the experts to clearly understand the questionnaires and provide accurate answers. Interview was conducted with the key informant supervisors working on Akaki Sub-city Environmental Protection and Green Development Office.

3.3.2 SECONDARY DATA

The secondary data sources were books, journals, researches, articles, and reports related to the study. In addition, other environmental and smart initiative policy and strategic paper was used for this particular study.

3.4 SAMPLING TECHNIQUE AND SAMPLE SIZE

Purposive sampling is a non-probability form of sampling. The goal of purposive sampling is to sample cases/participants in a strategic way, so that those sampled are relevant to the research questions that are being posed (Bryman, 2012). The experts' participants in this research were selected using a purposive sampling method. Expert sampling (or judgment sampling) is a method of obtaining a sample from experts in the field being studied. It's used when you need the opinions or assessment of people with a high degree of knowledge about the study area. When used in this manner, expert sampling is simply a subset of purposive sampling (Stephanie, 2015). Accordingly, all experts available at work on Akaki-Kality Sub-city Environmental Protection and Green Development Office were selected for this research. Based on this, the selected participants or experts in this study consists total of 98 samples. The research was conducted in all 13 Woredas of Environmental Protection and Green Development Office Akaki-Kality Sub-city Administration in Addis Ababa, Ethiopia.

3.5 METHODS OF DATA ANALYSIS

Data analysis is systematic application of statistical and logical techniques to describe the data scope, improving the data structure, summarize the data representation, demonstrate via tables, and graphs, and evaluate statistical trends, probability data, and develop meaningful conclusions (Kaur Arora, 2021). From the total sample size of 98 respondents, all 98 questionnaires were fully responded by both experts from 13 Woredas and Akaki-Sub-city Environmental Protection and Green Development Offices from May10, 2021 to May14, 2021 for 4 days. Furthermore, 4 key informants from Akaki-Kality Sub-city Environmental Protection and Green Development Offices were interviewed on May14, 2021.

The data were organized, coded and converted to frequency, percentage forms and analyzed using computer software, Statistical Package for the Social Sciences (SPSS) version 24. The data was arranged in the form of table, chart and graphs. This study focuses to assess urban smart environment practices in Akaki-Kality Sub-city, Addis Ababa. Therefore, frequencies and percentage was applied to describe results obtained from questionnaires. Information that was generated from key informant interviews, were analyzed through listening, and transcription personal observations were analyzed using thematic analysis method. Thematic analysis is a powerful yet flexible method for analyzing qualitative data. That is an appropriate method of

analysis for seeking to understand experiences, thoughts, or behaviors across a data set. Themes are actively constructed patterns (or meanings) derived from a data set that answer research question, as opposed to mere summaries or categorizations of codes. Themes can be generated inductively or deductively (Kiger & Varpio, 2020).

3.6 MODEL DESCRIPTION

The study aimed to examine the effect relationship between independent variable and dependent variable. In this conceptual framework, urban smart environment is the dependent variable, whereas collaboration of stakeholders, institutions governance and challenges are independent variables. To predict the event probability for a categorical response variable with two outcomes, binary logistic regression is the best option to use. Since the probability of an event must lie between 0 and 1, it is impractical to model probabilities with linear regression techniques, because the linear regression model allows the dependent variable to take values greater than 1 or less than 0. The logistic regression model is a form of generalized linear model that extends the linear regression model by connecting the real-number range to the 0-1 range (Hosmer & Hjort, 2002).

3.7 ETHICAL CONSIDERATIONS

At first, the letter received from Addis Ababa university was delivered to Akaki Kality Kality Sub-city Environmental Protection and Green Development Office and permission letter was obtained to conduct research in all 13 Woreda Environmental Protection and Green Development Offices. The researcher also enables the respondents to make a voluntary consent to participate in the study and without disclose the name of employee to the third parties. In addition, the researcher distributed the questioner without any discrimination and provide free of personal opinion. Similarly, the researcher gave proper acknowledge and cited the sources that were used during the study and the respondents became more open to provide better information needed to be gathered for the study. Finally, all information were collected from respondents and key informants and also all information obtained from the sources were kept confidentially the data was analyzed and interpreted without naming any of the respondents and informant.

CHAPTER FOUR

4 RESULTS, ANALYSIS AND DISCUSSION

Introduction

This chapter contains the presentation, analysis, and interpretation of data gathered from primary sources and discussions. The main objective of this study is to assess urban smart environment practices in Akaki-Kality Sub-city, Addis Ababa City Administration. To address the study's objectives, the researcher collected data from the source via questionnaires and interviews which exists in Akaki-Kality Sub-city Environment Protection and Green Development Office. In addition, Statistical Package for the Social Sciences (SPSS) was used to convert the activity data of the organization into tables, graphs and charts which have been applied to analyze the data.

4.1 DEMOGRAPHIC INFORMATION OF RESPONDENTS

A total number of 98 experts (respondents) participated; 4 out of whom were used as key informants in this study. Age, sex, educational level and working experience were the demographic variables included in the study. The Table 4.1 shows the demographic information of the respondents

TABLE 4-1: Demographic Information of Respondents

Variables	Categories	Frequency	%
Sex	Male	70	71.4
	Female	28	28.6
Working experience in years	0-2 Years	41	41.8
	3-6 Years	37	37.8
	>6 Years	20	20.4
Age	25-30	68	69.4
	30-35	30	30.6
Educational background	Degree	97	99.0
	Masters	1	1.0

Source: Author‘s Research Survey, 2021

As shown in Table 4-1, majority of the respondents were male (71.4%) 70 while (28.6%) 28 of them were female. Majority of the respondents (experts) had less than or equal to two years of work experience (41.8%) 41 , while (37.8%) 37 of them had 3-6 years of experience and 20.4%

of respondents had above 6 years of experience. 69.4% (68) of the respondents were between the ages 25 and 30. It is also found out that respondents of age 30-35 constituted 30.6% (30). The finding for educational status in years of schooling revealed that 99% of the study's population had completed their undergraduate education, and 1% their masters' education. This implies that the majority of the staff at the Office of Environmental Protection and Green Development; are young in age, have a bachelor's degree. This helps their experience and knowledge will contribute to give a quality response about the current environmental activities of the Akaki Kality Sub - city.

4.2 EXPERTS' PERCEPTIONS OF NEW TECHNOLOGIES

This study tries to understand experts' perception of new technologies. The term 'new technologies', in this study, indicates; personal smartphones, computers and equipment used by experts for daily environmental protection activities; such as noise pollution measurement (Decibel Meter), sensors, GPS equipment, etc. In this regard, it is important to know expert's understanding to communicate, access, collect, manage, integrate, and evaluate information using these technologies. Table 4-2, shows respondents' perception of new technologies.

Table 4-2: Respondents' Perceptions of New Technologies

Items	Categories	Frequency	%
Understand the advantages and disadvantages of new technologies	Very Difficult	5	5.1
	Difficult	27	27.6
	Easy	42	42.9
	Very Easy	24	24.5
Understand the information coming from the new technologies	Very Difficult	1	1
	Difficult	26	26.5
	Easy	48	49
	Very Easy	23	23.5
Search information using the new technologies	Very Difficult	1	1
	Difficult	22	22.4
	Easy	55	56.1
	Very Easy	20	20.4

Source: Author's Research Survey, 2021

With regard to the finding of the survey, as it is shown in Table 4-2 , of the total, 42.9% (42) of the respondents revealed that they can easily understand the advantages and disadvantages of new technologies. Respondents that accounted for 49% (48) revealed that they can easily

understand the information coming from the new technologies. Majority of the respondents, 56.1% (55), indicated that they can easily search information using new technologies. This result shows that experts have better understanding on the advantages and disadvantages of new technologies, they can understand the information coming from the new technologies and they can easily search information using new technologies.

4.2.1 EXPERTS' OPINION ON THE REQUIREMENTS OF SMART OFFICE

This research tries to understand experts' opinions on the smartness of their office and to know what an office should fulfill to be considered as a smart office in the Addis Ababa context. Tuzcuoğlu et al., (2021) cited different authors describe Smart (intelligent) office as workplaces equipped with new technology, where interactive systems are supported by the internet, sensors and mobile devices. Smart office concepts are expected to work together with new workplace practices and characteristics, such as sharing workstations, activity-based workplaces, clean desk policy, and user applications. The table below shows the experts' opinion on the smartness of their office.

TABLE 4-3: Experts' Opinion on Smart Office

Items	Categories	Frequency	%
Experts' opinion on smartness of their office	No at all	37	37.8
	Some what	40	40.8
	Smart office	17	17.3
	Very smart office	4	4.1
Office that has Internet access	Not Requirement	21	21.4
	Requirement	77	78.6
Office that has advanced technologies such as noise pollution measuring device (Decibel Meter), etc. inputs for daily activities	Not Requirement	19	19.4
	Requirement	79	80.6
Office that has smart Expert (Smart Thinking)	Not Requirement	32	32.7
	Requirement	66	67.3
Office that always provides capacity building and training skills about up-to date knowledge, technologies and skills.	Not Requirement	28	28.6
	Requirement	70	71.4

Source: Author's Research Survey, 2021

As shown in Table 4-3, of the total respondents, 40.8% (40) revealed that their office is somewhat a smart office. With regard to would make an office a smart office, 78.6% (77) of

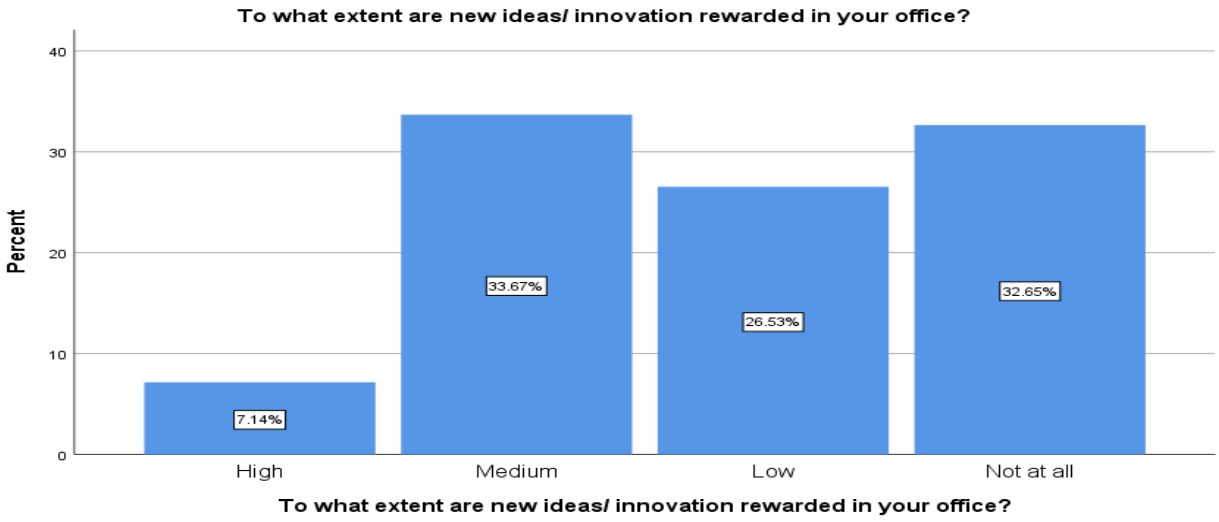
respondents reflected having internet access, 80.6% (79) of respondents indicated having advanced technology inputs for daily activities (Noise pollution measuring device), 67.3% (66) of respondents indicated having smart expert (Smart Thinking) – an expert who always tries to bring solutions for the problems and always motivates the team to create new innovations/ideas and 71.4% (70) indicating offices that always provide capacity building and training skills on up-to date knowledge, technologies and skills would be considered as a smart office.

The respondent from one of the key informant interviews also provided the following perspective on the requirements of a smart office as follows:

> *"In the institutional context, an office that uses advanced ICT and technologies that will make the service delivery quicker for the community and bring solutions for the complaints that arise by the community and stakeholders related with environmental protection*." *(Interview Akaki-Kality Sub-city Environmental Protection and Green Development Office, May 14, 2021, Addis Ababa)*

This implies that, office setting, which has internet access, advanced technology such as a noise pollution measuring device (Decibel Meter, etc.), inputs for daily activities; to make the service delivery quicker for the community and bring solutions for the complaints that arise by the community and stakeholders related with environmental protection. In addition, always having an environment which encourages new ideas and creates smart experts to achieve those goals is considered as a smart office. This result is aligned with Attaran et al., (2019). The main purposes of smart office design are to provide effective and efficient workspaces which respond better to work dynamics and user needs. Smart office is the foundation for a successful organizational strategy; it enhances collaboration and leads to increased productivity.

FIGURE 5: Practices Encouraging New Ideas and Innovation Rewarded In Office



Source: Author's Research Survey, 2021

As it is shown on Figure 5, with regard to the question, to what extent new ideas/ innovation are rewarded by your institution; of the total respondents; 7.14% responded high, 33.67% responded medium, 26.5% responded low and 32.65% responded not at all. This result shows that, there is a medium reward by office Woredas and Akaki-Kality Sub-city of Environmental Protection and Green Development for those experts who brings new ideas and create new innovations. Federal institutions should continue to motivate the employees for better performance. They should raise (increase) pay for the employees, give them adequate bonuses, assign staff responsibilities, and recognize and reward employees for their dedication to their jobs (Musa, 2021). Strengthening innovation and development of talent base enhances competitiveness. Meanwhile, to increase investment in scientific research, implement cooperative innovation of science and technology, strengths can be evaluated, and different policy plans can be adjusted to maximize the benefits of green economy, taking into account the long-term development of the ecological environment. Environmental investment and monitoring should be sustainable, steady and efficient. Green economy does not mean job elimination, but rather the creation of more jobs and potential for economic growth in terms of increased environmental carrying capacity (Wu et al., 2021).

4.2.2 THE BENEFITS' OF NEW TECHNOLOGIES TO THE CITIZENS

Cities are becoming more and more intelligent by integrating advanced technologies and infrastructure such as using Artificial Intelligence algorithms and 5G broadband data transmission technology. The benefits of new technology allows for the improved connectivity of rapidly increasing urban populations, promotes the creation of smarter and safer modes of transportation, and promises better traffic, energy and water management **(**WÓJCIK & KULA, 2021**)**. The table below shows the benefits of new technologies to the citizens.

TABLE 4-4: The Benefits' of New Technologies to the Citizens

Items	Categories	Frequency	%
Save time	Not at all	5	5.1
	A little	11	11.2
	Some what	19	19.4
	Considerably	36	36.7
	much obvious	27	27.6
Save money	Not at all	9	9.2
	A little	5	5.1
	Some what	29	29.6
	Considerably	36	36.7
	much obvious	19	19.4
Save unnecessary travel	Not at all	4	4.1
	A little	14	14.3
	Some what	19	19.4
	Considerably	29	29.6
	much obvious	32	32.7
Can be used at any time	Not at all	3	3.1
	A little	15	15.3
	Some what	31	31.6
	Considerably	25	25.5
	much obvious	24	24.5
Information Can be easily accessible	Not at all	9	9.2
	A little	10	10.2
	Some what	21	21.4
	Considerably	21	21.4
	much obvious	37	37.8

Source: Author's Research Survey, 2021

As it shown in Table 4-4, with regards to the benefits of using new technologies for citizens in terms of time saved, 36.7% (36) of the respondents revealed that using new technologies considerably saves time, 27.6% (27) of them agreed that, using new technologies much obviously save time. This result implies using new technologies considerably saves time for citizens.

As it shown in Table 4-4, with regards to the benefits of using new technologies for citizens in terms of saving money, 36.7% (36) of the respondents revealed that using new technologies considerably saves money, 29.6% (29) responded that, using new technologies somewhat saves money, 19.4% (19) responded that, using new technologies much obviously saves money, 5.1% (5) of them agreed that, using new technologies save money a little while 9.2% (9) responded that, using new technologies does not at all save money. This result implies using new technologies considerably saves money for citizens.

As it shown in Table 4-4, with regard using new technologies benefits for citizens in terms of save unnecessary travel, 32.7% (32) of the respondents indicated that, using new technologies can much obvious save unnecessary travel 29.6% (29) of them revealed that, using new technologies considerably save unnecessary travel. This result implies using new technologies benefits for citizens much obvious save unnecessary travel.

As it shown in Table 4-4, with regard using new technologies benefits for citizens in terms of can be used at any time, of the total of respondents 31.6% (31) indicated that using new technologies somewhat can be used at any time. Of the respondents 25.5% (25) indicated that, using new technologies considerably used at any time. Of the respondents 24.5% (24) indicated that, using new technologies much obvious used at any time .Of the respondents 15.3% (15) responded that, using new technologies has a little benefit to be used at any time. Of the respondents 3.1% (31) of them agreed that, using new technologies not at all benefit to be used at any time. This implies using new technologies somewhat benefits for citizens any time

As it shown in Table 4-4, with regard using new technologies benefits for citizens in terms of information can be accessible, over 50% of respondents believe that using new technologies information can be accessible considerably or very obviously. This implies using new technologies very obviously benefit for citizens to access information.

Similarly, the key informant interview by understanding the benefits of new technologies reflected that:

> *"New technologies such as smart waste, water management and recycling technology can benefit the communities in terms of improving environmental quality." (Interview Akaki-Kality Sub-city Environmental Protection and Green Development Office, May 14, 2021, Addis Ababa)*

This result implies that, using new technologies could provide benefits in terms of saving time, money and unnecessary travel. Information can be easily accessible and environmental quality potentially improved using new technologies. New technologies result in effectiveness and deliver a sustainable future for city development. Green innovation which involves creating a green city in terms of urban form, transportation system, and energy and resources is an important approach for achieving sustainable city development (Goi, 2017). Advantages of ICTs are indisputable. ICT has the ability to make urban infrastructure management practices more efficient and sustainable for Ethiopian cities. This study also agrees with Novita & Supranoto, (2019) on the use of introducing new technologies to the people; the sophistication of information technology is often regarded as a measure for the successful implementation of smart cities in urban areas. Energy readiness, infrastructure, and especially human resources cannot be separated from the socio-cultural conditions of the community here the smart city program is implemented. Government officials must continue to adapt the technological developments in order to be able to absorb all the input, demands, and needs of the people in the city by the challenges of the times.

4.3 THE COMMUNICATION SYSTEM BETWEEN STAKEHOLDERS AND AKAKI-KALITY SUB-CITY ENVIRONMENTAL PROTECTION AND GREEN DEVELOPMENT OFFICES

This study tries to examine how well all stakeholders (community, government, non-governmental, academic, research institutions, etc.) are working together and their role in the implementation of smart environments and in tackling the environmental problems. The table below shows the communication system between stakeholders and Akaki-Kality Sub-city Environmental Protection and Green Development Offices.

TABLE 4-5: The Communication System between Stakeholders and Akaki-Kality Sub-city Environmental Protection and Green Development Offices

Items	Categories	Frequency	%
The communication system	Regularly	36	36.7
	To some extent	27	27.6
	Rarely	35	35.7
Stakeholders	Community in general	56	57.1
	Industries and companies	10	10.2
	Private business	14	14.3
	NGOs who are working with environmental protection	18	18.4
Communication frequency period among different stakeholders	Every month	56	57.1
	Every three months	12	12.2
	Every 6 months	12	12.2
	Once in a year	18	18.4
Communication frequency rate among stakeholders	Regularly	38	38.8
	To some extent	43	43.9
	Rarely	17	17.3

Source: Author's Research Survey, 2021

As it shown in Table 4-5 , of the total respondents, 36.7% (36) indicated that, there is a regular communication system of environmental protection activity between Woreda and Akaki-Kality Sub-city environmental protection offices. With regards to the collaboration system between different stakeholders and Akaki-Kality Sub-city Environmental Protection and Development offices, majority of the respondents, 57.1% (56), responded they work with the Community every month on activities related to environmental protection. On the other hand, 10 (10%) responded that they communicate with industries and companies, 14.3% (14) with private businesses and 18.4% (18) with NGOs who are working with environmental protection.

This result implies that, even though there is a good communication system among Woreda, Akaki-Kality Sub-city offices, and with community in environmental protection activities, there is low collaboration between government offices and NGOs, private business, industries and companies. This result agreed with Rachmawati & Pertiwi, (2017) by doing research and learning good practice from the success of Bandung City, suggested that city government should establish good cooperation with other agencies within the governments and with other higher level of government (national government and other local governments), and also with

third parties such as private sectors and NGOs. Further, every initiative was characterized with the community engagement which contributed to its success.

4.3.1 GOOD PRACTICES TO ENHANCE CITIZEN'S PARTICIPATION

It is important to improve citizen participation in any new strategies and polices because it helps to understand the point of view of the community and to get successful outcomes from any smart environment implementation practices. The table below shows good practices to enhance citizen's participation

Table 4-6: Good Practices to Enhance Citizen's Participation

Variables	Categories	Frequency	%
Improving participation in decisions concerning issues of citizenship's interest.	Not Agreed	70	71.4
	Agreed	28	28.6
Being involved in the planning of the new public services.	Not Agreed	41	41.8
	Agreed	57	58.2
Allowing access to services provided by the Woreda via smartphones.	Not Agreed	94	95.9
	Agreed	4	4.1
Reporting service problems of the Woreda via social medias.	Not Agreed	70	71.4
	Agreed	28	28.6

Source: Author's Research Survey, 2021

As it shown in Table 4-6 above, majority of the workers, 71.4% (70) disagreed improving participation in decisions concerning issues of citizenship's interest is not one of the practices to enhance citizen's participation in implementing smart environment. Of the total respondent 58.2% (57) agreed being involved in the planning of the new public services is one of the practices to enhance citizen's participation in implementing smart environment in Woreda.

As it shown in Table 4-6, Majority of the respondents, 95.9% (94), disagreed that allowing access to services provided by the Woreda via smartphones is not a practice to enhance citizen's participation in implementing smart environment in Woreda. 71.4% (70) of the respondents disagreed that reporting service problems of the Woreda via social-medias is a practice to enhance citizen's participation in implementing smart environment in Woreda.

This result implies that, being involved in the planning of the new public services is one of the practices to enhance citizen's participation in implementing smart environment. This study

agrees with the concept of Collaborative Governance Regime (CGR). According to Gavriloaia, (2019) CGR is a specific, systemic approach to making public decisions in which cross-sectional cooperation is the preferred mode of behavior and activity. Simultaneously, the model examines a viewpoint on the political, tangible, socioeconomic, and environmental contexts and functions as a preliminary analysis of opportunities and constraints taken into account when talking about collaboration.

4.4 THE RESPONDENTS' OPINIONS ON WHY THE URBAN ENVIRONMENTAL PROBLEMS IN AKAKI-KALITY SUB-CITY HAVE NOT BEEN SOLVED

Urban environment can generally be represented by the level of clean water supply and urban sanitation as well as the air, soil and water quality. In addition to this, proper management of the urban ecosystem and efficiency of the urban system such as transport and energy use can be taken as part of the urban environment. Therefore, urban environmental problems include water and air pollution, settlement of low-income groups in highly polluted peripheries and pockets within settled urban areas without the fear of eviction, and widespread removal of vegetation to support urban ecosystems (A et al., 2010). This study tries to understand the reason why urban environmental problems are not solved in Akaki-Kality Sub-city. The table below shows the respondents' opinion on the reason why urban environmental problems have not been solved in Akaki-Kality Sub-city.

TABLE 4-7: The Respondents' Opinions on why the Urban Environmental Problems in Akaki-Kality Sub-city have not been Solved

Items	Categories	Frequency	%
Lack of community awareness on environmental protection	Not Reason	38	38.8
	Reason	60	61.2
Lack of expert commitment	Not Reason	49	50.0
	Reason	49	50.0
Lack attention to environmental protection by the government	Not Reason	44	44.9
	Reason	54	55.1
Lack of collaboration with different stakeholders	Not Reason	40	40.8
	Reason	58	59.2
Shortage of Budget compares to the vast environmental problems	Not Reason	34	34.7
	Reason	64	65.3
Lack of new innovations and technologies for environmental protection	Not Reason	40	40.8
	Reason	58	59.2

Source: Author's Research Survey, 2021

As shown in Table 4-7, with regards to the reason urban environmental problems are not solved in Akaki-Kality Sub-city; of the total of respondents, 61.2% (60) responded lack of community awareness on environmental protection, 55.1% (54) lack of attention to environmental protection by the government, 59.2% (58) lack of collaboration among different stakeholders, (64) 65.3% shortage of budget compared to the vast environmental problems and 59.2 % (58) of the respondents revealed that, lack of new innovations and technologies for environmental protection are the reasons the environmental problems in Akaki-Kaliti Sub-city have not solved.

Similarly, from the interview one of the key informants agreed that:

> *The reason why environmental problems are not solved is because of lack of budget, shortage of human resources, the attitude and skills of the experts, lack of advanced technologies equipment (pollution sensor devices, smart meter, etc.) and shortage of office equipment (Computers, Access to internet, etc.), to monitor environmental pollution protection. (Interview Akaki-Kality Sub-city Environmental Protection and Green Development Office, May 14, 2021, Addis Ababa)*

This result implies the main reasons environmental problems are not solved in Akaki-Kality Sub-city are lack of community awareness on environmental protection, lack of attention to environmental protection by the government, lack of collaboration with different stakeholders, shortage of budget compared to the vast environmental problems and, lack of new innovations and technologies for environmental protection. This result is in line with the findings of this study identifying lack of public and government employee awareness, inadequate institutional capacities, a lack of coordination among stakeholders, and the lack of clear ownership and enforcement mechanisms are all major barriers to the establishment and management of cooperative housing green areas and street trees (Kefelew & Megento, 2015). This study also agrees with the findings of the research of Amare, (2019) that corporate environmental responsibility is very low. The majority of large scale industries did not show considerable effort on protecting the environment responsibly, absence of corporate environmental responsibility, low pressure from the enforcing institutions, and lack of financial and human resources This result agreed with the concept of Open Government Data (OGD) presented by Khurshid et al., (2020), which implies OGD has enormous potential to improve transparency, accountability, and participation while also improving operational efficiency, data-driven and evidence-based policymaking, and trust in government institutions.

4.5 SMART DECISION IN ORDER TO SOLVE ENVIRONMENTAL PROBLEMS

Smart decisions for the environment necessitate prioritization. In order to prevent long-term loss and degradation of biodiversity the funds available for conservation need to be allocated both efficiently and effectively. While we can attempt to increase the resources available for conservation, at present, funding is insufficient to achieve stated goals, and environmental concerns compete with other societal priorities, such as global food production, energy generation, and resource extraction (Wilson, 2018). This study tries to find the answer to the question, "What is the most important and smart decision that can be made to solve environmental problems in Akaki Kality?" The table below shows respondents' perspectives on the importance of smart decision in order to solve to solve environmental problems in Akaki-Kality Sub-city.

TABLE 4-8: The Smart Decision in order to Solve Environmental Problems

Items	Categories	Frequency	% (%)
Integration of Smart Communication system	Not Agreed	46	46.9
	Agreed	52	53.1
Implements advance sensor devices	Not Agreed	42	42.9
	Agreed	56	57.1
Team up with research institutions and universities	Not Agreed	32	32.7
	Agreed	66	67.3
Improve collaboration and engagement of stakeholders and citizen	Not Agreed	44	44.9
	Agreed	54	55.1

Source: Author's Research Survey, 2021

As it is shown in Table 4-8, of the total respondents (participants) (52) 53.1% agreed that, integration of smart communication system among environmental protection offices using internet access is a smart decision in order to solve environmental problem. Moreover, 57.1% (56) of the respondents agreed that implementing new sensor devices in the industries, parking, traffic maps, energy, and water and waste management to monitor and control environmental pollution are smart decisions that should be used to solve environmental problems.

Furthermore, 67.3% (66) reported that, Akaki-Kality Sub-city and Woredas teaming up with research institutions and universities are the smart decisions in order to solve environmental

problems. 55.1% (54) reported that improving collaboration with stakeholders and enhancing citizen engagement are smart solutions that can solve environmental problems.

From the interview, the key informant reflected that:

> *In order solve environmental problems in the Akaki Sub-city context, the government should recognize the role of stakeholders and private businesses in environmental protection and smart environment implementation by allowing these actors to collaborate and participate in mitigation activities, enhance the participation in green development and create awareness (Interview Akaki-Kality Sub-city Environmental Protection and Green Development Office, May 14, 2021, Addis Ababa).*

This result implies integration of smart communication systems among the environmental protection offices using internet access, implementing new sensor devices in the industries, parking, traffic maps, energy, and water and waste management to monitor and control environmental pollution, improving collaboration with stakeholders and enhancing citizen engagement and teaming up with research institutions and universities are the smart decisions that should be applied by the Akaki-Kality Sub-city and Woredas Environmental Protection and Green Development Office in order to solve the environmental problems of their Sub-city.

4.6 EXPERTS' UNDERSTANDING OF THE MEANING OF SMART ENVIRONMENT

This study tries to assess experts working in the Environmental Protection Office of Akaki Kality, Addis Ababa on their familiarity with the meaning of smart environment practices. The table below shows the respondents' understanding of the meaning of smart Environment practices.

TABLE 4-9: The Respondents' Understanding of the Meaning of Smart Environment Practices

Variables	Categories	Frequency	% (%)
Do you think there is smart environment implementation in your Woreda?	Yes	22	22.4
	No	76	77.6
Modern management	Could not be the meaning	21	21.4
	Could be the meaning	77	78.6
Using new technologies	Could not be the meaning	34	34.7
	Could be the meaning	64	65.3

Smart Communication and information	Could not be the meaning	37	37.8
	Could be the meaning	61	62.2
Good Governance	Could not be the meaning	18	18.4
	Could be the meaning	80	81.6
Good citizen participation	Could not be the meaning	26	26.5
	Could be the meaning	72	73.5

Source: Author's Research Survey, 2021

As shown in Table 4-9, of the total respondents, 77.6% (76) of them reported that there is no smart environment implementation in their Woreda while 22.4% (22) of them responded that there is implementation of smart environment in their Woreda. This result implies that, so far there is no smart implementation in Akaki-Kality Sub-city.

The key informant interview also shows that:

> *There is a limited resource of new technologies in the Sub-city and Addis Ababa in general. In Akaki-Kality Sub-city, the environmental protection has used new technologies like sound pollution measurement device (Decibel Meter), GPS, etc. But in general, they don't consider there is a smart environment implementation in Akaki-Kality Sub-city (Interview Akaki-Kality Sub-city Environmental Protection and Green Development Office, May 14, 2021, Addis Ababa).*

This result shows that there is no smart environment implementation in Akaki-Kality Sub-city

Furthermore, as shown in Table 4-9, majority of the respondents 78.6% (77) indicated that they understand modern management is the meaning of smart environment. Of the total respondents 65.3% (64) revealed that using new technologies is the meaning of smart environment. Majority 62.2% (61) of the respondents responded that using information and communication is the meaning of smart environment. 81.6% (80) of the respondents reported that good governance is the meaning of smart environment. Similarly 73.5% (72) of the respondents reported that good citizen participation is the meaning of smart environment.

Likewise, the key informant interview reflects on their understanding of smart environment:

> *Smart Environment is a new concept involving the use of computers and other smart devices in everyday settings and tasks. Smart environment includes smart home cities and*

many factories, and it is a new innovation to create cities that are conducive to human life in general (Interview Akaki-Kality Sub-city Environmental Protection and Green Development Office, May 14, 2021, Addis Ababa).

The result indicates that, the experts understand the concept of smart environment, which involves modern management, using new technologies, using smart communication and information, good governance and improving good citizen participation to create cities that are conducive to human life in general.

4.7 THE BENEFITS OF IMPLEMENTING SMART ENVIRONMENT

Smart Environment involves the use of technology to improve crucial aspects of city living such as waste disposal, food growth, pollution control, smart electric grids, housing quality, and facility management. The widespread use of IoT sensors (such as Radio Frequency Identification chips, proximity detectors, pressure sensors, optical sensors) can drastically change the way we manage the urban environment (Appio et al., 2019). This study tries to determine what could be the benefit of implementing smart environment in Akaki-Kality Sub-city, Addis Ababa. The table below shows the perspectives of the respondents on the benefits of implementing smart environment.

TABLE 4-10: The Benefits of Implementing Smart Environment

Variables	Categories	Frequency	% (%)
Improve Urban Solid Waste Management	Not Agreed	27	27.6
	Agreed	71	72.4
Support Energy Efficiency	Not Agreed	35	35.7
	Agreed	63	64.3
Reduce Carbon Emissions	Not Agreed	16	16.3
	Agreed	82	83.7
Sustainable development	Not Agreed	59	60.2
	Agreed	39	39.8

Source: Author's Research Survey, 2021

As shown in Table 4-10, of the total of respondents, 72.4% (71) of them reported that the benefit of implementing smart environment in their Woreda is improving urban solid waste management. 64.3% (63) of them agreed that the benefits of implementing smart environment in their Woreda are supporting energy efficiency. Majority of the respondents 83.7% (82) indicated

that reducing carbon emissions is the benefit of implementing smart environment. 60.2% (59) of the participants agreed that sustainable development is the benefit of implementing smart environment.

This result implies that, smart environment implementation at Woreda level can lead to reducing carbon emission, improving urban solid waste management and supporting energy efficiency This result agreed with the concept presented by Silva et al., (2020) which emphasizes that energy management is a new concept of using energy efficiently and sustainably. Energy management benefits are multipurpose and appropriate to any smart environment. Similarly, Dwevedi et al., (2018) in smart cities, air pollution can be reduced effectively using green transport, bicycle lanes, more greenbelt areas, more renewable energy, and a ban on the burning of municipal and agricultural garbage are all things that should be considered. The advantage of smart city people depends on the rapid collection of big data, modeling, analysis, and forecasts, as well as translating it to practical information..

4.7.1 THE IMPORTANT OBJECTIVES FOR SMART ENVIRONMENT PROJECT AT WOREDA LEVEL

This study tries to understand the main objectives in order to implement smart environment at Woreda level. The data below shows the important objectives for smart environment Project at Woreda level.

TABLE 4-11: The Important Objectives for Smart Environment Project at Woreda Level

Variables	Categories	Frequency	%
Smart waste management system (sensors for waste containers, etc.)	Very Important	54	55.1
	Moderately	10	10.2
	Important	28	28.6
	Not Important	6	6.1
Smart water and wastewater management system (smart meters, automated leak detection, etc.)	Very Important	65	66.3
	Moderately	14	14.3
	Important	19	19.4
Smart Energy (smart meters, renewable energy, etc.)	Very Important	58	59.2
	Moderately	11	11.2
	Important	29	29.6
Smart built environment (building management systems, streetlights with Wi-Fi, or other services, etc.)	Very Important	57	58.2
	Moderately	28	28.6
	Important	13	13.3

Source: Author‘s Research Survey, 2021

As shown in Table 4-11, with regards to the important objectives to implement smart environment at Woreda level; majority of the respondents, 55.1% (54) indicated that implementing smart waste management system (sensors for waste containers, etc.) is a very important objective for the smart environment project in Woreda context. Similarly 28.6% (28) reflected that, is an important objective. While, 10.2% (10) of them agreed that it is a moderately important objective for a smart environment project in the Woreda context.

Majority of the respondents, 66.3% (66) revealed that, implementing smart water and wastewater (smart meters, automated leak detection, etc.) is a very important objective for smart environment project in the Woreda context. 14.3% (14) that it is moderately important and 19.4% (19) is important. This implies that implementing smart water and wastewater (smart meters, automated leak detection, etc.) is a very important objective.

Furthermore, 59.2% (58), 11.2% (11), 29.6% (29) of the respondents reported that implementing smart energy (smart meters, renewable energy, etc.) is a very important, moderately important and important objective for smart environment project in the Woreda context respectively. This implies that implementing smart energy (smart meters, renewable energy, etc.) is a very important objective.

As shown in Table 4-11, with regard the important objectives to implement smart environment at Woreda level; majority of the respondent 58.2% (57) reported that smart built environment (building management systems, streetlights with Wi-Fi, or other services, etc.) is very important objectives for smart environment project in Woreda. 28.6% (28) that smart built environment (building management systems, streetlights with Wi-Fi, or other services, etc.) is moderately important and 13.3% (13) is important. This implies that, implementing smart built environment (building management systems, streetlights with Wi-Fi, or other services, etc.) is very important

This result implies that implementing for waste management (sensors for waste containers, etc…), for water and wastewater (smart meters, automated leak detection, etc.), for energy (smart meters, renewable energy, etc.) and built environment (building management systems, streetlights with Wi-Fi, or other services, etc.) are very important objectives to implement smart environment project at Woreda level. Benefits of applying advance sensors in cities presented by Ramírez-Moreno et al., (2021) emphasize that regarding smart water monitoring, sensors are used to measure water quantity and quality data continuously and consistently. The obtained data

can be processed and visualized in real-time to the end-users, or forecasts can be developed for the water agencies. These technologies allow minimization of the risks associated with poor water quality and deficiencies in water supply. Regarding solid waste management, currently sensors can identify wet, dry, or metal garbage. However, it would be optimal to develop sensors that allow identifying waste in greater detail. Because of their adaptability, ICT-based innovations in energy consumption monitoring in buildings, public lighting systems, and urban settings are a great alternative. Intelligent lighting systems with sensors adaptable to weather conditions, hours of use and presence of people or vehicles where the street lamps serve as Wi-Fi connection points, allowing interconnected networks over the entire urban area monitoring the quality of the environment, noise levels, and surveillance, among others.

4.8 EXPERTS' OPINIONS ON THE GOVERNMENT COMMITMENT TOWARD ENVIRONMENTAL PROTECTION IMPLEMENTING URBAN SMART ENVIRONMENT

This study tries to assess the government's commitment to protect the environment and practices in implementing smart environment in Akaki-Kality Sub-city. This is primarily used to assess the practices of the government toward smart environment. The table below shows the experts' opinion on the government's commitment toward environmental protection implementing urban smart environment.

TABLE 4-12: Government's Commitment to Environmental Protection and Practices to Implement Smart Environment

Variables	Categories	Frequency	% (%)
The Level of Commitment and Attention of Woreda Administration offices to Environmental protection practices	Very Low	12	12.2
	Low	24	24.5
	Middle	44	44.9
	High	10	10.2
	Very High	8	8.2
The Level of Commitment and Attention of Akaki-Kality Sub-city Administration offices to Implement Smart Environment	High priority	10	10.2
	Medium priority	53	54.1
	Low priority	14	14.3
	Not a priority	6	6.1
	Not applicable	15	15.3

Source: Author's Research Survey, 2021

As it is shown in Table 4-12, with regards to the Woreda administration level government' attention to environmental practices; 44.9% (44) of the respondents reported that, at Woreda administration level attention to environmental protection practices is medium. 8.2% (8) of them responded that, that at Woreda administration level government gives very high attention to environmental protection practices. While 10.2% (10) of them responded that at Woreda administration level government gives high attention to environmental protection practices and 24.5% (24) and 12.2% (12) of the respondents responded that, at Woreda administration level government gives low and very low attention to environment protection practices respectively. This result indicates that at Woreda administration level, government has a moderate focus on environmental protection and smart environment implementation. Government departments should aim to reduce pressure on resources, increasing resource efficiency, developing new energy sources, developing clean energy, maintain and increase the environmental protection investment, on the basis of high resource and environment carrying capacity to realize the sustainable development (Wu et al., 2021).

Furthermore, as shown in Table 4-12, with regards to government practices to implement smart environment, 54.1% (53) of the respondents reported that Akaki-Kality Sub-city administrations level government gives medium priority to implement smart environment, 14.3% (14) responded that Akaki-Kality Sub-city administrations give low priority, while 6.1% (6) responded that Akaki-Kality Sub-city administrations do not give priority to implement smart environment. Contrarily, of the total respondents, 15.3% (15) of them replied that in Akaki-Kality Sub-city administration, smart environment implementation is not applicable. This result indicates that Akaki-Kality Sub-city Administration has a medium focus on environmental protection and smart environment implementation.

4.9 THE CHALLENGES OF IMPLEMENTING A SMART ENVIRONMENT

This study tries to find the answer to the question of what the challenges to implementation of urban smart environment in Akaki-Kality, Addis Ababa could be and to set the possible solution. The table below shows the challenges of implementing urban smart environment.

TABLE 4-13: The Challenges Implementing of Smart Environment

Items	Categories	Frequency	% (%)
Not having clear understanding, how smart environment works with our Woredas context (lack of clarity around benefits).	No	42	42.9
	Yes	56	57.1
Lack of knowhow by the expert about Smart Environment/ Need more technical expertise	No	35	35.7
	Yes	63	64.3
Need to gain community support.	No	34	34.7
	Yes	64	65.3
Need more supportive policies.	No	26	26.5
	Yes	72	73.5
Needed high initial budget for new technologies implementation	No	37	37.8
	Yes	61	62.2
Lack of Government Commitments	No	40	40.8
	Yes	58	59.2
Technology challenges with coverage and capacity	No	29	29.6
	Yes	69	70.4
Existing infrastructure for energy, water and transportation systems	No	24	24.5
	Yes	74	75.5

Source: Author's Research Survey, 2021

As it is shown in Table 4-13, (56) 57.1% of the respondents reported that not having clear understanding on how smart environment works in our Woredas context (lack of clarity around benefits) is one of the challenges of implementing smart environment in the Woreda. 64.3% (63) of them reported that lack of knowhow by the expert about smart environment is a challenge. 65.3% (64) of the participant indicated that the need to gain community support is a challenge to implementing smart environment. In other words, this result implies lack of clarity around benefits, lack of knowhow by the experts about smart environment and lack of community support is a challenge to implement smart environment.

As it is shown in Table 4-13, 73.5% (72) of the respondents responded the need for more supportive policies is a challenge to implementing smart environment. This result indicated that there lack of more supportive polices is a challenge to implement smart environment.

62.2% (61) of the respondents indicated the need for high initial budget for new technologies implementation is a challenge to implementing smart environment. 59.2% (58) reported that lack of government commitment is a challenge to implementing smart environment. 70.4% (69)

reported that technology challenges with coverage and capacity is a challenge to implementing smart environment. 75.5% (74) revealed that existing, old infrastructure for energy, water and transportation systems is a challenge to implementing smart environment.

The key informant from the interview considers:

> *The potential challenges of implementing a smart environment because Addis Ababa's master plan is outdated and unmanageable. The collaboration among stakeholders is not as strong as it could be, and people's solidarity is also a concern, as is the lack of current technology, attitudes, skills, and knowledge (Interview Akaki-Kality Sub-city Environmental Protection and Green Development Office, May 14, 2021, Addis Ababa).*

This result implies that, lack of clarity around benefits, lack of attitudes, skills, and knowledge of the expert about smart environment, lack of community support, unavailability of more supportive police, the existing old infrastructure systems, weak collaboration among stakeholders, and lack of advanced technologies are the challenges to implementing a smart environment. The challenges of implementing smart environment are lack of Information and Communication Technology (ICT) infrastructure. Sophisticated metering systems, control strategies, communication systems, and other information technologies are not appropriately available in current power distribution and transmission systems. Massive investments require and lack of awareness and compromised user comfort. Users are not well informed about benefits and incentives implementation in smart environments (Silva et al., 2020).

4.10 EVALUATING URBAN SMART ENVIRONMENTAL PRACTICES USING CHI-SQUARE TEST

> *"The Chi-Square statistic is most commonly used to evaluate Tests of Independence when using a cross tabulation (also known as a bivariate table). The Test of Independence assesses whether an association exists between the two variables by comparing the observed pattern of responses in the cells to the pattern that would be expected if the variables were truly independent of each other"* (Moore et al., 2017).

The data below shows chi-square test of the urban smart environmental practices.

Table 4-14: Chi-Square Test of the Urban Smart Environmental Practices

Variables	Categories	Smart environment		Chi-square test value	Sig. value
		No	Yes		
Smart communication and information	Not Selected	43	18	4.625	0.032**
	Selected	33	4		
Lack of new innovations and technologies for environmental protection	Not Selected	41	17	3.843	0.03**
	Selected	35	5		
Lack of community awareness on environmental protection	Not Selected	35	14	7.12	0.032**
	Selected	41	8		
Lack attention to environmental protection by the government	Not Selected	35	9	9.512	0.042**
	Selected	41	13		
Lack of collaboration with different stakeholders	Not Selected	45	13	12.367	0.012**
	Selected	31	9		
Shortage of Budget compares to the vast environmental problems	Not Selected	48	16	1.156	0.075**
	Selected	28	6		

Source: Author's Research Survey, 2021

Note: ****** The Chi-square statistic is significant at the .05 level.

As shown in Table 4-14, there is association between lack of new innovations and technologies for environmental protection, and smart communication with implementation of smart environment. Since the significance value of these variables, 0.03 and 0.032 respectively, is less than 0.05. There is enough evidence to say that there is association between lack of community awareness on smart environment, since its significance value (0.032) is less than 0.05.

Similarly, there is association between lack of attention to environmental protection by the government and smart environment since its significance value (0.042) is less than 0.05. Lastly we can say that there is a relationship between lack of collaboration with different stakeholders and smart environment, since its significance value (0.012) is less than 0.05 which is statically significant.

This result implies that smart environment implementation is dependent on new innovations and technologies, smart communication, community awareness, government attention and the collaboration among different stakeholders.

4.11 LOGISTIC REGRESSION FITTED MODEL OF THE URBAN SMART ENVIRONMENTAL PRACTICES

In general, if the significance level of the Wald statistic (which tests the effect of individual predictor while controlling other predictors.) is less than 0.05 then the parameter is useful to the model. In other word, if the result of a given variable significance value is less than 0.05 it means statistically significant. Therefore, this variable's odds ratio will be used to predict the outcomes of events of interest. We get positive and negative coefficient of predictors when subtracting odds ratio of 1. The positive coefficient of predictors are more likely to odds of events of interest when we compare them with their corresponding reference category and the negative coefficients of the predictors are less likely to odds of smart environment implementation when we comparing them with their corresponding reference category (Hosmer & Hjort, 2002).

Table 4-15: Hosmer and Lemeshow Test of Smart Environment

Hosmer and Lemeshow Test			
Step	**Chi-square**	**df**	**Sig.**
1	9.104	3	0.093

Source: Author's Research Survey, 2021

The above Table 4-15, shows that, the model is significant since the non-significance of Hosmer and Lemeshow test indicates the significance of the model. I.e. The Hosmer-Lemeshow statistic indicates a poor fit if the significance value is less than 0.05. Here, the model adequately fits the data.

TABLE 4-16: Logistic Regression Fitted Model of Smart Environment

Variables	Odds Ratio	Std. Err.	Z	P>z	[95% Conf. Interval]	
AGE						
30-35	0.4886886	0.475055	-0.74	0.461	0.072707	3.284636
Working on environmental protection						
Industries and companies	1.747437	1.856722	0.53	0.599	0.217754	14.02289
Private business	1.543451	1.769883	0.38	0.705	0.163086	14.6073
NGOs who are working with environmental protection	1.240404	1.334538	0.2	0.841	0.150579	10.21791
Reason lack of commitment (Selected)	0.7848726	0.878723	-0.22	0.829	0.087461	7.043399

Reason_gov't attention (Selected)	1.885614	1.487585	0.8	0.421	0.401725	8.850682
Reason_lack of collaboration (Selected)	1.892858	1.69311	0.71	0.476	0.3279	10.92685
Reason_shortage of budget (Selected)	0.7871599	0.747831	-0.25	0.801	0.12229	5.06682
Reason_lack of new innovations (Selected)	0.1169375	0.12311	-2.04	0.041	0.014853	0.920633
Innovation rewarded						
Medium	0.3410058	0.391011	-0.94	0.348	0.036036	3.226881
Low	0.4426594	0.480073	-0.75	0.452	0.052835	3.708646
Not at all	0.2624422	0.270458	-1.3	0.194	0.03482	1.978033
Administration Commitment						
Medium priority	0.7242756	0.8694	-0.27	0.788	0.068888	7.614871
Low priority	0.6995148	1.035989	-0.24	0.809	0.038385	12.74781
Not a priority	0.0045705	0.009836	-2.5	0.012	6.73E-05	0.310303
Not applicable	0.1528935	0.290687	-0.99	0.323	0.003682	6.34928
Administration Attention						
Low	1.0305345	0.040352	-2.64	0.008	0.00229	0.407074
Middle	1.0169282	0.022116	-3.12	0.002	0.001308	0.21912
High	1.004225	0.006817	-3.39	0.001	0.000179	0.099825
Very High	1.0111176	0.018335	-2.73	0.006	0.000439	0.281692
_cons	67.49165	145.3863	1.96	0.051	0.990023	4601.027

Source: Author's Research Survey, 2021

As shown above in Table 4 16, With regard to the reason environmental problems is not solved, the odds of the smart environment implementation for those who have selected lack of new innovations and technologies for environmental protection variable is statistically significant because the significance value is 0.041 which is less than 0.05. Therefore, lack of new innovations and technologies for environmental protection the reason environmental problem is not solved are 0.117 times less likely to the odds of the smart environment for implementation those who have been not selected lack of new innovations and technologies for environmental protection is not the reason environmental problem is not solved. This result implies that lack of new innovations and technologies for environmental protection could be a factor for implementing smart environment.

The result in Table 4 16, shows that the variable about to what extent Akaki-Kality Sub-city Administration commitment for smart environment implementation is statically significant, because the significance value for not priority is 0.012 which is less than 0.05. Therefore, the administration's commitment is less likely to the odds of the smart environment implementation

than high administration's commitment of the smart environment implementation. This result implies that government attention to environment is one factor to implement smart environment.

The result in Table 4 16, shows that the variable about to what extent the Woreda Administration give attention to the environment is statistically significant, because the significance value for low, middle, high and very high are 0.08, 0.002, 0.001 and 0.006 respectively which is less than 0.05. The expected smart environment implementation by the administration selected for low, middle, high and very high environment implementation were about 3% 2%, 0.4% and 100% respectively more likely as compared to the administration who selected very low attention to the environment. This result implies that government commitment to environment is one factor to implement smart environment.

NOTE: - 1. Odds ratio = Exp (B)

2. % of the result is comes from (odds ratio-1)100% or (Exp (B) – 1)100%

This result of this study implies that, smart environment implementation is dependent on community awareness, government attention and the collaboration of different stakeholders. Also, the finding of the study proves there is significance evidence that lack of new innovations, government attention and lack of collaboration of different stakeholders is the reason that environmental problem were not solved and smart environment not implemented in Akaki-Kality Sub-city respectively. In order to solve this issues , this results agreed with Israilidis et al., (2021) mitigation and adaptation strategies for climate change must be better integrated into national and local policies, strategies, and planning procedures Policy must be changed to ensure that citizens are both knowledge keepers and knowledge generators.. Knowledge generated should be used to inform future policy, and the use of technology can help strengthen communications and facilitate knowledge acquisition and transfer in order to develop actions. Organizational learning capabilities that promote dialogue, learning, cross-team collaboration, and knowledge sharing within and across urban communities are required

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CHAPTER FIVE

5 CONCLUSION AND RECOMMENDATION

This chapter deals with conclusions, and recommendation of the study. These conclusions are based on statistical analysis results, and discussions of the findings in chapter four.

5.1 CONCLUSION

Based on the research reviews, indicate that the main problem environmental problems are not solved in Akaki-Kality Sub-city, lack of attention to environmental protection by the government and lack of community awareness on environmental protection. Similarly, there is no smart environment implementation practice in Akaki-Kality Sub-city, Addis Ababa.

Based on the research finding, the environmental experts understand the concept of smart environment which involves modern management, using new technologies, using smart communication and information, good governance and improving good citizen participation to create cities that are conducive to human life in general. The benefit of smart environment implementation at Woreda level is reducing carbon emission, improving urban solid waste management and supporting energy efficiency. Furthermore, implementing smart environment for waste management (sensors for waste containers, etc.), for water and wastewater (smart meters, automated leak detection, etc.), for energy (smart meters, renewable energy, etc.) and built environment (building management systems, streetlights with Wi-Fi, or other services, etc.) are very important objectives to implement smart environment project at Woreda level.

This research finding indicates that lack of clarity around benefits, lack of attitudes, skills, and knowledge of the expert about smart environment, lack of community support, unavailability of more supportive polices, existing old infrastructure systems, weak collaboration among stakeholders, and lack of advanced technology are the challenges to implementing a smart environment.

This study states that, collaboration and engagement of different stakeholders is important factor in implementing smart environment in Akaki Kality Sub-city.

5.2 RECOMMENDATION

The findings in this study should be of awareness for the environmental protection sectors considering the implementation of urban smart environment as a new perspective to solve environmental problems in the future. The researcher has forwarded the following recommendations:

In this regard, Government and stakeholders in the field of environmental protection should encourage and reward a professional who has done a good job because it will serve as a model for other professionals to create a positive competitive environment and create better competition on bringing new solutions to environmental problems. Government service providers in Ethiopian cities need a complete refurbishing including the following: Appointing expert members in the executive boards, having expertise in planning, finance, accounting and technical aspects, revision of remunerations to the officials and staff to avoid higher turnover rates, keeping the updated record for the specialized human resource requirements indifferent trades and making appointments proactively, starting proper asset management practices on finance and other resources (Tiwari, 2016).The government actors should integrate the concept of smart office in Environmental Protection and Green Development office to deliver successful services related to environmental protection.

To create a smart environment system toward achieving clean and green city in Akaki Kality, Addis Ababa, the government should pay attention and fully commit to environmental issues, recognize the benefits of a smart environment, and seek to implement it for environmental protection, as well as raise community awareness of environmental protection activities.

Furthermore, the government should recognize the role of stakeholders' collaboration in environmental protection and smart environment implementation by allowing these actors to collaborate and participate in mitigation activities, enhance the participation in greenery development and create awareness. Because, this enables all stakeholders to collaborate as one to achieve successful smart environment initiatives, implementation, and resolution of environmental issues in Akaki-Kality Sub-city and Addis Ababa City in general.

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APPENDIX I: RESEARCH QUESTIONNAIRES'

Addis Ababa University

College of Development Studies

A	Expert Name	
B	Date of interview	yy-mm-dd

Hello! My name is Henok Tekie; I am a graduate student at Addis Ababa University. My study focuses on Smart Environment deals with any professional and people can better understand and control their environment the idea of building an environment with sensors, technology and computer equipment and creating an environment conducive to the residents. The following survey aimed to know your opinion about your Environmental Protection office, Akaki-Kality Sub-city Environmental Protection office as Smart Environment and its services. There is no right or wrong to your answer, so feel free to answer the questions. About the information that you are going to provide for me, I ensure you a complete confidentiality and anonymity.

0	Do you want to participate in this voluntary survey?	Yes Thank you for your participation.	No (End interview)

1.	How many years' experience do you have in your field?	o 0-2 Years o 3-6 Years o >6 Years	
2.	Regarding your relation with new technologies, indicate how easy for you to…	…Understand the advantages and disadvantage s of new technologies	o Very Difficult o Difficult o Easy o Very Easy
		… Understand the information coming from the new technologies	o Very Difficult o Difficult o Easy o Very Easy
		… Search information using the new technologies	o Very Difficult o Difficult o Easy o Very Easy

3.	In your opinion, to consider a given office as smart office which of the following should the office have?	○ Internet Access ○ Advanced technologies inputs for daily activities (Noise pollution measuring device….) ○ Smart Expert (Smart Thinking) an expert always tries to bring solutions for the problems and always motivate to create new innovations/ideas ○ Always that provides capacity building and training skills about up-to-date knowledge, technologies and skills ○ Others, Please Specify _____
4.	To what extent do you think your office is smart office?	○ No at all ○ Some what ○ Smart office ○ Very smart office
5.	How do you explain the communication system about activity of environmental protection your office with Akaki-Kality Sub-city environmental protection office?	○ Regularly ○ To some extent ○ Rarely
6.	Which one of these Actors actively working on environmental protection activities in your Woreda?	○ Community in general ○ Industries and companies ○ Private business ○ NGOs who are working with environmental protection ○ Others, Please Specify
7.	How often do communicate about activities of environmental protection your office with Community, Industries, Private Business and NGOs?	○ Every month ○ Every three months ○ Every 6 months ○ Once in a year
8.	How do you explain the communication system about activity of environmental protection your office with Community, Industries, Private Business and NGOs?	○ Regularly ○ To some extent ○ Rarely
9.	In your opinion, what are the reason environmental problems is not solved? *(You Can choose as many as you like)*	○ Lack of community awareness on environmental protection ○ Lack of expert commitment ○ Lack attention to environmental protection by the government ○ Lack of collaboration with different stakeholders

		○ Shortage of Budget compares to the vast environmental problems ○ Lack of new innovations and technologies for environmental protection ○ Others, Please Specify	
10.	To what extent are new ideas/ innovation rewarded in your office?	○ High ○ Medium ○ Low ○ Not at all	
11.	Indicate in what aspects the new technologies improve the quality of life of the citizen?	Save time	○ Not at all ○ A little ○ Some what ○ considerably ○ much obvious
		Save money	○ Not at all ○ A little ○ Some what ○ considerably ○ much obvious
		Save unnecessary travel	○ Not at all ○ A little ○ Some what ○ considerably ○ much obvious
		Can be used at any time	○ Not at all ○ A little ○ Some what ○ considerably ○ much obvious
		Information Can be easily accessible	○ Not at all ○ A little ○ Some what ○ considerably ○ much obvious

12.	How do you understand the meaning of Smart Environment?	○ Modern management. ○ Using new technologies ○ Smart communication and information ○ Good Governance ○ Good citizen participation ○ I don't know ○ Others, Please Specify
13.	Do you think there is smart environment implementation in your Woreda?	○ Yes ○ No
14.	In your opinion, What are the benefits to implement Smart Environment in your woreda?	○ Improve Urban Solid Waste Management ○ Support Energy Efficiency ○ Reduce Carbon Emissions ○ Sustainable development ○ I don't Know ○ Others, Please Specify
15.	In order to solve the environmental problems on your woreda, what are smart decisions with context of your woreda or Akaki-Kality Sub-city?	○ Integret Smart Communication (Interconnect all environmental protection offices using internet system to share information and data regarding with the environmental protection activities) ○ Implements new sensor devices on the industries, parking, traffic maps, energy, water and waste management to monitor and control environmental pollution ○ Akaki-Kality Sub-city and woredas should team up with research institutions and universities ○ Improve collaboration with stakeholders and enhance citizen engagement ○ Others, Please Specify
16.	In your opinion as expert, To what extent does your Woreda Administration give attention to environmental protection practices?	◎ Very Low ◎ Low ◎ Middle ◎ High ◎ Very High

17.	How would you characterize Akaki-Kality Sub-city administration's overall commitment to implement smart Environment? (Select one.)	○ High priority ○ Medium priority ○ Low priority ○ Not a priority ○ Not applicable	
18.	In your opinion, What are the challenges implementing smart environment in your woreda? (Select as much as you like)	○ ○ Not having clear understanding, how smart environment works with our woredas context (lack of clarity around benefits). ○ Lack of knowhow by the expert about Smart Environment/ Need more technical expertise ○ Need to gain community support ○ Need more supportive policies ○ Needed high initial budget for new technologies implementation ○ Lack of Government Commitments ○ Technology challenges with coverage and capacity ○ Existing infrastructure for energy, water and transportation systems ○ Others, Please Specify	
19.	How important are each of the following objectives for smart Environment project in your Woreda?	Smart waste management system (sensors for waste containers, etc.)	○ Very Important ○ Important Moderately ○ Important ○ Less Important ○ Not Important ○ Others, Please Specify
		Smart water and wastewater (smart meters, automated leak detection, etc.)	○ Very Important ○ Important Moderately ○ Important ○ Less Important ○ Not Important
		Smart energy (smart meters, renewable energy, etc.)	○ Very Important ○ Important Moderately ○ Important

			○ Less Important ○ Not Important
		Smart Built environment (building management systems, streetlights with WiFi, or other services, etc.)	○ Very Important ○ Important Moderately ○ Important ○ Less Important ○ Not Important
	Others Please specify and include their level of importance		
20.	In your opinion, Which of these practices do you think in your Woreda to enhance citizen's participation in implementing smart environment?	○ Improving participation in decisions concerning issues of citizenship's interest ○ Being involved in the planning of the new public services ○ Allowing access to services provided by the Worda via smartphones ○ Reporting service problems of the woreda via social medias ○ Others, Please specify	
21.	What further improvement and public services related with new technologies do you think that should be implemented?		

End interview: Thank you very much for your time. Have a great day!

C	Sex of respondent	Male	Female
D	Age		
E	Professional background/ position etc.		
F`	Respondent higher level of Education		

APPENDIX II: KEY INFORMANT QUESTIONARIES'

A	Expert Name	
B	Date of interview	yy-mm-dd
C	Survey Start Time	HH:MM

Hello! My name is Henok Tekie; I am a graduate student at Addis Ababa University. My study focuses on Smart Environment deals with any professional and people can better understand and control their environment the idea of building an environment with sensors, technology and computer equipment and creating an environment conducive to the residents. The following interview aimed to know your opinion about your Akaki-Kality Sub-city Environmental Protection office as Smart Environment and its services. There is no right or wrong to your answer, so feel free to answer the questions. About the information that you are going to provide for me, I ensure you a complete confidentiality and anonymity.

0.	Do you want to participate in this voluntary survey?	Yes Thank you for your participation.	No (End interview)

1.	In your opinion, does Akaki-Kality Sub-city uses new technology as method for environmental protection system? Please, Explain	
2.	What is your understanding of smart environment? Can you please explain?	
3.	How will Akaki-Kality Sub-city primarily implement smart environment technologies?	
4.	How can Smart environment concepts be implemented within the Akaki Kality, Addis Ababa context?	
5.	How private institutions can work with Akaki-Kality Sub-city together and contribute to the environment protection?	

6.	What is the main role of various stakeholders working on environmental protection in the formation and implementation of the smart environment?	
7.	What is the key "smart" solution that you want to see implemented in environmental protection sector, which can benefit most people with minimum intervention?	
8.	Can you please explain what are challenges regarding implementing environmental protection activities in environmental protection sector?	
9.	How, in what way, is environmental protection sector addressing (resolving, alleviating or mitigating) the problem?	
10.	Why do you think the environment problem in Akaki-Kality Sub-city , Addis Ababa? Couldn't solve?	
11.	What do you think the main challenges to become smart environment in Akaki-Kality Sub-city ?	
12.	Please share additional comments related to smart city activities in Addis Ababa. Feel free to mention an activity about which you are proud, a challenge and opportunity you are working to overcome, or any other thoughts.	

End interview: Thank you very much for your time. Have a great day!

E	Sex of respondent	Male	Female
F	Age		
G	Professional background/ position etc.		
H	Respondent higher level of Education		
I	Survey End Time	HH:MM	