TRANSFORMATION OF URBAN CITIES TO SUSTAINABLE SMART CITIES - CHALLENGES AND OPPORTUNITIES FACED BY SAUDI ARABIA

DR. MURAD ANDEJANY[1], DR. ARIF MALIK[2], DR. WAQAR AHMAD[3], DR. ABDULLAH M. ALHARBI[4], DR. SYED UMAR[5]

[1]Associate Professor, Department of Industrial and Systems Engineering, College of Engineering, University of Jeddah, Jeddah, Saudi Arabia

[2]Network Engineer, Zuhair Fayez Partnership Consultants, Project of Academic and Administrative Building and Infrastructure Works, Jeddah, Saudi Arabia

[3]Associate Professor, Department of Industrial Engineering, College of Engineering, King Abdul Aziz University, Jeddah, Saudi Arabia

[4]Assistant Professor, Department of Industrial and Systems Engineering, College of Engineering, University of Jeddah, Jeddah, Saudi Arabia

[5]Professor, Department of Computer Science, College of Engineering and Technology Wollega University, Ethiopia

E-mail: [1]mbazzar@uj.edu.sa, [2]malik_aarif@yahoo.com, [3]wahmed@kau.edu.sa, [4]amealharbi@uj.edu.sa, [5]umar332@gmail.com

ABSTRACT

Transformation of urban cities to sustainable smart cities is growing rapidly in last few decades. This process has strong impact on country's infrastructural and financial growth. This paper focused on the overall challenges and opportunities in transformation of urban cities to sustainable smart cities in Kingdom of Saudi Arabia. Key study objectives are to show the significance of transformation trend mapping with urban influences and to address the challenges and opportunities of sustainable smart city transformation process. Literature has shown significant evidence of taking further initiatives to bridge the gap in the process of urban cities sustainable transformation. Study has shown the importance of transformation of urban cities to sustainable smart cities based on the literature and discussed the challenges and opportunities as per the global standards recommended by UN in Sustainable Development Objectives (SDGs). For this purpose, first study details the population of Saudi Arabia, in terms of its growth, based on gender and age group and showed the population stats of Saudis and Non-Saudis living in the Kingdom, until the mid-year of 2021. Secondly, study further observed the overall impact of transformation process aligned with the seventeen UN-SDGs by showing a trend mapping of transformation process of sustainable smart cities. Study has shown a comparison of local and global advancements in transformation of urban cities. Study has also pointed out some challenges like increase of capital cost, lack of skilled labor, privacy and security concerns, policy based framework, establishing the competitive environment, public dependency on public transport and internet related security and connectivity risks needs. Study also focused on opportunities like automation, efficient administration, eco-friendly sustainable environment, analytical use of data and better connectivity with efficiency can also be a great opportunity for a sustainable smart city transformation process.

Keywords: ICT, IOT, Smart Cities, Sustainable Development, UN-SDGs.

1. INTRODUCTION

Transformation of traditional urban cities to smart cities is rapidly growing globally. Smart cities are providing state of art technical, scientific and industrial base upon which the residents can avail the best services. Generally, smart cities known as providing modern information and communication technology (ICT) for performance based operational efficiencies. In addition to this, technological infrastructural development, taking special initiatives for sustainable environmental development in smart cities. Furthermore, highly effective functional public transport supported by well-planned city plans to provide best of services to the residents is one of the key role. The ultimate objective of smart cities is to modernize and optimize the general city functions, promote the economic growth, and to provide quality life to residents by using the smart technologies. The primary focus in the transformation process is not

availability of technology but it makes sure that the technology is fully deployed and accessible to the residents of smart cities.

Main features of smart cities are smart use of economy, smart services for residents, smart mechanism of governance, smart means of transportation, smart living style and most importantly a healthy and sustainable environment for residents [1]. This urban transformation becomes successful by deploying the smart technological solutions, smart use of ICT infrastructure, smart deployment of Internet of Things (IoTs), analytical use of big data applications and cloud-computing platforms. However, smart technologies are deployed as a supportive tool towards sustainable environmental development in urban cities [2].

This phenomenon is facing some general to serious level of concerns on environmental sustainability. These concerns are leading to socio-economic as a common problem in smart cities. Most of urban areas are consuming 70% of financial resources, which are spent on major contributors to greenhouse gas emissions and sustainable developments in smart cities [3].

Since the growth in urbanization is growing heavily, economical issues are also rising and putting a stress on the equal distribution of financial resources at different levels. United Nations details that over 55% globally population is still living in traditional cities and this number is increasing to 70% in near future [4]. Which is a serious concern leading towards transport problems, huge construction waste and over populated and polluted environment? Which is becoming a serious hazard for the people living both in traditional and smart cities [5]. These concerns needs to be addressed on priority to protect the urban environment and avoid wastage of natural resources. Researchers and field experts have been focusing on these concerns and reporting these issues in the academia as well. This needs to be further observed for a better and sustainable environmental development.

Kingdom of Saudi Arabia is also giving huge importance of this phenomenon of globalization and putting concrete efforts to transform the urban cities to smart cities. Most of the traditional cities are at different phases of transformation like Riyadh, Yanbu, Makkah, Jeddah, Madinah, Al-Ahsa and NEOM city [6]. Saudi government is granting huge resources for transformation of urban cities to smart cities, NEOM is one of the main example, which is planned city to be equipped with the most modern and state of the art use of technology [5].

The approximate estimation of Saudi smart cities was more than $3500 million in 2019 and this figure is increasing more by the end of year 2022. Recent market research and survey shows that the urban population is growing at a rapid speed, main cities are expanding both horizontally and vertically [6]. On the other hand rapid population growth adds stress on financial resources and it creates extra pressure along with planning concerns for sustainable development [7].

2. RESEARCH OBJECTIVES:

This study aims to focus on observing the overall impact of transformation of traditional urban cities to modern and sustainable smart cities. Study will focus on challenges, concerns in this transformation, and will try to improve the smart cities execution process by addressing the most recent challenges and opportunities. Following are the key objectives of the study:

1. Transformation trend mapping with significant urban influences in smart city transformation process.
2. Addressing the challenges and opportunities during smart city transformation process.

Furthermore, this paper addresses the above-mentioned two main areas smart city transformation of urban cities to sustainable smart cities to further observe and explore the ways and means of transformation trends in this process. Finally, study will look on the important challenges and valuable opportunities in the transformation process of smart cities faced by the Kingdom of Saudi Arabia.

3. RESEARCH PROBLEM:

Despite increasing awareness and efforts towards smart cities transformation, urban cities continue to face a multitude of challenges in their transition to becoming sustainable. These challenges include inadequate urban planning, limited access to renewable energy, inefficient waste management systems, and a lack of sustainable transportation options. Consequently, the current urban development model is unsustainable and poses significant threats to the environment, public health, and overall quality of life for urban residents. This research paper aims to identify and analyze the key obstacles hindering the transformation of urban cities into sustainable cities by observing the Saudi population and available resources to overcome these challenges and increase the level of opportunities. By

addressing these issues, this study seeks to contribute to the development of effective policies and practices that can guide urban cities transformation process towards achieving a more sustainable future.

4. LITERATURE REVIEW:

Recent literature shows a rich evidence of increase in transformation of urban cities into smart cities globally. This trend has been very high in modern world where urbanization is taking place on a true spectrum with proper and organized resource allocation as per the need of the residents. Issues arises in developing countries, where urbanization trend is not going through an organized process, which is causing some serious infrastructural and financial concerns for the authorities [2]. A big number of population is moving towards smart cities from neighboring areas to avail and enjoy the modern facilities provided in smart cities. This is raising many issues, which are affecting in provision of smart resources to the rapidly growing city population. This leads to recourse allocation issues in less developed cities, which will add more problems in some areas specially lack of resources for the less developed cities. It is important to differentiate between the smart cities and sustainable smart cities, state below:

4.1 Smart Cities and Sustainable Cities – Difference

It is vital to clear the concept of both smart and sustainable smart cities, as smart cities are growing at a rapid speed and the gap between both is becoming very thin. At this stage realization of impact of this transformation on social and economic sustainability and on quality of life of citizens. This transformation of urbanization is must be addressed on high priority because transformation speed is affecting the existing infrastructures [8]. One of the solution recommended by the professionals is that transformation from urban to smart cities should be reduced and new environmentally sustainable smart cities must be planned [9]. This must be adhered to adopt important ecologically measures ensuring the economically viability of the smart cities sustainable transformation process.

4.2 Environmental Sustainability:

Environmental sustainability is known as 'cities focusing on social and economic importance, aligned with the global environmental indicators'. Sustainable environment must be measurable through environmental indicators

and economic growth must go in parallel showing one director of progress available to citizens across the board [10]. This growth must impact the overall developmental processes in sustainable cities, like high level of quality of life, proper waste management and taking strong initiatives for keeping the environment inclusively green [3]. Developmental planning includes the Internet of Things (IOTs) and smart sustainable cities planning can further enhance the quality of life by reshaping the modern smart cities to be more feasible, integrated and sustainable [11].

4.3 Urban Transformation to Smart Cities

Smart cities basic concept is to provide solutions for the cumbersome issues faced by the people living in towns and cities. This phenomena has evolved with as the population is growing and daily routine issues are longer time and resources [12]. Smart cities known as providing state of the art services to facilitate the daily life of residents. It provides a digital framework where residents can enjoy comfort, city data accessibility and integrated communication between residents and the public and private functionaries [5].

Industrial growth is another serious concern, as it will add extra pressure on financial recourse spending in smart cities transformation. It is witnessed there is huge gap in the development of industrial revolution and city automation process at different access levels. Residents have benefitted in the use of IoTs, smart grids, sensors but at the same time case studies investigating the IoTs emergence in smart cities has pointed out the as the smart cities are growing, more challenges will emerge for traditional cities [13]. Smart grid technology improves utility proficiency, lessen the operational expenditures and minimalize power outages by using power energy saving measures [14]. Smart electric grid is an automated system, identifies potential disturbances, self-healing, and performs. In terms of difference between the two, smart cities mainly focuses on techno centric and urban entrepreneurial perspective and sustainable smart cities mainly focuses on economic and social perspective.

Furthermore, smart cities are mixed of soft capital associated with human resources and financial resources [15]. This also focuses on deployment of modern technologies to provide eminence environment, improved economy and to conserve a high quality of life. Whereas, smart

cities first priority is to acquire the financial sustainability.

4.4 Literature Synthesis for the Study

With reference to the current study, researcher gathered the relevant data from available online sources from last few years. The main purpose was to bring out the most relevant research conducted in this domain, as transformation of urban cities to sustainable smart cities is important topic in the recent past. The key point is to collect the relevant literature, which is addressing the seventeen UN-GDs as a benchmark for the current study. Then the literature is then filtered using Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) for the current study. PRISMA was adopted to improve the level of transparency and the scientific merit of a preferred reported systematic review or meta-analysis for evaluating the literature and recommended by the professionals for an evidence based, to help the researcher in completing this important process for the current research [16]. For this purpose, some important key words used in search process, like urban transformation, smart cities, and sustainable development goals etc. This literature search process was completed by searching online through the Web of Science database (https://www.sciencedirect.com/journal/UrbanTransformation) and some other sources were also used [17].

Total 58 research papers and articles selected through this process and after applying the filers like, journal ranking; publication in English language and research must be within the same domain. Lastly, after applying the PRISMA checklist, total 34 research papers found valid for the study. Below is the further given detail of the selection and rejection process of literature for the current study:

4.5 Literature Selection and Rejection Process

Mostly studies were searched addressing to the smart cities transformation, sustainable development and mapping with UN-SDGs and the focus was that studies must be published in peer reviewed journals, Full text availability in English language was ensured and most importantly studies must be focusing the relationship of smart city transformation. Similarly, rejection is done, if the article is not published in English language, research method is not clearly defined and if the research is as a review paper. The criteria for selection and rejection of the research articles for the current study details below in literature synthesis table given below:

Table 1: Literature Acceptance for Descriptive Mapping

Selection Conditions		Rejection Conditions	
Criteria 1	Smart City Transformation	**Criteria 3**	Published in other than Smart City
	Urbanization to Smart Cities		Published other than Urban Transformation
	Urban Transformation		Research method is not clearly defined
Criteria 2	Peer Reviewed Journal		Review Studies
	Full Text Availability in English Language		Other than English Language

PRISM data flow shown in the figure below, which explains the process of selection and rejection of relevant literature for the current study:
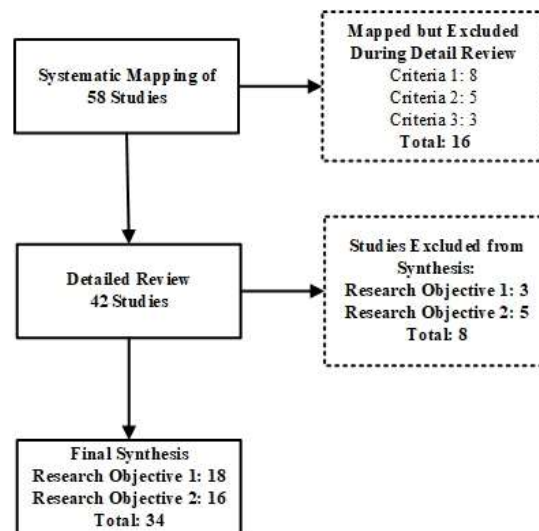

Figure 1: Descriptive Mapping Flow of Literature Review

In addition to this, for handling the biasness in the selection process, a thorough process adopted in searching for the required articles on web databases. Total 34 valid and found relevant studies articles. The main focus was on study area must be related to smart city transformation, urbanization and digital transformation, study objectives must be clearly addressing the sustainable smart city development aligned with the UN-SDGs. Most of research was from last five years to make the current study most recent one in terms of body of knowledge. Furthermore, the literature synthesis detail given below for better understanding:

Table 2: Literature Synthesis detail used in the current study

Study Area	Study Objectives	References	Mapped UN-SDGs
Industry 4.0 mapping UN-SDGs IT and Smart Cities Sustainable Development Smart City-Line in in KSA	Sustainability Development Goals Digital Learning Society 5.0	[18], [15], [3], [7]	*7, 8, 9, and 11.*
Smart Cities, Challenges and opportunities Digital Transformation	Mapping industry 4.0 System Thinking Smart City-Line	[19], [11]	*8, 9, and 11.*
Future Cities of Saudi Arabia Smart City Initiatives	UN-SDGs Risks of Smart Cities Corporate Social Responsibility	[20], [21]	*7, 8 and 9.*
Ecological indicators of smart urban metabolism Smart and sustainable city initiatives Sustainable development in cities	Smart City Development Sustainable Development Goals Integrated Enterprise Sustainable Development	[22], [23], [1]	*7, 9, and 12.*
Transformational nature of smart city governance Smart and sustainable city Smart and sustainable Development	Gender Based Digital Divide Sustainability Development Goals Environmental Sustainability Internet of Things (IoT) Adoption	[24], [9], [25]	*7, 8, and 9.*
Smart Grid for Smart Cities Solutions to the Smart Cities Challenges in Smart Cities Development	Urbanization of cities Transformation to Smart Cities Data Governance in the Development	[14], [26], [27]	*7, 8, 9, and 11.*
Sustainable smart cities Urbanization Smart Grid for Smart Cities	Sustainable Smart Cities Development Urbanization Implementation Digital Competence of Students	[2], [5], [12]	*8, 9, and 13.*
Drivers of Smart City Development Challenges in Smart Cities Development	Circular Economy Contribution to Smart Cities Sustainable Development Urban computing in smart cities	[28], [8]	*7, 8, 9, and 17.*
Drivers of Smart City Development	Smart City Transformation Framework Smart Grid and Smart Cities Smart cities: Challenges and Opportunities	[10], [29], [30]	*7, 9, and 13.*
Drivers of Smart City Sustainable Development Smart City Sustainable Development in Educational Robotics	Sustainable development goals Indicators of smart urban metabolism Drivers of Smart City Development Digital transformation on innovation	[31], [32], [33], [34]	*7, 8, 9, and 17.*

5. SMART CITY MAPPING WITH UN-SDGs:

Transformation from urban cities to sustainable smart cities needs some well-studied and defined set of objectives aligned with international standards. United Organization is also concerned about this and continuously working on developing a common framework for the global requirements for sustainable environmental development [4]. UN Sustainable Development Goals (SDGs) mainly focuses on the key initiatives considered for urbanization, which should be comprehensive, resilient, and sustainable. UN-SDGs is largely addressing to develop a framework for digital governance, e-democracy, health care access, public-private partnership, well-being and many other areas of concerned in this domain [20].

United Nations (UN) works globally for the betterment of the people living in different countries by developing common country strategic framework. UN is also working in collaboration with Saudi Government in the Vision 2030 and National Transformation Programs to facilitate in achieving the SDGs by addressing the challenges and opportunities in Kingdom of Saudi Arabia [35]. SDGs are focusing to take appropriate actions to deal with poverty, protect the environment and ensure the peace and prosperity of the people living in Kingdom of Saudi Arabia[36].

United Nations have formed seventeen sustainable developmental goals for the transformation of urban cities to smart cities. Goal 1 is focusing on No Poverty, Goal 2 is making sure of Zero Hunger, Goal 3 is addressing the Good Health and Well-being, Goal 4 is providing Quality Education, Goal 5 focuses Gender Equality, Goal 6 is for Clean Water and Sanitation, Goal 7 is for Affordable and Clean Energy, Goal 8 is for Decent Work and Economic Growth, Goal 9 is for developing the Industry, Innovation and Infrastructure, Goal 10 is focusing on Reduced Inequality, Goal 11 focuses on Sustainable Cities and Communities, Goal 12 is addressing the Responsible Consumption and Production, Goal 13 works on Climate Action, Goal 14 focuses on Life Below Water, Goal 15 is addressing the Life on Land, Goal 16 is providing Peace and Justice Strong Institutions and seventeenth goal is for Partnerships to achieve all

and lastly Goal 17 in global collaboration for sustainable smart cities [35]. Main purpose of forming SDGs is that there has to be transparent process of urbanization towards sustainable smart cities in the world.

Below is mapping of seventeen smart city initiatives with UN-SDGs, as per the detail literature synthesis given in table 2.0 listed below in terms of mapping of smart city initiatives mapped in different part of the world. It is worthy to mention here that only those smart city projects are included those minimum qualifies with three UN-SDGs, shown below in table 3:

Table 3: Mapping of Smart City Transformation with UN-SDGs

ITEMs/SDGs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
European Energy Award							☐		☐		☐						
SETIS							☐								☐		
Qatar Smart City Program							☐	☐			☐						
Singapore Intelligent Nation		☐		☐													☐
Smart Dubai				☐					☐		☐					☐	☐
Smart City Berlin Strategy							☐		☐		☐			☐			
Urban Agenda for EU								☐	☐								
Plan IT Valley									☐		☐						☐
Chiang Rai City								☐								☐	
Grow smarter Europe							☐				☐	☐					
NEOM Smart City									☐	☐	☐						
Dallas Innovation Alliance									☐		☐						☐
ESPRESSO									☐		☐						☐
Energy Cities								☐									☐
EERA Joint Program							☐		☐		☐						
Smart America Challenge							☐	☐	☐		☐				☐		☐
Smart London 2.0									☐		☐						
Global Digital Seoul 2020							☐	☐	☐								
One NYC									☐	☐	☐		☐				☐
Helsinki's Six City Strategy									☐		☐						☐
Boston Beta Blocks											☐						
Amsterdam Smart City		☐					☐				☐	☐	☐				☐
Oslo SSC Project						☐					☐	☐					☐

Above mentioned table shows, the detail of qualifying for the seventeen UN-SDGs adopted for the transformation of smart cities globally. Different smart city projects chosen based on qualifying minimum three sustainable development goals and their mapping shown with UN-SDGs. This process has many challenges regarding sustainable urbanization and it needs strong initiatives from the stakeholders for developing policies to deploy strong management strategies, developing interrelatedness [4]. It also needs to involve the resident's to contribute in developing a qualitative policy to address the concerns and challenges.

5.1   *Smart Cities Initiatvies in KSA*

Generally, in terms of smart city initiatives NEOM is located at the red sea, it is not only a tourist resort; it is state of the art technology park. This is not the case; Saudi Arabia has launched some other smart city projects, like King Abdullah City, Yanbu and Jubail. In addition to this, there are some other project have been recently initiated. MOMRA, the ministry of Municipal, Rural Affairs and Housing adopted a smart city strategy last year in February 2022. This strategy is mainly focusing on launching fifty more smart cities in different areas as per the VISION 2030 [26]. They key of these new strategy initiatives is use of Artificial Intelligence (AI) and Internet of Things (IoTs) applications to make three proposed sites more digital among the world's best cities [35]. Furthermore, MOMRA also announced in the GOLBAL AI Summit last year in September 2022 that in future this number of transformation to smart cities would go up to 200. The focus would be to

provide a modern transport infrastructure to residents and comprehensive logistics support system. Recently, MOMRA has setup the Municipal Investment Forum (FORAS) to attract the investors in the smart cities. Saudi government is aiming to increase private sector participation from 40% to 65% to raise the Small to Medium Enterprises contribution in the Kingdom GDP [21]. These initiatives will bridge the gap between the municipal assets and investors offering them short term diversified contract based leases. In this regards, bank guarantee is also reduced from 100% to 25%, which will help investors in participating development and construction industry [35]. This will also help to achieve the Kingdom's Vision 2030 by adding value to quality of service in smart cities and to improve the urban scenery, privatization programs, serving pilgrims, and housing, financial sustainability,

evolving and expanding the entertainment openings to meet the resident's needs. In this regards, ministry has offered 37,000 investment opportunities worth 7 billion Saudi Riyals to 66,000 investors with local and international companies [21].

5.2 Saudi Population:

Population is playing a key role in planning for sustainable smart cities. Resources allocation purely based on the population growth. Saudi Arabia's population is growing rapidly in last few years but there is 2.6% decrease during mid-year of 2020, the official population statistics by mid-year of 2021, were 34.1 million [37]. The detail of Saudi population by age group and gender in the table given below:

Table 4: Population Distribution By Gender Till 2021

Age Group	Male	Female	Total
0 - 4	1,363,224	1,326,207	2,689,431
5 - 9	1,534,506	1,452,198	2,986,704
10 - 14	1,364,949	1,335,118	2,700,067
15 - 19	1,241,851	1,163,398	2,405,249
20 - 24	1,322,887	1,228,785	2,551,672
25 - 29	1,632,882	1,449,705	3,082,587
30 - 34	1,763,292	1,392,654	3,155,946
35 - 39	2,218,109	1,412,209	3,630,318
40 - 44	2,050,295	1,215,070	3,265,365
45 - 49	1,684,521	904,284	2,588,805
50 - 54	1,210,141	582,870	1,793,011
55 - 59	832,274	430,021	1,262,295
60 - 64	511,757	297,796	809,553
65 +	632,968	556,850	1,189,818
Grand Total:	**19,363,656**	**14,747,165**	**34,110,821**

Above mentioned table shows, the overall population as per the age group and order from highest to lowest and illustrates the population detail. It is important to mention here that Saudi Arabia is 13th largest country by area and ranked high in terms of high population in the world. Riyadh being capital of Kingdom is highly populated, the population is over 4 million, which demands big infrastructural level developments and this needs huge financial spending. Other than capital city, there are three other main cities, which are highly populated, and the population in these cities is more than a million. Furthermore, nineteen other cities of Kingdom have population over

100,000 and lastly 44 cities are surpassing the number 10,000 in 13 different regions of Kingdom of Saudi Arabia [37]. This is alarming in terms of the providing the best and quality services to the residents.

Such a large population, where 83% of residents are living in urban cities and only 17% of residents are living in rural areas. This big difference demands huge infrastructural and environmental sustainable developments to cater the huge urban population. Saudi authorities are allocating enough resources for the urban development but still there is big gap from the urbanization to smart cities [7]. An additional load of expats working in the

kingdom adds burden on the sustainable environmental development. Government authorities' needs further developmental and both horizontal and vertical expansion of cities. Saudi government has taken big initiatives like urbanization and renovation of big cities, launching new modern smart city projects in downtown area of big cities to lessen the load on existing big cities [5].

Saudi population particularly in cities due to urbanization moved from 9.32 million in 1980 to 26.30 million in the year 2018. This increase is growing rapidly as people want to enjoy more facilities which are provide in cities due vast urbanization in last few years and it is also predicted that urbanization will further grow in future. As per the official sources, urbanization will increase up to 97.6% by the year 2030. Riyadh being capital of the Kingdom will have approximate increase of 8.2 million. On the other side annual demographic growth is also expected to reach 0.87%, which will be 31.457 million by the year 2030 [5]. This also needs to be catered for future development in this regards.

This forces the academia researchers to observe and assess this data and look for the future concerns and stress on the urban cities, to recommend the measures to authorities to monitor this rapid and drastic population move to urban cities. Authorities should address this issue and make sustainable environmental policies and plans to cater the financial resources based on the realistic demand of the transformation of urban cities to smart cities. These polices and plans must be consistent and aligned with geographical, cultural, economic requirements for sustainable environmental development. Recently ministry of municipal and rural affairs have planned 10 new smart cities under the National Transformation Program (NTP) to provide facilities to the population and lessen the load from the existing smart cities [21]. There is another very important aspect of the Saudi population, which is local (Saudis) and Expats (Non-Saudis) living in the Kingdom. A big number of people from other counties are living here as workforce and they are considered very high in terms of their contribution in sustainable infrastructural and developmental growth of the Kingdom in various sectors both public and private. Non-Saudi population figure is 12420173, whereas Saudis population figures is 21690648, which is almost 36% of the total Saudi population [37]. Table 6 shows the population estimates until mid-year 2021:

Table 6: Preliminary Population Estimates till Mid-Year 2021

Age	Saudi Nationals			Non Saudis/Expats			Total Population		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
0 - 4	1,103,151	1,085,223	**2,188,374**	260,073	240,984	**501,057**	1,363,224	1,326,207	**2,689,431**
5 - 9	1,165,051	1,097,326	**2,262,377**	369,455	354,872	**724,327**	1,534,506	1,452,198	**2,986,704**
10 - 14	1,043,917	1,032,094	**2,076,011**	321,032	303,024	**624,056**	1,364,949	1,335,118	**2,700,067**
15 - 19	951,818	894,816	**1,846,634**	290,033	268,582	**558,615**	1,241,851	1,163,398	**2,405,249**
20 - 24	1,074,376	998,140	**2,072,516**	248,511	230,645	**479,156**	1,322,887	1,228,785	**2,551,672**
25 - 29	1,041,974	1,026,056	**2,068,030**	590,908	423,649	**1,014,557**	1,632,882	1,449,705	**3,082,587**
30 - 34	936,104	941,473	**1,877,577**	827,188	451,181	**1,278,369**	1,763,292	1,392,654	**3,155,946**
35 - 39	856,123	821,573	**1,677,696**	1,361,986	590,636	**1,952,622**	2,218,109	1,412,209	**3,630,318**
40 - 44	684,143	673,694	**1,357,837**	1,366,152	541,376	**1,907,528**	2,050,295	1,215,070	**3,265,365**
45 - 49	593,073	560,761	**1,153,834**	1,091,448	343,523	**1,434,971**	1,684,521	904,284	**2,588,805**
50 - 54	474,238	450,961	**925,199**	735,903	131,909	**867,812**	1,210,141	582,870	**1,793,011**
55 - 59	377,003	350,308	**727,311**	455,271	79,713	**534,984**	832,274	430,021	**1,262,295**
60 - 64	258,833	245,608	**504,441**	252,924	52,188	**305,112**	511,757	297,796	**809,553**
65+	468,202	484,609	**952,811**	164,766	72,241	**237,007**	632,968	556,850	**1,189,818**
Total:	**11,028,006**	**10,662,642**	**21,690,648**	**8,335,650**	**4,084,523**	**12,420,173**	**19,363,656**	**14,747,165**	**34,110,821**

Figure two, details the overall population estimates till the mid-year 2021, which clearly indicates big number of that population statistics of both Saudis and Non-Saudis (male and female) residents living in Kingdom of Saudi Arabia. This is important to mention here that smart city

transformation process planning and development is highly associated on the population growth in the Kingdom for appropriate allocation of required resources for developing an environmentally sustainable smart city in the Kingdom of Saudi Arabia. It is worthy to mention here that the main aspect of the Saudi population is the resident is aged 20 to 39. It is a big number 9,868,851, which could play a vital role in the sustainable transformation process. Detail given below in Figure 2:
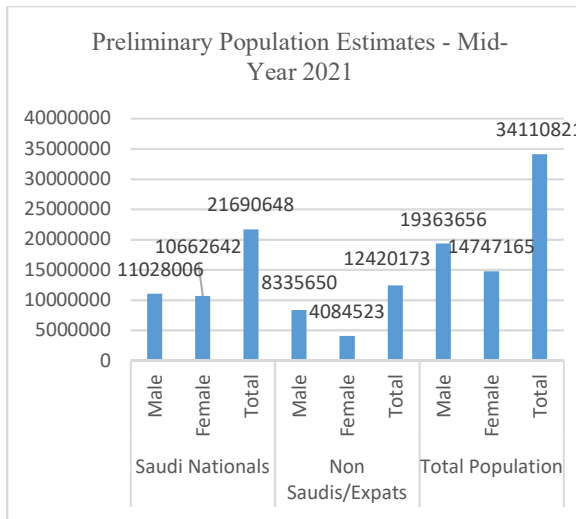

Figure 2: Preliminary Population Estimates – Mid-Year 2021

Figure 3 shows the population estimates of both Saudis and Non-Saudi population. The population number is 12420173, which is 36% for Non-Saudis living the Kingdom from different part of world. Whereas Saudis population number for Saudis is 21690648, which is almost 64% of the total Saudi population [37]. Further detail is shown in a pie chart in Figure 3.
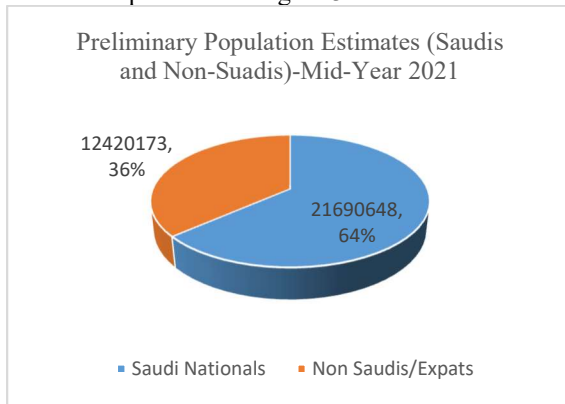

Figure 3. Preliminary Population Estimates - Mid-Year 2021

5.3 Smart City Challenges and Opportunities

Transformation of urban cities to sustainable smart cities is rapidly growing globally. Kingdom of Saudi Arabia is also highly focused and putting necessary efforts and improve this process. This research first discovers the challenges and opportunities faced by Saudi Arabia in the transformation process.

Based on the population growth in the Kingdom of Saudi Arabia, resource allocation for sustainable smart cities is very important factor and have high impact on the Saudi economy. Transformation of urban cities to smart cities has brought many challenges and opportunities for the authorities and people living in these cities. These challenges are categorized in three main areas, i.e. Government, Business and People living smart cities. One of the main challenge is use of ICT, IoTs, digital surveillance etc. This brings safety and security concerns to residents affecting their privacy and disparity in both in public and private sector. These concerns are of intermediate to high level of risks involving some serious threats to individuals living in smart cities [25]. Modern way of living in smart cities, where digitization is at its best of use, generates serious level of concerns related to personal, social and work life, transport related issues and digital home using sensor based technologies. Technological based concerns affect all three categories, hence must be addressed on priority to ensure the transparency in the smart cities [3]. For this purpose smart city planner and developer must adhere to some basic principles, which are, confidentiality and integrity of information with information availability at all levels for the official and personal use with fool proof security measures deployed.

Saudi authorities and professionals are highly focused in addressing these issues and providing necessary and important resources for the better execution of this sustainable transformation process.

Based on the literature evidence following are some of common challenges and opportunities in sustainable smart cities to Saudi government, both public and private business and people are shown in Table 7:

Table 7: Challenges and Opportunities towards Sustainable Smart Cities

Sector/Area	Categories	Challenges	Opportunities	Literature Evidence

GOVERNMENT	**Economic**	High Capital Costs	Automation	[20], [19]
	Managerial	Skilled Labor Requirement	Efficient Administration	[12], [3]
	Resource Utilization	Data Collection Privacy	Eco-Friendly Environment	[11], [6]
	Waste Management	High Capital Costs	Sustainable Environment	[9], [38]
	IT/ICT	Cyber-Security Concerns	Data Analytical Use	[2], [18]
BUSINESS	**Administration**	Policy Based Framework	Skilled People Availability	[6], [20]
	IT/ICT	Competitive Environment	More Business Opportunities	[24], [5]
PEOPLE	**Transport**	Public Transport Dependency	Effective and Economical	[6], [20]
	IT/ICT	Data Privacy and Security	Better Connectivity	[11], [6]
	Internet Services	Internet related Privacy Risks	Efficiency	[5]

In light of above mentioned table, it clearly states that technologically powered smart cities have botnet activities, which launches a serious security threat in cyber domain, infecting the connected devices and leading to a serious security breach by disrupting the entire network. In addition to this, data sharing brings another serious vulnerability of confidentiality of personal data breaches in smart cities. Moreover, technological infrastructure setup by the private companies create a monopoly, where more authoritative control lies with the providers and a little freedom is given to the residents in terms of data access and security [3]. Hence, this leads to lack of autonomy of residents on their personal data and causes a fear factor regarding the privacy and security concerns in the smart cities.

High capital costs at different level of transformation is another key concern in this process. It increases the value of the smart cities in terms of using the most modern technologies in automation of different smart city processes but it also increases the cost. Which is a serious concern and needs to be addressed for transparent distribution of financial resources.

Another area of concern is management skills at different levels of this process, because right man for the right job will enhance the entire process and will add value to the smart city projects for efficient administration. Proper and adequate resource utilization in terms of data collection and developing eco-friendly and sustainable environment will add the trust in technology in the smart cities [25]. Administrative affairs have a great impact in developing a policy-based framework where highly skilled professionals must be available to deal with the administrative issues in smart cities.

Waste management is another key concern and bringing a serious challenge for the smart city planners as its cost is very high and there are many areas which needs to be addressed right from the waste collection mechanism and destroying the waste in smart cities [1]. It requires high capital cost on priority for the development of sustainable in smart cities.

Lastly, public transport is a great opportunity to smart city residents but it is also an intermediate level of concern, which can affect the smart city sustainability in many ways. Transportation services must be as per the international standards and must be effective and economical for green and sustainable environment in smart cities. Internet services must be secure and risk free with efficient availability of 24/7 to the residents.

6. DISCUSSION:

This paper focused on the overall transformation development process of urban cities to sustainable smart cities particularly in Saudi Arabia. Firstly, study focused on observing the overall impact of transformation of traditional urban cities to smart cities. Mainly study focused on the trend mapping of seventeen UN-SDGS in transforming the urban cities to smart cities globally. Trend mapping indicates the world's smart cities achievements with UN-SDGs. NEOM, is mapped with three UN-SDGS, goal 9, Industry, Innovation and Infrastructure, goal 10 Reduced Inequality and goal 11, Sustainable Cities and Communities, being in the initial stage of infrastructural phase. Some of the other smart city projects listed in the table and mapped with UN-SDGs. Research has shown the population detail of kingdom of Saudi Arabia until mid of 2021 to give a realistic picture of the population growth in coming future.

Study has focused on the challenges and opportunities in the process of transformation. Some of the common challenges pointed out in light of recent literature. High capital cost is one of the main concern, skilled labor requirements is another challenge, privacy and security concerns, requirement of policy based framework, establishing the competitive environment, public

dependency on public transport and lastly, internet related security and connectivity risks needs to be addressed on priority. In addition to this, some valuable and strong opportunities were also highlighted one automation will enhance and ease the daily life of residents. Efficient administration will facilitate the daily life operations. Eco-friendly sustainable environment will add additional strength. Analytical use of data can further help to observe and assess the future requirements. Skilled people availability and better connectivity with efficiency can also be a great opportunity to provide necessary services to the smart city residents.

7. CRITICAL ANALYSIS:

The transformation of urban cities into sustainable smart cities is a growing trend worldwide, and Saudi Arabia is no exception. This paper first explores the challenges and opportunities faced by Saudi Arabia in this transformation process. Saudi Arabia, with its rapidly growing population and urbanization, is facing various challenges in its quest to become a sustainable smart city.

One of the main challenges is the existing infrastructure, which is often outdated and not equipped to handle the demands of a sustainable smart city. Upgrading the infrastructure to support advanced technologies such as IoTs, intelligent transportation systems, and renewable energy sources poses a significant challenge.

Another challenge is the need for strong governance and regulations to ensure the successful implementation of smart city initiatives. Saudi Arabia must develop and enforce policies that promote sustainability, data privacy, and cybersecurity. Additionally, establishing effective partnerships between the public and private sectors is crucial to overcome financial and resource constraints.

Despite these challenges, Saudi Arabia also has unique opportunities to transform its urban cities into sustainable smart cities. The country has a wealth of natural resources, particularly solar energy, which can be harnessed to power smart city infrastructure and reduce reliance on fossil fuels. The government's Vision 2030 initiative, which aims to diversify the economy and improve quality of life, provides a strategic framework for the development of sustainable smart cities.

Furthermore, Saudi Arabia has a young and tech-savvy population, which can drive innovation and adoption of smart city technologies. The country can leverage this human capital to develop local talent and create a thriving ecosystem of startups and technology companies focused on smart city solutions.

The transformation of urban cities into sustainable smart cities presents both challenges and opportunities for Saudi Arabia. Overcoming infrastructure limitations, establishing effective governance and regulations, and fostering partnerships are key challenges that need to be addressed. However, the country's abundant natural resources and young population provide unique opportunities for Saudi Arabia to become a leader in smart city development.

Study mainly observed the impact of transformation of traditional cities to smart cities and focused on trend mapping aligned with seventeen UN-SDGs. Study has shown a comparison of local and global advancements in transformation of urban cities. Study has also pointed out some challenges like increase of capital cost, lack of skilled labor, privacy and security concerns, policy based framework, establishing the competitive environment, public dependency on public transport and lastly, internet related security and connectivity risks needs. Study also focused on opportunities like automation, efficient administration, eco-friendly sustainable environment, analytical use of data, better connectivity with efficiency can also be a great opportunity.

8. CONCLUSION:

Study has shown the population detail, in terms of its growth, with reference both Saudis and Non-Saudis until the mid-year of 2021. Smart city transformation planners and developers must adhere to the population growth rate in the Kingdom of Saudi Arabia. This will give clear understandings for further planning and resource allocation in the future. Study highlighted the common concerns of economic and technical issues and lists down some important opportunities to overcome the concerns and to facilitate the transformation process of sustainable smart cities.

Study has given adequate importance to the main topic of urbanization to smart cities based on the literature and found results very informative in terms of aligning and mapping the local challenges and opportunities with the international level of efforts made in this entire process of transformation aligned with the UN-SDGs.

Study mainly pointed out the global UN-SDGs trend mapping, which clearly indicates that transformation process still need some major efforts to meet the UN standards for sustainable transformation process. Authorities must identify

the challenges to ease the transformation process and look for the opportunities to enhance the sustainable transformation process. Challenges like increasing cost, lack of skilled workers, privacy and security concerns, develop policy based framework, encouraging sustainable competitive environment, operative and viable public transport and internet based concerns must be handled more carefully. Opportunities like automation, efficient administration, eco-friendly sustainable environment, analytical use of data, and better connectivity with efficiency must be availed on priority in terms of maximizing the benefits for sustainable transformation process of smart cities.

Based on study outcome, future studies could be further planned to observe and assess the sustainable city transformation process by using other research methods, as quantitative methodology could be used for numeral analysis and qualitative methodology can be used to further address the latent viewpoint of the residents. In relation to the UN-SDGs mapping, future studies could also observe a deeper association of ground realities with the United Nations seventeen sustainable development goals for better and more realistic understanding of the research.

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