Saudi Arabia's March towards Sustainable Development through Innovation and Technology

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Abstract - Sustainable development requires concerted effort and persistence on various fronts using available resources and technological tools to improve the quality of life. Global sustainability goals are designed to benefit developments in all walks of life of the present and future generations. To attain global sustainability, every country should make best efforts with the available resources and shared means. This paper analyses the case of Saudi Arabia in achieving sustainability through innovations and Information technology in key areas of national development. The contribution of this research is to provide a comprehensive understanding of the key projects undertaken by Saudi Arabia to transform the nation into modernity and prosperity by means of cutting-edge technologies and tools. This study shows that the innovation, science and technology play critical role towards achieving sustainable development. Conclusions of this study can serve as an example to achieve sustainability in other parts of the world.

Keywords: Sustainable Development, Sustainable Innovation, Global Innovation, System Interventions, Technological Paradigms.

I. INTRODUCTION

There are many definitions and interpretations of sustainability. In simple words, sustainability amounts to meeting needs without compromising the ability of future generations to meet their own needs. Sustainability improves the quality of our lives, protects our ecosystem and preserves natural resources for future generations. Global sustainability defines the conditions under which humans and nature, societies and the biosphere, the world and the Earth can co-exist in ways that enable productive harmony, stability and resilience to support present and future generations. The sustainable development goals are aimed at achieving a prosperous future for all. They address the challenge and solve the problems we face, like poverty, inequality, climate change, environmental degradation, peace and justice. These are the common global issues although different countries may face additional problems due to the factors associated with their region and society. A critical view of Sustainability developments is presented in [1].

Sustainable development essentials include food, health, water, energy, education and manufac-tured goods, which must be provided to the citizens for their wellbeing. Many parts of the world, including the norther America, Europe, Australasia, and some countries of Asia (Japan, South Korea, Singapore, Hong Kong, Taiwan, and Malaysia) have shown remarkable progress towards achieving sustainability. Some other countries of the world, including the Kingdom of Saudi Ara-bia (KSA), are showing noticeable progress towards achieving sustainability. On the global stage, some remarkable innovations are taking place, which are destined to resolve many issues, and create some unimaginable new avenues in our life. We can see that electric/autonomous cars, drones, biological farming, and robotics are the innovations which are utilizing modern technolo-gies like Artificial Intelligence, Internet of Things, Sensor Networks, Cloud and Fog computing, RFID, Renewable Sources, and E-things (E-health, E-government, E-learning, etc.). These are some of the new and ongoing innovations to help create sustainable future. These technologies, and the associated tools are helping developments, faith in which is reinforced by both public and private sector opinions, and frequently utilized to achieve sustainable development. Some of these developments are also driven by green initiatives through their decentralized, economical, elastic, smart, and self-governing qualities that have been absent in conservative techniques for decades and centuries. These developments are qualified with their potential to encounter local/global difficulties such as climate/weather change, growing discriminations, etc. [2-3].

Saudi Arabia is the largest exporter of crude oil and petroleum products. Also, the KSA is the most influential, by size and economic superiority [4], member of the Gulf Cooperation Council (GCC) [5]. The GDP of Saudi Arabia [6], is expected to be around seven hundred billion dollars in 2021. However, the Saudi Vision 2030 [7] aspires to increase it to nine hundred billion dollars.

Saudi Arabia is an influential member country in the Middle East and North Africa (MENA). The KSA also houses Ka'aba in Makkah (Mecca), which all people belonging to the Islamic faith face in their five daily prayers. Makkah is also the center of the annual pilgrimage, known as the Hajj [8-9], which normally allows up to three million pilgrims, from about one hundred and ninety countries of the world. Round the clock performance of 'Umrah' (also known as lesser Hajj), takes place in all seasons. About ten million people from different countries travel to the KSA for their pilgrimages. Organization of the Hajj and Umrah, a mammoth organizational and economic task, is organized by the king of Saudi Arabia, who is also titled as the custodian of the two holy mosques.

A. Contribution in this Paper

This is a review article and analyses the progress of the innovations and developments in Saudi Arabia. The paper looks at the programs and projects in different sectors of the

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country. The focus in this paper is to analyze only those projects which are using latest technologies and tools, in particular, the Information Technology. The research relates to the sustainability model and goals set by the United Nation.

This research highlights the significance of innovation in various areas such as economic de-velopment, global warming, sustainable farming, prevention of hunger, fulfilment of social and religious needs, education, transportation, and delivery of other essentials goods and services. The analysis and conclusions in this paper can encourage other countries of the region, especially those in the Asia and Africa, to follow the example of Saudi Arabia towards modernizing their country and making themselves self-sufficient in many of their social-economic areas.

II. Literature Review

Saudi Arabia of the 21st century is a transformed country, marching rapidly towards great achievements with massive developments in several sectors. Historically, Saudi Arabia is per-ceived to be an oil producing, desert dominated, dry with little or no greenery, backward in educa-tion, and a socially conservative country. This description of Saudi Arabia has now become a history. Today's Saudi Arabia is a modern, vibrant, fast developing country with rapid and immense changes in many sectors of life. Many researchers have commented on socio-economical and educational aspects of Saudi Arabia, we provide a brief summary here.

Authors in [10] have provided an overview of the artificial intelligence strategy for higher education in Saudi Arabia. In [11-12], authors have extensively discussed the e-government structure and its success in Saudi Arabia. Female education and other issues are discussed by Yamin et al. in [13]. In [14], an integrated approach to sustainability in the energy sectors is discussed.

Crowd management is a central issue for the KSA to deal with because every year about three million people gather in Makkah for a period of about two weeks or more. The Crowd issues of Saudi Arabia, including those with the Hajj pilgrimage, are elaborated in [15]. In [13], authors have provided Socio-Cultural Overview of e-learning in Saudi Arabia, with an emphasis on the woman education and other affairs related to them. In [16], authors have explored the opportunities and challenges of embracing green city principles in Saudi Arabia future cities. An integrated approach, adopted by the KSA towards achieving energy sustainability, is presented in [14].

Fig. 1. Saudi Vision 2030

Saudi Arabian socio-economic development is being steered by the Saudi Vision 2030 [7], which is providing a launching pad for several programs aimed at improving the life of people. Some issues and projects associated with the march of Saudi Arabia into a prosperous and sustainable future can be tracked from the Saudi Vision 2030 portal. In brief, the Saudi Vision is synonymous to the United Nation's 2030 Vision [17]. All major issues (climate control, agriculture, energy, and health and wellbeing) are part of the Saudi Vision. An additional issue, with which the KSA has to deal on a continuous basis, is that of Hajj and Umrah.

Saudi Arabia has successfully contained the spread of COVID-19. As compared the countries of the region, the KSA has managed to keep the number of infections and fatalities low. Some details of the COVID-19 and its global management, including Saudi Arabia, can be found in [18-19]. Saudi Arabia has managed education delivery in an exemplary manner [20]. Authors in [21-22] have extensively discussed management of education delivery during the COVID-19, which can serve as a model to the neighboring countries.

III. Sustainable Development Goals

The United Nations in 2015 had drawn up the Vision 2030, and identified seventeen sustainable development goals, which are depicted and briefly described in Figure 1 [17]. Many countries have adapted and redrawn these goals with the ground realities of their region and issues. The KSA has also adapted them into Saudi Vision 2030.

A. Umbrella of Saudi Vision 2030

Saudi Arabia has a very ambitious set of programs as part of its Vision 2030. Umbrella of Saudi Vision 2030, as shown in Figure 2, provides the kingdom's indicators to be accomplished from the policies to accomplish sustainable goals, such as clean water distribution and sanitation, inexpen-sive and renewable energy, financial growth, industrial revolution and organization, decreasing inequalities, and ecological cities and public [4]. Indicators of the umbrella are outlined in Table I.

Fig. 2. Umbrella of Saudi Vision 2030

Various factors which are being witnessed in the KSA's sustainable development are of main fo-cus represented in Figure 1. Vision 2030 is built around three primary themes: a vibrant society, a thriving economy and an ambitious nation. These themes are spelled out in Table II.

TABLE I. Indicators of Umbrella

S. No.	Indicators
1	No Poverty
2	Zero Hunger
3	Good Heath & wellbeing
4	Quality Education
5	Gender Equality
6	Clean Water & Sanitation
7	Affordable & Clean Energy
8	Decent Work & Economic Growth
9	Industry, Innovation and Infrastructure
10	Reduced Inequalities
11	Sustainable Cities & Communities
12	Responsible Consumption & Production
13	Climate Action
14	Life Below Water
15	Life on Land
16	Peace, Justice and Strong Institutions
17	Partnership for the Goals

TABLE II. Vision 2030 targets for Sustainability [23]

Vibrant Society	Thriving Economy	Ambitious Nation
To more than double the number of Saudi heritage sites registered with UNESCO	To increase SME contribution to GDP from 20% to 35%	To increase non-oil government revenue from SAR 163 billion to SAR 1 trillion
To increase household spending on cultural and entertainment activities inside the Kingdom from 2.9% to 6%	To rise from our current position of 25 to the top 10 countries on the Global Competitiveness Index.	To raise the non-profit sector's contribution to GDP from less than 1% to 5%
To have three Saudi cities recognized in the top-ranked 100 cities in the world.	To increase the Public Investment Fund's assets, from SAR 600 billion to over 7 trillion.	-
To raise Saudi Arabia's position from 26 to 10 in the Social Capital Index	To raise the share of non-oil exports in non-oil GDP from 16% to 50%.	-

B. Sustainable Development Matrix

Economic development and product development are convolutedly related. They are the two sides of the same coin. Faster economic development without productivity is not feasible to achieve. To achieve sustainable development, a number of initiatives, including efficient design and measurement techniques of the enterprises, holistic approaches for fullest utilization of re-sources, produce renewable energy and enable the adoption of green production, need to be com-bined [17, 24]. This is gathered in a matrix which resembles sustainable development is provided in Figure 3.

The matrix in Figure 3 integrates the broad conceptions of entities which all start with the letter P (3 P's), which stand for Planet, People, and Profit, as shown in Figure 4. Planet signifies compe-tence and the acceptance of limited resources; People signifies the prospect for value; and Profit signifies the service to be accomplished. To express this advice visually, the matrix is embodied as a three-sided fractal symmetrical figure. The matrix visually signifies a green development ap-proach that penetrates deeper and deeper into all facets of development with improved decision-making.

Fig. 3. Matrix of sustainable development

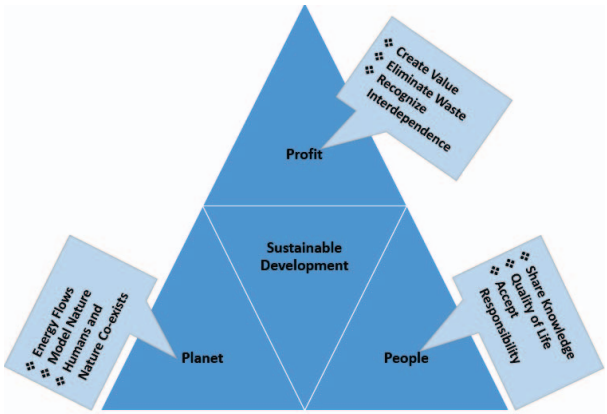

Fig. 4. Stakeholders of sustainable development

C. Qualified Major Concerns

Innovations and changes are not confined to the developed countries but also many developing nations. These innovations and changes should remove misconceptions and apprehensions such as:

- What is the role of green technology in the sustainable development? In particular, should the technological element of innovation include green expertise, tangible potential, and their rapid expansion lead towards sustainable growth of society?
- What is the participation of demographic and strategy advances in encouraging and assisting sustainable development through cooperating with the technological revolutions?
- Are the evolving changes improve sustainability and guarantee that they replace the age old conservative models or merely connect and cooperate with them?
- Are the organizational changes required? If so, what organizational changes are necessary to support innovation for sustainable growth? How can system interventions drive development?
- How should national march ahead. In particular, should the organizations embrace and endorse innovation, without any hesitation and concerns?

IV. Sustainable Development of KSA through Innovation and Technology

The Kingdom of Saudi Arabia is undergoing through social and economic transformations to accomplish Saudi Vision 2030 through National Transformation Programme. The government is offering system interventions through a number of regulations and policy modifications intended at streamlining business and investments through technology and innovation [17, 25]. Some of the notable developments of the KSA follow.

A. NEOM

In its march towards development, the KSA is developing an innovative and high tech city known as NOPM, which is an acronym for "New Future and New Enterprise Operating Model'. NEOM is located in the north-west region of Saudi Arabia, and directly faces Sharm el-Sheikh, a famous Egyptian tourist resort. NEOM extends along with Aqaba Gulf and a coastline of about four hundred and seventy kilometers with beaches and coral reefs, as well as mountains up to two thousand and five hundred meters high, with a total area of around twenty-six and half thousand kilometers. It is a cognitive and smart city, and stands for a new vision of what the future could be and a home for people who dream big. It is designed to attract investment and promote interna-tional tourism at a large scale. In the meantime, the Kingdom is strong to adapt technological innovation in various areas such as education, health, desalination, renewable energy sources, and power supply. With cutting-edge technical centers, the government has planned for the NEOM project with more than 500 billion US dollars' worth to concentrate on innovation for the prospec-tive businesses' operations. This project is meant for implementing smart city technologies, con-necting globally through intelligence, imparting cognitive learning, and delivering efficient services. For detail of NEOM, refer to [26].

B. King Salman Energy Park

King Salman Energy Park (SPARK) is an enormous and innovative project to drive clean energy initiative. The park is located between Dammam and Al-Ahsa regions of Saudi Arabia. It is being established, activated, and accomplished by Saudi Aramco, the largest oil company of the world. This project aims at giving diverse services such as production, renewable power, water supply, etc. More detail of SPARK are available in [27].

C. Leadership of Silicon Valley of the Middle East

The KSA is devoting itself deeply towards achieving economic development and stability away from dependence on oil by increasing technology driven projects and promoting entrepreneurship. The government is spending billions of dollars and moving forward with an envelope of economic transformations to reinforce the digital sector. The kingdom is the Middle East's leading economy, with a gross domestic product of about seven hundred billions, and availing various opportunities of technology to reach the country's goals by 2030.

V. Information Technology for Innovation and Sustainibilty

Saudi Arabia has undertaken several technological initiatives, described as follows.

A. Digital Software and Platforms

Digital software and Platforms is a massive digital transformation program [28]. It consists of the following subprograms:

- Digital Giving Initiative: This program was initiated by Communications and Information Technology ministry. It is a non-profit initiative to spread digital awareness in of the KSA.
- Digital Government Journal: It is the first homegrown Science magazine which focuses on artificial intelligence, digital transformation, and emerging technologies locally and globally.

There are at least eight more subprograms [28] directed toward making Saudi Arabia self-sufficient in software development. Universities are encouraged to publish scholarly articles in reputed journals. In 2020, there was a big jump in scholarly articles [29].

B. Blockchain

Saudi Arabia is one of the first countries where institutions of higher learning promote use of Blockchain [28]. The initiative was regulated by the Saudi Arabian Monitory Authority (SAMA), which enabled businesses and corporations to benefit from the technology. Several national and international projects, which use blockchain, are in progress. A number of Government agencies are collaborating to make use of this technology. Some aspects of the use of technology are dis-cussed in [30].

C. Artificial Intelligence (AI)

The KSA is setting an example of making good use of this advancing technology, and has set up several organizations to promote the use of AI in many sectors and daily life [29, 33]. Many entities are collaborating with Saudi government departments to reap the benefits of the technology. The government has already finalized a national strategy for data and AI, and attained early successes in energy, environmental management, health care, open data, smart cities, smart manufacturing sectors [28].

D. Internet of Things (IoT)

The KSA doesn't want to miss on any technological development. That being the vision, the nation has invested heavily in in IoT solutions. The IoT now has billions of things in it and so bil-lions of applications take place touching almost every walk of life. Other notable projects under-taken by the KSA are Big Data, Robotics and Automation, Drones, and 5G. Success of many innovations and projects depends on the quality and speed of internet. The Kingdom has second position among the G20 countries for the allocation of frequency bands [28].

E. Digital Infrastructure to Manage Pandemic

After declaration of COVID-19 as a pandemic, Saudi Arabia, like other nations, entered into complete social, and economic and educational lockdowns, except for the essential ones. Saudi Arabia too enforced lockdown, and even imposed night-curfew to limit the movement of the peo-ple. With the passage of time, the kingdom started educational activities at all levels in virtual mode with the help of online tools and systems such Teams, Zoom, Blackboard, etc. When the vaccines were approved for the emergency use, the KSA ordered leading brands in enough quantity.

The rate of coronavirus infections in the KSA initially was low but gradually went up to thousands of cases every day. The KSA, from the very beginning started implementing a very strict program all precautions, including social distancing, use of face mask and sanitization. At the same time, the KSA adopted a number of home grown mobile apps for monitoring and managing the general health of the individuals. These apps have been instrumental in controlling the rate of infections and hence the death rate due to the pandemic.

Saudi Arabia has recently signed an environment and water deals to promote technology and scientific research. Digital Infrstructure and the technology is helping to realize many goals of the nationalinfrastrure and prosperity. Several of these aspects are discussed in [31-34].

F. Managing Hajj and Umrah during COVID-19 with Digital Technology

Saudi Arabia is a home for the annual pilgrimage Hajj and regular visits and prayers during every day. About ten million people from different parts of the world travel to Makkah (Mecca) to perform these pilgrimages.

With the declaration of COVID-19 as a global pandemic, all activities of the grand mosque in Makkah and elsewhere were cancelled indefinitely. With the passage of time, by well management of vaccination program, the caseload of coronavirus came down. As a result, in October 2020, the mosques again opened their doors for worshippers, with the conditions of hygiene and social distancing. With the help of the digitally enabled apps, the KSA managed Hajj 2020 and 2021, but only for a very low number of people. Although the virus is still active but the KSA is managing it religious programs for over a hundred thousand pilgrims every day with the help of apps. The health controls are in place and there are no reports of caseload increasing..

G. A March towards Progress with Emerging Technologies

Various new technologies, which are used in sustainable development to produce value and provide prospects for development, are being used for other achievements in the KSA. Research programs and grants are knit around the Artificial Intelligence technology, and in particular the Robotics, Machine Learning, and drones. In particular, the emphasis is on developing and using tools with AI-based expert models.

Data intelligence based emerging technologies, including distributed ledger process, IoT, data collaboration and open data, are being promoted by the academic research and development. Collective intelligence based emerging technologies includes co-creation and citizen science, open innovation, smarter crowdsourcing and citizen crowd law. Collectively all technologies are serving sustainable development.

VI. Conclusion and Future Work

Sustainable development allows every individual, organization and society across the globe to accomplish sustainable goals. Sometimes due to various factors and issues, technologies and inno-vations either do not improve the situation. This may happen due to the absence of an adequate profitable market or lack of adequate infrastructure or coordination among the stakeholders. To overcome these hurdles, in this paper we have argued how successfully the emerging and modern technologies are being used in Saudi Arabia. During the ongoing pandemic, a humanitarian crisis and disaster, use of technological tools have been effectively used. This study shows that the KSA has overcome many obstacles and is marching towards tremendous progress and sustainability in many fields. This has been possible, largely, due to the use of latest technologies. The countries of the regions, especially those in the Middle East and Northern Africa should follow the example of Saudi Arabia.

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