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Accelerating SDGs Implementation
Future Policy Roadmap

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Accelerating the Sustainable Development Goals through Digital Transformation
Conference Proceedings, UAE Public Policy Forum 2019

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Mohammed Bin Rashid School of Government

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PREFACE

Accelerating the Sustainable Development Goals through Digital Transformation

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The growing global movement towards achieving the Sustainable Development Goals (SDGs) is driving governments around the world to seek innovative responses to persistent policy challenges. Meanwhile, the world is witnessing rapid technological advancements with significant effects on development efforts globally. It is widely recognized that during the implementing phase of the Millennium Development Goals (MDGs), information and communication technologies played a crucial role in meeting development goals such as education, healthcare and poverty.

There is a strong connection between the emerging digital transformation and development. For example, the United Nations 2030 Agenda for Sustainable Development highlights how crucial the societal adoption of these digital technologies is for achieving the SDGs. The Agenda states "the spread of information and communication technology and global interconnectedness has great potential to accelerate human progress, to bridge the digital divide and to develop knowledge societies", including for example, quality of education (SDG4), gender equality (SDG5), industry innovation (SDG9) and partnership and implementation (SDG17).

Today, the universal datafication of societies, the ubiquitous digitization of government practices, the rapidly growing maturity of big data techniques, artificial intelligence applications and the advent of the "4th Industrial Revolution" are collectively presenting policymakers with unprecedented capabilities, toolsets and policy options. While such transformations have triggered numerous opportunities to develop better fitting policy responses, solve chronic developmental challenges, and accelerate implementation of the SDGs, they also created new challenges and evolving dilemmas for governments and societies globally.

On a regional level, the findings of a region-wide policy report produced by MBRSG on digital transformation over two decades in the region, clearly highlights that people in the Arab region see these potentials with diverse levels of readiness and share many of these concerns. Similar findings are emerging from other regions around the world.

The theme of the 3rd edition of UAE Public Policy Forum is "Accelerating SDGs Implementation: Future Policy Roadmap". The Forum focused on the emerging accelerating dynamics for implementing the SDGs in the age of the "4th Industrial Revolution". As a policy and knowledge platform, the Forum addressed policy implications, challenges, responses and future sustainable development prospects in the UAE with the objective of contributing to efforts to draft a "policy roadmap" for the UAE's 2030 agenda. Ultimately, the Forum aims to contribute to the local and global efforts to accelerate the SDGs implementations through proactive discussions on future directions of sustainability policies in the age of digital governance, big data, artificial intelligence, smart cities and universal digital transformation.

The proceedings include nine accepted papers, in response to an international Call for Papers. These papers were presented during PPF 2019. Given the theme of the PPF 2019, academic papers and case studies were invited to be submitted primary related to accelerating sustainable development goals implementation through digital transformation. These papers mainly focus on how big data, information communication technologies, digitization, and Internet of Things (IoT) can contribute to various aspects of development. Besides these, topics such as design thinking and circular economy and governance are also covered. The following section provides a synopses of the accepted papers during the 3rd UAE Public Policy Forum:

Section 1: Digitalization and Accelerating Sustainable Development Goals – A Global Outlook

1.1 Big Data + Big Poverty Alleviation - China's Precisely Targeted Poverty Alleviation: A Case Study on Guizhou Province
Hao Nan

"No Poverty" is the very first goal of United Nations Sustainable Development Goals. Contributing most to poverty reduction of United Nations Millennium Development Goals, China kept its pace in the course by launching a new movement named "Precisely Targeted Poverty Alleviation". Performing notably in the movement, Guizhou province, with one of the largest poor population in China, has accomplished enormously by innovatively combining frontline technology, Big Data, with poverty alleviation. Though the Guizhou model still faces several challenges and problems, this pioneering practice has been widely recognized and worth being learned and adapted broadly.

1.2 Building Drought Resilience in Rural Communities
Narayanan Velayutham

The study focuses on the use of Information Communication Technologies (ICT) and argues that access to information on drought patterns is crucial to building resilience in the agricultural sector. A qualitative study was conducted amongst rice farmers, village heads and government authorities, access to such information was identified as a key issue in Chiang Mai, Thailand. The study proposes collaboration across various government entities for efficient and effective agricultural and water resource management.

1.3 Digital Dividends for Development - Using Technology to Achieve the SDGs
Elham Seyedsayamdost and Peter Vanderwal

Distributed Ledger Technologies – the most common of which is the blockchain – indicate great promise in accelerating the achievement of the Sustainable Development Goals through, inter alia, sending aid to refugees, disrupting human trafficking, and enabling and enhancing access to finance, education and health care. The efficiency of smart contracts, the transparency, cost-effectiveness and immutability of hashed transactions and the ability to remove intermediaries and their costs from financial transactions should be extremely advantageous to communities in emerging economies. This paper examines a series of use cases and offers policy recommendations to enhance use of this disruptive technology in achieving the SDGs.

1.4 Web-Based Technology and Distance Learning: Lessons from a Case Study in Dadaab, Kenya
Robert M. Bridi

Information and communication technologies play a crucial role in meeting development goals such as quality education (SDG4). Online videoconferencing is a popular medium for synchronous and asynchronous distance learning. This investigation explores one case study of educational activities using online videoconferencing as part of the Borderless Higher Education for Refugees project in Dadaab, Kenya. The research design is a qualitative exploratory case study focusing on the learning opportunities afforded by online videoconferencing. This investigation provides valuable insights to educators and policy makers about the effectiveness of such technologies for meeting the increasing demands of students to gain skills and knowledge.

1.5 Sustainable Development, Infrastructure and Digital Transformation: Encouraging Financial Innovation
Pythagoras N. Petratos

The World Economic Forum defines Infrastructure as one of the key pillars and basic requirements for competitiveness, development and the Sustainable Development Goals (SDGs). The Fourth Industrial Revolution (4IR) and Megatrends are transforming infrastructure and increase its role. Despite the critical role of infrastructure for the UAE economy, there is a dearth of studies. In this paper we try to frame persistent policy challenge for UAE, concerning infrastructure and associated investment. We provide some initial recommendations. UAE's global leadership can be enhanced with more financial innovation, improving the infrastructure for innovation, integrating emerging technologies and infrastructure, and creating partnerships.

Section 2: Accelerating Sustainable Development Goals – The Local Landscape

2.1 Internet of Things Importance in Construction Industry: Dubai
Khulood Raheem and Abdelatif Tchantchane

Dubai became one of the smartest cities in the world. The main goal is to transform the city to serve people to achieve happiness. This vision and mission are the aspirations shaped by H.H Sheikh Mohammed bin Rashid. The aim of this study is to assess the use of Internet of Things (IOT) in Dubai construction Industry. Qualitative methods are conducted through case studies, interviews of Dubai Municipality Departments, visits to IOT providers and a survey targeting 15 UAE and 50 USA construction companies.

2.2 Home Automation Awareness in United Arab Emirates
Munira Abdulla Alsuwaidi and Riad Saraiji

It is estimated that by 2020, 21 billion devices are going to be connected to the internet. Internet of Things (IoT), Home Automation and Artificial Intelligence will transform our homes and the way we live. Such technologies are found to accelerate achievement of Sustainable Development Goals. The paper attempts to determine the level awareness of UAE nationals concerning Home Automation and their willingness to adopt such technologies in teh future.

2.3 Rethinking design - responsible production processes for sustainable consumption in the UAE
Tina Sleiman and Teresa Chahine

Millions of tons of waste are generated annually in the UAE, reflecting the global pattern

of unsustainable productions and consumption practices. This challenge presents an opportunity for governments, academics, and the private sector. Using a human centered design thinking approach, this paper puts forth suggested interventions aimed to complement existing efforts with the production and supply of environmentally friendly consumer goods. We discuss the role of design at several points along the supply chain. These include the input materials, packaging, and promotion of a circular economy with smart recycling points, and the design of new systems for customer flow.

2.4 Transforming Board's Thinking to Steward the Future Sustainability Strategy for an Organization Promoting a Robust and Resilient Future Business
Dr Waddah S. Ghanem Al Hashmi

This paper addresses the key governance issues in the private sector that should drive the sustainability agenda in line with the United Nation's Sustainable Development Goals (SDGs). It addresses the key links between social accountability, financial stability and environmental stewardship and explores these aspects from the wider sustainability debate that pertains to the stakeholder theory vis-à-vis the shareholder theory and economic value maximization.

Finally, the UAE Public Policy Forum is as an annual global discussion platform bringing together government leaders, the academic elite, and experts from all over the world who are dedicated to enhancing government policymaking in the UAE and the region. Each year, the two-day event sheds light on a unique theme through addressing several related pillars within the panel discussions, concurrent sessions, closed round-table discussions, workshops and academic exhibition.

Over the past three years, The UAE Public Policy Forum (PPF) brought together a wide range of global thought-leaders, policymakers, academics, policy-focused private sector practitioners and international experts to debate thematic public policy challenges and responses. As a policy and knowledge platform, the annual UAE Public Policy Forum has successfully positioned itself as a platform for knowledge creation and sharing in the UAE around public policy themes. We invite scholars and practitioners in the multi-disciplinary areas of public policy and government studies to join the researchers and faculty of the Mohammed Bin Rashid School of Government in the annual thematic policy debate and knowledge sharing platform created by the UAE Public Policy Forum.

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I - Digitalization and Accelerating Sustainable Development Goals – A Global Outlook

Big Data + Big Poverty Alleviation - China's Precisely Targeted Poverty Alleviation: A Case Study on Guizhou Province

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Abstract

"No Poverty" is the very first goal of United Nations Sustainable Development Goals. Contributing most to poverty reduction of United Nations Millennium Development Goals, China kept its pace in the course by launching a new movement named "Precisely Targeted Poverty Alleviation". Performing notably in the movement, Guizhou province, with one of the largest poor population in China, innovatively combined frontline technology with poverty alleviation. Applying big data and cloud computing, Guizhou province has built a cloud platform to connect all 17 relevant government agencies' data, so as to precisely target poor population. The government are therefore able to precisely and effectively grant favorable policies and fee-waiving on verified poor households. Integrating with e-commerce, Guizhou government can coordinate its poor agriculture population to farm most needed crops that can be sold out from the mountainous province to nationwide market through e-commerce orders. Holding Big Data Expo, Guizhou government is trying its best to bring in high-tech companies to run business and join its efforts to alleviate poverty. Though the Guizhou model still faces several challenges and problems, this pioneering practice has been widely recognized by China and various other countries and international organizations. The practice is also worth being learned and adapted by other poor areas and countries.

Keywords: Big Data, Poverty Alleviation, SDGs, Precisely Targeted Poverty Alleviation

1. Introduction

Identified as the first goal for United Nations' both Millennium Development Goals (MDGs) concluded in 2015, and Sustainable Development Goals (SDGs) commenced in the same year, poverty alleviation lies as one of the most crucial issues for the global governance and national policy agendas. Moving to this century, the importance is particularly highlighted since the world has witnessed unprecedented prosperity and prevailing inequality,

In the MDGs, the poverty alleviation goal was narrated as "halve the proportion of people whose income is less than USD 1.25 a day", targeting at the extreme poverty across the world. The goal was actually achieved 5 years earlier with notable accomplishments. The rate of extreme poor population living on less than USD 1.25 a day dropped to 14% in 2015 from around the half of the world population in 1990, which elevated 1 billion people out of the extreme poverty. Meanwhile, the global middle class living on more than USD 4 a day has almost tripled between 1991 and 2015, which accounted for around half of the developing countries' workforce in 2015 on the basis of only 18% in 1991. The undernourished people in the developing regions also declined by almost half since 1990 from 23.3% in 1990-1992 to 12.9% in 2014-2016. Unfortunately, by its expiry, the MDGs still left 800 million people living in extreme poverty (United Nations, 2015).

Following the path of MDGs, the SDGs announced in 2015 set its very first goal to tackle the poverty as well, which was worded as No Poverty. Upholding the spirit of economic inclusivity and equity and the gendered perspective, the goal is aimed, by 2030, at halving the proportion of 783 million poor men, women and children living on USD 1.9 a day, and ensuring the poor and vulnerable people's access to economic resources, basic services, ownerships and controls of properties through various approaches. The goal is being translated into solid actions under the recognitions and supports of UN member states. The latest statistic indicates that, by 2017, the worker's living with their families on less than USD 1.9 per person a day has declined significantly to 9.2% of the world population in 2017 (United Nations, 2018). In the face of the goal No Poverty ahead, the task is still challenging, as illustrated by UN Development Porgramme (UNDP) in its 2018 Global Multidimensional Poverty Index (MPI).

Concluded by UN High-Level Political Forum on Sustainable Development themed End Poverty in All Its Forms Everywhere (2017), countries are encouraged to work on such several aspects as preventing and reducing vulnerability to conflict, natural disasters and economic downturns that send poor households into a downward spiral; curbing inequalities and exclusion that leave segments of society stuck in poverty; supporting effective governance that ensures all citizens have voice, particularly those left behind; enabling governments to generate growth that is inclusive, sustainable and sustained; helping countries halt environmental degradation that causes and aggravates deprivation and increases the risks of setbacks.

Working towards the same direction, various countries, sectors and international

organizations are employing a variety of policy instruments to tackle the issue. The application of big data is perceived as one of the effective but also demanding way, particularly for those developing countries and regions struggling in the mud of the poverty. To support the cause, United Nations, in December 2017, has launched its initiative to unleash the big data for sustainable development by setting up the Data-Pop Alliance to enhance relevant research, capacity building and community engagement. Various other projects are also undergoing, such as opening a federal system of SDG Data Hub. In addition, in light of the importance of developing countries' official statistics to the application of Big Data, the UN Statistical Commission agreed at its 45th meeting to create the Global Working Group (GWG) on Big Data for Official Statistics, which has been improving various developing countries' governmental statistics by means of Automated Identification and Counting and Spatial Data.

Diagram 1: 2018 MPI estimates, by region (millions)
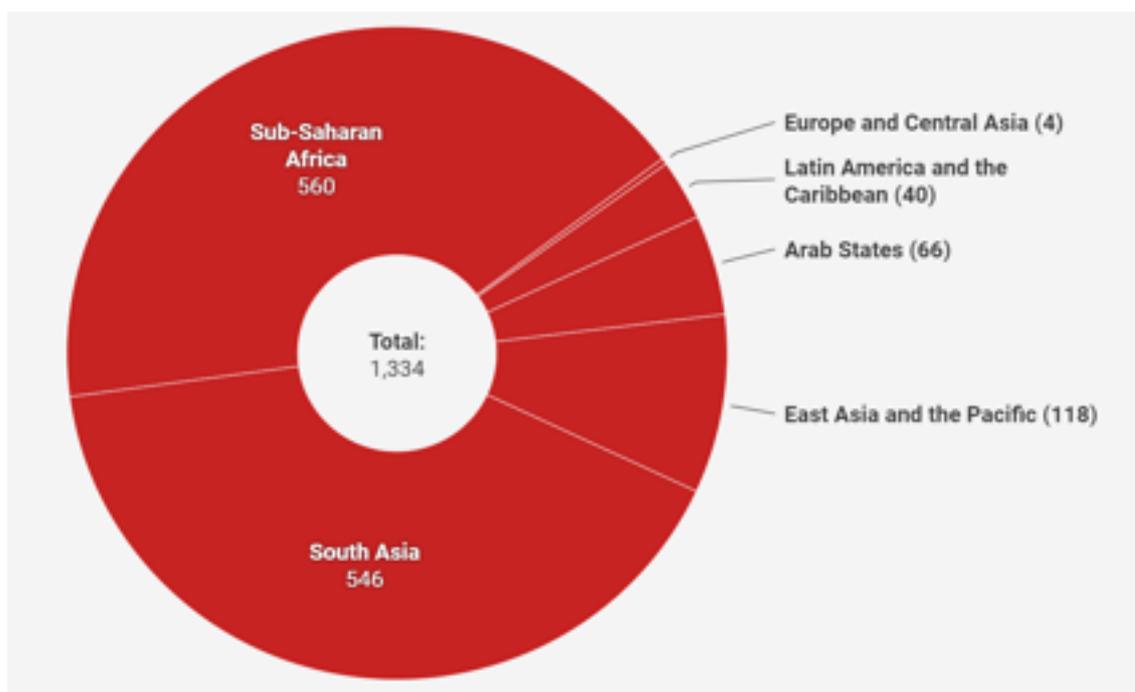
The World Bank is researching big data as well and they have developed a map that visualizes the locations of World Bank-financed projects to better monitor development impact, improve aid effectiveness and coordination, and enhance transparency and social accountability. The International Aid Transparency Initiative makes information on aid-spending easier to access, use and understand. They also employed big data to predicate poverty. That project views targeting as the sort of simple prediction problem which machine learning tools are designed to address. It replaces the existing linear models with the machine-learning driven model that provides the structured methods to search over a wider set of functions to maximize a model's predicative power.

2. China's Precisely Targeted Poverty Alleviation Scheme

China has been implementing its organized nationwide poverty reduction movements since 1970s. Its continuously enhanced efforts include tasking special agencies in charge, identifying the key areas and groups of people, arranging special budget and granting favorable policies. Poverty reduction has also been worded in China's national development strategy as a principal component. Particularly, after China's ruling party, Communist Party of Chan's 18th Party Congress, poverty reduction has been elevated to an ever-higher status in its policy agenda. The statement of the congress called on lifting all population out of the poverty by 2020, which was later translated into government's actionable tasks in the government's 13th Five-Year Plan. Each level of the government and its leadership have been required to shoulder specific responsibilities towards the poverty reduction in the area under their purview. These responsibilities are normally specified into quantitative goals.

China's unremitting and constant efforts have been rewarded with notable achievements. By 2015, it has elevated over 700 million out of poverty with only 55.75 million left. According to UN's standard, China's poor population has decreased from 61% in 1990 to 4.2% in 2014, which was interpreted as a substantial contribution to the world efforts, accounting for over 70% of the total elevated population across the world. This also marked China as the very first country among others to fulfill its commitment to UNMDGs and the country with largest elevated poor population.

Specifically, its policies ranging from special budget allocation to poor areas and groups and education, bioenvironment, and displacement approaches. The displacement moves poor people from the economically disagreeable areas to identified suitable places with government's financial subsidies and matched favorable policies with an aim of helping the displaced people to settle down and make decent living. Understanding the vicious circle of degrading the bioenvironment to earn living, the bioenvironmental approach refers to giant projects of preserving and conserving the forest, meadow and de-desertification so to create conducive environment for poor population to live and develop sustainably. The education approach is to narrow education gap between urban and rural areas so to prepare poor population especially younger generation with profitable skillsets and possibility of social mobility. In addition, medical approach avoids the possibility of falling in poverty due to bad health conditions and medical financial burdens. Entrepreneurship and start-up assistance programs are aimed at creating jobs and growing economy to eradicate poverty. Special supports are given to women, children and the disabled people (State Council Information Office of China, 2016). Above all, the set roadmap indicated that China would be able to elevate over 10 million poor people out of poverty every year since 2016, so to achieve No Poverty by 2020.

However, with the poverty reduction moving to the final and bottleneck stage, the past large-scale poverty reduction programs have been discovered inefficient and ineffective,

manifesting in cheating, faking and fraud in particular. Against this backdrop, a new approach has been proposed, namely Precisely Targeted Poverty Reduction. The term was coined by China's President Xi Jinping during his visit to a poor area in west Hunan province, which literally means that government should precisely identify the real poor population and their reasons of falling in poverty, and accordingly issue targeting policies and make targeting efforts. The term was later adopted by the government and translated into a comprehensive scheme with a characteristic of group-specific and area-specific scoops. The scheme consists of such several components as precisely identifying the poor population, precisely supporting and assisting poor population, precisely managing data of poor people and budget and resources towards them.

Echoing the calling, China naturally started to exploit its booming strength in Internet-related technology under the supports from various Chinese top companies and research institutes in this field. Under an umbrella coined "Internet +" poverty alleviation, China's State Council Leading Group Office of Poverty Alleviation and Development launched various online platforms including love-sharing mutual help website, crowdfunding platform for poverty reduction, and e-commerce platform. Furthermore, they are currently working on poverty reduction demonstration and rating platform to enhance the monitoring and encourage the successful practice sharing. All of these are based on the application of machine learning, big data, cloud computing and blockchain, with a goal of cultivating a social ecosystem of poverty alleviation.

Regarding the application of the big data, owing to its status as a government agency specially working on the poverty alleviation, the Office's online platforms are easily able to collect the data of the poor people in need across the country. The data are gathered, analyzed, verified and stored on the platforms with functional systems of recommendations, approval, credibility rating and monitoring. This enables the government poverty alleviation system to precisely target at the poor population even in the most rural area, and monitor the efficacy of local agencies' efforts. This is possible because the government has accomplished that the wideband Internet has covered 86% of China's poor rural areas. In addition, the big data is also used for enhancing the poor farmers' knowledge of market information. By means of big data analysis, farmers are able to know what agriculture products are popular in which area among whom. Under the supports of the already-developed online and offline e-commerce system in China, even the most rural area's agriculture product, by means of Unmanned Aerial Vehicle, can be efficiently delivered to any part of the nationwide market within very short period of time, usually one or two days.

The big data poverty alleviation is not purely government-led. Instead, it is backed up by a strong public-private partnership. Almost all the China's giant internet companies have been mobilized to contribute to the course through their technological advantages and financial supports. Alibaba and JD helped Chinese rural farmers to sell their products out of the limited local market. Rising up for its widely used social media, Tencent, by means of its network economic effects, recommends the poor population's products on its platform and

offers technological support to government's poverty alleviation-related administration. In addition, all of these companies, along with other companies regardless of state-owned or private enterprises, help governments in fund-raising as well.

3. Case Study: Guizhou's Big Data + Big Poverty Alleviation

3.1. Introduction to Guizhou

Guizhou is a province located in rural Southwest China well known for its mountainous but agreeable natural environment, and underdevelopment and poverty. Before, the province was constrained by its mountainous landscape to develop industrialization, and therefore witnessed striking development gap in itself and the thriving coastal provinces in China. One of the key manifestations was poverty, millions of people living below the poverty line, which was even harder to elevate due to the geographical difficulties to reach out.

The tipping point was brought by its government's foresight in developing big data. The constraining factor in the past, its mountainous but agreeable environment, has been a facilitating factor for big data industries to move in because the temperature, humidity and good air are very conducive to big data equipment. Together with targeting favorable policies, Guizhou has attracted various leading data-related companies to its capital city, Guiyang. Since 2015, its name-card Big Data Expo was inaugurated and lasted until now to be held annually where a number of big data-related major companies are regularly present. In 2017, an unprecedented administrative innovation was initiated by the Guizhou provincial government, namely the establishment of a new special in-charge agency named Big Data Development Administration. This practice was later followed by its neighbor provinces. In addition, the setting-up of Guizhou Government Data Open Platform, along with other platforms and services, also mark the provincial government's determination and efforts. In addition, Guizhou also invested considerably in Internet infrastructure. At present, 100% of its villages have been connected with 4G network and the fiber-optical telecommunication has covered 98% of the villages.

Keep moving towards the big data, Guizhou is striving for building itself into an international data hub, or in its own word, Guizhou in the Cloud and China Data Valley. It has been designated by the central government as National Experimental Base for Comprehensive Application of Big Data, South China Demonstrative Data Centre, National Super Computing Center, National Bio-Medical Data Centre, etc. In China's policy practice, this title-granting is traditionally perceived as central government's strong recognition and support which is normally going along with favorable policies and extra budget. Centered on the big data application, Guizhou is also ambitious to touch upon the development of artificial intelligence, robotics, and advanced equipment manufacturing.

With the back-up of data technology and infrastructure, Guizhou has introduced the big data into the poverty alleviation with an innovation named Poverty Alleviation Cloud in 2015, which is a cloud database gathering data from various government agencies including public

security, health, education, civil affairs, housing, social security, sanitation, commerce, etc. totaling 17 agencies. By 2017, the Cloud has accumulatively monitored, in a dynamic way, 6.23 million poor populations, over 9 thousand poor villages, 934 poor towns and 66 poor counties.

By means of this, Guizhou has been able to chart its own path of precisely targeting poverty alleviation that covers 6-aspect precision in identifying the poor citizens, taking household-specific assistance measures, arranging local-oriented projects, spending local-demanded budgets, staffing capable agents and gathering policy effects. All these have helped Guizhou achieve notable progress in poverty alleviation. Since 2012, by means of the big data approach, its poor population has decreased to 2.8 million from 9.23 million with declining poverty incidence down to 8% from 26.8%, which ranked the very top one among all Chinese provincial regions.

3.2 Successful Practice

In 2015, Guizhou built its Poverty Alleviation Cloud in its Big Data Cloud System (Diagram 2), a database gathering huge amount of data relevant to poverty alleviation. The data was widely and effectively collected from the field through a determined government channel. The collecting process was strictly monitored by the government with data verification and fact-checking. The data helps the system to come up with Poverty Index through such technologies as virtual reality, remote sensing and remote control, cloud computing and so on. In this Index, the poverty is rated as three levels ranging from less than 60 scores, 60 to 80 scores, and over 80 scores. Households with these respective scores are perceived by the system as the absolute poor households, easily-falling-in-poverty households, and almost-relieved poor households.

Diagram 2: The Structure of Big Data Cloud System built by Guizhou Government
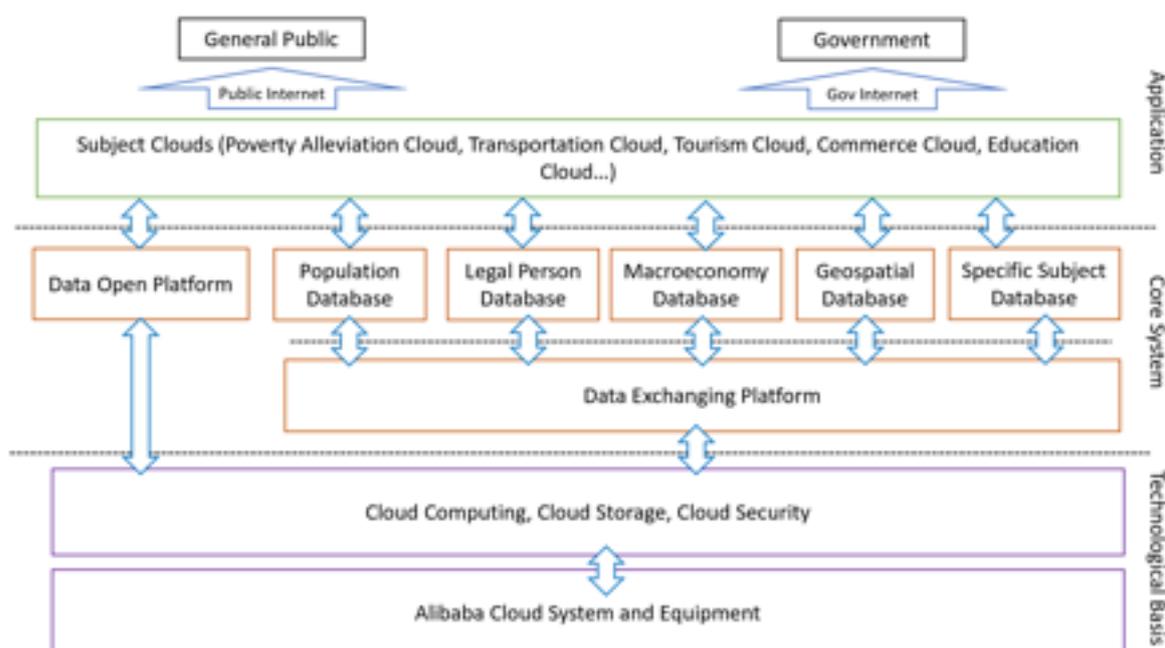
The database system also enables the government poverty alleviation forces to precisely monitor the project progress and responsibility fulfillment, manage the project implementation and fund-spending, etc. Specifically, by means of the system, the government officials are able to undertake the poverty alleviation projects online from the very beginning to the end in which each step is with reference to the real-world data. To match up the system with tasked workforce, the provincial government staffed officials with designated responsibilities from the top to the bottom. The leader of each level government is appointed as the person-in-charge on applying the cloud platform to reach the designated poverty alleviation goal.

Diagram 3: Screenshot of Guizhou Poverty Alleviation Cloud Platform

The database specially targeted at several identified fields. In education, the education department can use the online system to automatically waive the tuition fee and grant subsidies to the students from the poor households. This is due to the database 24-7 monitoring the dynamic changes of each poor household. Once the household's children admitted by school and universities, the family members will immediately receive a reminder message of the granting of financial assistance or waiving of the tuition fee, and relevant policy information. The big data has been introduced into the classroom through Smart Education Cloud, a component of the Big Data Cloud. The big data-based pedagogy effectively enables teachers to monitor each student's performance and help students to access to the best education resources within the whole provincial education system and even outside of the province. This approach has significantly increased the rate of its students' university admission. The educated young generation, in turn, contributed significantly to elevate their households from the poverty.

The big data has also been combined with the local agriculture sector. Guizhou now is exploring to construct a modern agriculture system where big data could be used to provide market information, agriculture skillset, and even agricultural product customization. By identifying such five first-developed agriculture fields as mushroom, tea leave, vegetable,

livestock and herb, the big date will be collected, managed and updated along each step of the whole process from producing, processing, transporting and selling. Therefore, the food security and quality can be traced, managed and improved. This enables farmers, the largest group of the poor, to make substantial profits from their farming, and therefore elevate themselves from the poverty by themselves.

Health Cloud is also part of the poverty alleviation cloud. In China, the medical condition is one of the most frequent reason that makes a household fall in poverty due to the unaffordable medical price and lagged-behind social security system. In addition, the access to the best medical treatment is also hard for the normal patients due to China's crowding population. By means of the big data, the hospitals in Guizhou are able to comprehensively monitor both the doctors' medical treatment and patients' health conditions. The database has collected over 2.27 million medical prescriptions from 31 million patients. In addition, the database has already gathered and stored all citizens' health conditions and disease histories. Citizens would be closely followed up on their diseases in each clinic and hospitals in the province. This significantly guarantees the health of the poor population, and relief them from the fears of disease-caused falling and staying in the poverty.

3.3 Problems and Challenges

Though Guizhou has witnessed substantial progress in applying big data to poverty alleviation, it is still on the way and has already faced various challenges. The poverty alleviation system is based on the data collecting under several designated criteria, namely the housing condition, the access to the food, the household's workforce and the education level. These four conditions have been doubted whether they can precisely capture the real poverty situations. The doubts also lie on the government officials' capability to undertake the demanding job of collecting, monitoring and operating the data system, given dealing with data is requiring a certain level of understanding and familiarity with the data science. Accordingly, whether the government grassroots officials' high pressure and heavy workload of poverty alleviation would compromise the quality of data collected is also doubted, given the poverty alleviation has been politicized and become a crucial key performance for the officials' career. In addition, there is an observation that the rating and feedback mechanism of the precisely targeting poverty alleviation with big data is not comprehensive and implementable enough. Another phenomenon is the big data fails to manage those poor households that exactly lie on the boundary lines of identified poor groups and non-poor groups in a certain area, since the big data system strictly follows the man-set numeric criteria. And of course, the big data system is not able to monitor those poor people who are not cooperative and honest during data collection in interviews, which is caused by various reasons, such as the Chinese Face Culture, lacking of trust on the interviewer-officials and so on.

4. Conclusion

Poverty alleviation is a pressing and difficult issue widely recognized by the world. Benefited from its strong governmental capacity, China has achieved enormously in elevating its population out of the poverty by means of its determination and large-scale poverty reduction programs, and therefore contributed the most to the world's poverty alleviation course. Moving to the bottleneck phase of the poverty alleviation and being aware of the inefficiency of its large-scale programs in the past, China started to exploit its technological strength and encouraged the local governments to explore more innovative, precise and effective instruments to accelerate the country's poverty alleviation process.

Guizhou government, as a slow runner in the country's booming economic growth, has accomplished tremendously through innovatively employing the big data instrument to precisely tackle the poverty. As a result, it has been able to push itself to be among the world's most attractive poverty alleviation models. Though it still faces various problems and challenges, it is believed that the Big Data + Big Poverty Alleviation would be sustained and finally achieved No Poverty in Guizhou and even in whole China due to the government's strong determination and a strong poverty alleviation ecological circle laying on a solid foundation of public-private partnership. Therefore, it is worth being learned and adapted by developing countries and regions suffering in the mud of poverty.

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Building Drought Resilience in Rural Communities

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Abstract

This study builds on existing literature that enhancing access to information on drought patterns is crucial to building resilience in the agricultural sector. Through qualitative studies conducted amongst rice farmers, village heads and government authorities, access to such information was identified as a key issue in Chiang Mai.

For this reason, the study proposes a collaboration with the Hydro and Agro Informatics Institute (HAII), a government agency in Thailand that supports agricultural and water resource management. The agency manages the Thailand component of the global Flood and Drought Portal, which provides real-time information on drought patterns. It enables stakeholders to compile information from models, indicators and existing planning approaches and develop robust planning scenarios.

The proposed project will promote greater subscription to the portal at the grassroots level through training of community-based organizations and farmers. In the longer-term, the scope of the portal can be expanded to include local and international best practices facilitating ground-up efforts and cross-learning amongst farmers of Chiang Mai, enabling them to remain resilient in face of worsening drought periods.

Keywords: SDGs, Drought Resilience, ICT for Sustainability, Agriculture and Water Resources Management

1. Introduction

Despite its transition to an industrialized economy, Thailand remains heavily invested in agriculture. Total food exports account for approximately 23% of its GDP (Thailand Board of Investment, 2016), making it one of the few net exporters of food in Asia and one of the world's largest exporters of rice (Pattanapant and Shivakoti, 2013). According to Thailand's Labour Force Survey, 32.8% of the labour force is involved in agriculture (National Statistical Office, 2016). Chiang Mai, the country's second largest city, is one of the country's major sources of agriculture products (Pattanapant and Shivakoti, 2013).

Yet, the agriculture sector remains vulnerable to acute meteorological events. For instance, Chiang Mai Province experienced severe droughts in 2012 and 2016, with the 2012 drought impacting 30,000 rai of crops and over 60,000 households (Government of Thailand, 2012). The Thailand Central Government has since enacted a number of disaster mitigation measures, including a Master Plan on Water Resource Management (Strategic Committee for Water Resource Management, 2012). However, these policies fall short of true climate change preparedness as the governing structures put in place do not have active civic participation, making progress on Sustainable Development Goal 13: Climate Action difficult.

Timely and relevant information is crucial for agriculture, but farmers often do not have the information they need to anticipate challenges. This is especially evident in irrigation systems. Throughout Thailand, the Royal Irrigation Department manages the distribution of water to farmlands. Farmers are not included in this decision-making process and are often not notified of their allocation until close to planting season. Without adequate prior information regarding their water allocation, farmers are not able to make optimal decisions. Typically, rice farmers also seek information on weather patterns, changes in soil conditions, pest epidemics, and seasonal plant diseases (Sangbuapuan and Guha, 2016).

2. Objective of the Study

This study aims to identify the best approach to building the drought resilience of rice farmers in Chiang Mai Province. In particular, we look at ways in which drought's impact on agricultural livelihoods can be minimized. Our analysis reveals that access to drought information is a key issue in climate change preparedness. Thus, we propose leveraging information communication technology (ICT) to improve communities' ability to gather and disseminate drought information.

3. Literature Review

Drought is a climatologically natural disaster caused by a deficit in rainfall. It ranks fourth in

terms of weather-related economic impacts, causing billions of dollars in losses worldwide every year. The severity of economic impacts depends on the duration of the drought and can be worsened by high air temperatures, high rates of evapotranspiration, heat-waves, and human activities (Bubeck et al., 2011). Beyond direct economic impacts, drought can threaten ecosystems, drinking water supplies, and even fluctuate food prices. The most vulnerable sectors to drought are agriculture and food security as well as water resources.

Although it may be difficult to prevent drought, communities' exposure, vulnerability and risks can be minimized through mitigation measures. Figure 3 shows the various approaches to enhance drought resilience.

3.1 Best Practices

Drought has affected many countries in the last decade and Asia suffers the brunt of the world's natural disasters. Between 2005 and 2014, eight out of ten countries with the most number of disasters came from Asia (UNISDR, 2015). Governments are working to reduce risk of more severe and frequent drought conditions by investing in both structural and non-structural measures. Countries like Afghanistan, India, and South Africa facing long-term drought have come up with effective strategies to minimize and mitigate its impact.

3.1.1 Afghanistan

Afghanistan has faced several seasons of drought, the longest stretch occurring between 1995 and 2001. These periods have badly affected agriculture, which contributes 31% to the country's GDP and on which approximately 85% of Afghans depend on for their livelihoods (USDS, 2010). Since 2000, 6.5 million people have been affected, with extreme droughts causing agricultural losses of ~$3 billion and severe food shortages countrywide (Palma, 2017). The Government in response undertook several structural and non-structural measures to respond to the situation.

Structural measures include employing water resource management to enhance supply and improve demand, with specific focus on irrigation restoration and development (World Bank, 2017). Afghanistan has started constructing 22 small and medium dams (Shirzad & Nusrat, 2018) to increase water storage capacity, ground water recharge, and small-scale water collection and transfers. Traditional irrigation systems (aqueduct and canals) have been revitalized and modern irrigation system introduced in affected areas.

Simultaneously, non-structural measures such as adjusting legal and institutional frameworks have been undertaken. Transitioning to less water-demanding crops and cropping systems, conducting research on drought-tolerant plant varieties, and adjusting cropping calendars are some noteworthy measures.

An important recent development was the launch of a US$71 million climate change adaptation portal by UNDP Afghanistan to improve the drought resilience of selected communities (UNDP, 2017). The program aimed to improve decision-making by deploying community-based early warning systems, supporting climate-resilient livelihood strategies, and strengthening institutional capacity. Such measures enabled the integration of climate risks and opportunities into national and provincial plans, budgets, and policies.

In addition, the Ministry of Rural Rehabilitation and Development has started research on information centres for farmers that will provide timely and updated information on crop diversification, crop rotation, pest management, modern irrigation system and other relevant agriculture advice (MRRD, 2018).

3.1.2 India

Agriculture is the biggest sector in India where 70% of the population is directly or indirectly dependent on this sector for their livelihood (Roy et al., 2011). More than 55% farmers in India depend on rainfall for raising crops (Aijaz, 2013) and around 68% of the country is drought-prone (Nandakumar, 2009). Unfortunately, droughts are a frequent occurrence in India. Prolonged breaks, late onset, and early withdrawal of the monsoon causes droughts that badly affect crop production (Nandakumar, 2009).

The Indian Government has adopted many drought management mechanisms and strategies including institutional mechanisms, employment generation, social welfare practices, central and state government support, and early warning systems (Gupta et al. 2011).

In addition, the Government uses technology to prevent, monitor, and mitigate drought, including satellite technology, remote sensing, and information and communications technology (ICT) (Jiwan, 2012). The provision of early warning systems and drought information via mobile phones have been shown to help drought-affected areas. Audio and video conferencing, websites, radio, and television are other channels through which information is delivered (Lavanya et al. 2010).

3.1.3 South Africa

Drought is one of the main deterrents for crop and livestock production in South Africa and its socio-economic impacts of droughts tend to be severe (Water Research Commission, 2016). Thus, the country takes a proactive approach to drought preparation and mitigation, focusing mainly on water management practices and reducing water shortages. These strategies consist of short-term actions that focus on utilizing the existing infrastructure and management policy framework, and long-term actions which reduce the vulnerability of the water-supply system (including institutional capacity-building).

Most of the drought mitigation and adaption activities are aimed at reducing the effect of water shortage before, during, and after drought. Moreover, South Africa considers water storage infrastructure (natural wetlands, in-field rainwater harvesting, groundwater, ponds and tanks, and reservoirs) as indispensable mitigation and adaptation tools for drought and climate change. Evaporation control methods, such as conservation farming, drip irrigation, and levelling of fields, are also promoted as these are the most economical and affordable for resource-poor farmers.

3.2 Drought Mitigation in Thailand
3.2.1 Current Measures

Thailand has attempted a range of ex-post measures, including emergency funds, subsidies, provision of water pumps, water distribution to those outside irrigation zones, daily water delivery, cloud seeding, and provision of dietary necessities like eggs and oil at lower prices. However, these measures were inadequate in combating the effects of drought (Government of Thailand, 2012). To reduce non-essential water usage during droughts, the Government asked farmers to delay or reduce rice production, stop off-season rice cropping, and ration water usage (Ghosh, 2015; Tanakasempipat, 2016).

Ex-ante measures range from national farming initiatives (e.g. Smart Farming Policy with training and support for sustainable farming, and through which authorities have found that farmers are unaware of weather information) (Saengpassa, 2017) and provision of irrigation systems to drought-related agricultural research (e.g. drought-tolerant rice varieties) and reforming farming practices (e.g. permaculture, organic farming, establishing ponds) (Haefele et al. 2014; Jongdee et al. 2006).

Despite the aforementioned efforts, the effectiveness of drought mitigation measures remains questionable. Government initiatives on sustainable farming are a long way from target. Education and training programs are key to this, but they have so far been limited to small segments of the farming community. Moreover, farmers lack sufficient up-to-date information on how to improve crop management. Thus, measures to tackle drought are at best tactical and do not develop the farmers'—and in turn the Province's—resilience to drought.

3.2.2. Research on Alternative Approaches

Studies have shown that locally based centres for information and research are an effective way to build resilience. A recent study with rice farmers in Thailand concluded that proximity to a Rice Research Centre determined the extent to which farm households used agricultural information, and this effect was more pronounced for smaller farms over medium and large ones. Such institutions are thus, important sources of innovation, skills, and technologies

(Aonngernthayakorn and Pongquan, 2016).

A pilot study to explore the effectiveness of installing information kiosks at these centres found that farmers who frequented centres with an information kiosk showed a significant improvement in skill and knowledge level compared to a centre that did not have one (Sangbuapuan and Guha, 2016). The findings of this study support research in India and Africa that ICT tools enhance agricultural knowledge, satisfaction with government services, participation in the local community, and farming productivity (Sangbuapuan and Guha, 2016).

Systems that promote knowledge sharing have also shown promising results. A study on water-sharing in Chiang Rai muang fai communities, which practice traditional weir-based irrigation, found that the system allowed a large number of farmers from diverse backgrounds to communicate effectively and adapt to new circumstances in times of scarcity. They were able to leverage on socio-technical information to maximize the total benefit, so that all members obtain a proportionately larger share (Ounvichit, 2010).

4. Research Methodology

In order to develop a recommendation to mitigate the long-term effects of drought on rice farming, this study drew on a range of primary and secondary sources. On the part of primary resources, on-site interviews were conducted with a diverse pool of stakeholders comprising of farmers, village leaders, administrators, and academics. International best practices were derived from an extensive literature review. Policy options were then distilled from the key findings of the study.

5. Findings

5.1 Stakeholder Interviews

5.1.1 Rice Farmers

Interviews with rice farmers in San Pa Tong, a district of Chiang Mai Province, revealed a strong reliance on Government and the vagaries of nature. Stated drought mitigation measures focused on the use of the national irrigation system and the limited adoption of drought-resistant (but less tasty) rice varieties provided by Government-funded agricultural research centres. As a result of their dependence on the former, farms located closer to the irrigation system are less impacted by drought. Otherwise, farmers simply wait for rains to come. The farmers portrayed a sense of helplessness in the face of climate change, with little confidence in the Government's ability to deal with the issue in the long-run. The community has taken steps to diversify farmers' sources of livelihood, such as the local cooperative's mushroom farming business, which also requires significantly less water than rice farming.

5.1.2 Village Chief

The Village Chief confirmed the community's dependence on government to tackle drought and expressed some displeasure with the execution of the irrigation scheme (e.g. water pricing and allocation), which the community does raise at their annual conference with authorities. There is also a perception that the government does not take on board their views, exemplified by the lack of response to farmers' negative feedback on the agricultural technology produced at the Research Centre.

5.1.3 Hydro and Agro Informatics Institute (HAII)

The Hydro and Agro Informatics Institute (HAII) is a research institute and responsible for the National Hydroinformatics and Climate Data Centre established by the Ministry of Science and Technology in 2009. The institute has developed ICT tools such as the ThaiWater mobile app and are collaborators with the Flood and Drought Portal, a project established by the Global Environment Facility (GEF), United Nations Environment Program (UNEP), DHI, and the International Water Association (IWA).

HAII is a key stakeholder for the Chao Phraya river basin project, one of three international pilot sites. They have disseminated the portal to local users but see the need to expand nationally and put the tools directly in the hands of farmers in the future.

5.2 Stakeholder Analysis

An analysis of stakeholders—rice farmers, agricultural cooperatives, HAII, and Government—underscored that drought resilience is crucial to all parties but in different ways (e.g. economic and social benefits from a Government viewpoint, financing from HAII's perspective). Of particular note is that rice farmers, those who will be most impacted, will need the most assistance to make their voices heard. Even though they are the final beneficiary of drought mitigation efforts, their influence over drought measures is low. Yet, their engagement will be crucial to the success of any project.

5.3 Main Findings: Policy Options

5.3.1 Access to Data

Water is a critical input for rice farming. The availability of water greatly affects the cultivation process. Rice farmers need information about the availability of water to make decisions, such as the optimal rice variety to use, the appropriate time to plant and apply fertilizer, and whether or not to plan for a bumper crop.

However, the study reveals that Chiang Mai's rice farmers do not have adequate access to such information. Local Government departments do provide information and alerts but the content and timing of such communication remains limited. A more reliable channel to provide farmers with real-time data is needed.

One possible solution is to leverage on ICT tools to give farmers direct access to information. HAII has already rolled out the Flood and Drought Portal and ThaiWater app, which could provide up-to-the-minute data on weather patterns and drought forecasting. This information, together with the weather forecast information by the Thai Meteorological Department, can be used to generate real-time drought reports for farmers.

ICT tools have obvious advantages due to their transmission speed and relative low cost. However, the role of governmental agencies should not be ignored, because farmers, especially the aged cohort may have difficulties utilizing Smartphone.

5.3.2 Education and Outreach

Education for farmers on drought is essential and urgent. This study found that rice farmers in Chiang Mai do not consider drought an actionable problem, despite its impact on their livelihood during recent years. Thus, greater awareness of drought mitigation methods, such as the availability of drought-resistant rice varieties, water-saving technologies, and adjusting cultivation schedules, is also needed. Government agencies and universities do provide agricultural education programs but are limited in their reach.

5.3.3 Water Management

Improving water management includes the following aspects:

5.3.3.1 Increase the Water Supply

Measures in this category include building new dams and reservoirs to store water for future use. Chiang Mai has abundant rainfall, which makes more dams and reservoirs possible and practical. However, this solution has obvious limitations. Firstly, building dams and reservoirs requires huge capital investment, which may exceed the financial capacity of the Government. Secondly, it is becoming more and more difficult to find the space needed for large-scale infrastructure. Thirdly, the growth of water supply may not keep pace with the expansion of water demand, because of the province's fast-paced economic and population growth.

5.3.3.2 Increase Irrigation Efficiency

Chiang Mai's irrigation canals are not paved; thus, a lot of water seeps into the ground during transmission. Though this replenishes groundwater, it reduces the amount of irrigation water available. Paving the water canals is an option to reduce loss, but further investigation is needed on the cost-effectiveness of this approach. Other water-saving methods, such as humid irrigation and shallow-wet irrigation technologies, can also significantly reduce water consumption.

6. Recommendations and Limitations

6.1 Improving Access to Information through ICT

While infrastructure upgrades can greatly assist drought mitigation efforts, local Governments often do not have the budget for such investments. Instead, studies show that improving information access and farmers' knowledge of water management techniques can be cost-effective methods for strengthening drought resilience.

Furthermore, technology can be used to deliver information faster and more contextualized to the person's needs. Thailand as a nation already tops global rankings for time spent on the internet, including mobile internet (Leesa-Nguansuk, 2018). ICT constitutes an important role in the plans of Ministry of Agriculture and Cooperatives: its Rice Department has a ICT Master Plan (2014-2018) (Sangbuapuan and Guha, 2016) and its Cooperative Auditing Department aims to achieve "Digital All" status by 2020-2021 (Cooperative Auditing Department, 2016). In its ICT plans, the Rice Department divides farmers into three categories: Smart, Professional, and Seed Farmers. Smart Farmers are capable of high productivity and sustainable practices, and will be tasked with transferring ICT know-how to Professional Farmers (Sangbuapuan and Guha, 2016).

6.2 Project Proposal

To aid the delivery of timely, drought-relevant information to farmers, we propose a two-year pilot project that trains Smart Farmers on HAII's existing digital tools, starting with the Flood and Drought Portal (FDP) and ThaiWater app. Furthermore, the project will conduct focus group discussions to gather feedback on the features necessary to make drought information accessible to farmers, for both the existing portal and a possible mobile version. Individual farmers are more likely to have a Smartphone than a computer and fixed internet line. At the end of 2009, the mobile penetration rate was 98.58%, while fixed telephony and Internet penetration rates were 11.12% and 25.80%, respectively (NTC, 2010).

The project will collaborate with five agricultural cooperatives for the pilot; each

cooperative will identify five Smart Farmers to be master trainers. Thailand currently has 3,671 agricultural cooperatives with more than 6.5 million individual members (Cooperative Auditing Department, 2016), 39 of which are in Chiang Mai (Multidisciplinary Academic Conference on Economics, Management and Marketing, 2016). They are influential in their communities as they offer support to farmers, such as credit and savings products, provision of agricultural equipment and inputs, and assistance with market entry. If this approach proves to be successful, there is enormous potential for scalability through the national cooperative network.

Along with providing much-needed information, an objective of the program is to empower agricultural communities to be informed consumers of data. There is currently no source of customized timely information for farmers. The FDP has the potential to act as this central source, but it is currently geared towards technical experts. By involving end-users and collaborating with HAII on the development of the website's features and a proposed mobile version, drought information will become increasingly accessible to farmers. Peer-to-peer knowledge sharing sessions will also change mind-sets regarding the futility of mitigating the impact of drought.

The proposed project comprises of the following components:

Activity	Details	Description
Year One		
Focus groups with Smart Farmers	**Participants: Five Smart Farmers from Five cooperatives** **Duration: Two days**	Feedback from farmers regarding usability features and data desired of the portal and app will be solicited at the beginning of the project.
Website updates and app development	**Participants: DHI, manager of the international FDP project, and HAII** **Duration: Six months**	Focus group findings to inform upgrades to the FDP and development of mobile app version.
Technology upgrades	**Participants: Five agricultural cooperatives** **Duration: Three months**	While some cooperatives have centres at which they host educational programs and run businesses that sustain their activities, additional infrastructure might be needed for this project. A survey of the IT capability of the participating cooperatives will be conducted and budget will be allocated for the purchase of up-to-date computers, internet connection, and other necessary equipment.
Training of trainers	**Participants: 25 Smart Farmers** **Duration: Five days**	Representatives from participating cooperatives will be trained on basic data collection and analysis skills, use of the HAII tools, and how to interpret the data.

Year Two[1]		
Community-based trainings	Participants: 25 farmers at each cooperative community Duration: multiple sessions across five months	Smart Farmers will train Professional Farmers on basic ICT skills, use of the HAII tools, and how to apply the information to farming practices.
Knowledge sharing	Participants: 25 Smart Farmers and 125 Professional Farmers xDuration: multiple sessions across nine months	Educational programs will be hosted so that farmers can learn the latest research-based findings on drought mitigation and share knowledge amongst peers regarding effective methods. Partnerships with government agencies such as the Chiang Mai Provincial Agriculture and Cooperatives Office and Chiang Mai Agricultural Extension Office, and universities like Chiang Mai and Mae Jo Universities, which already conduct training, could facilitate this component.

Note 1: Phase two of the project could involve the launch and training of the mobile app version of the FDP.

6.3 Limitations

6.3.1 Infrastructural Constraints

Agriculture cooperatives will vary widely in terms of their infrastructure level. Some may have offices, computer, and internet access, while some may not have any of these. In the pilot project phase, priority will be given to cooperatives with adequate facilities.

Another form of infrastructure constraint is information technology. A National Statistical Office study in 2012 found that only 26.9% of Thailand's rural population had an internet subscription (Srinuan, Srinuan and Bohlin, 2012). This is another factor that must be taken into account when choosing pilot project sites.

6.3.2 Technical Capability

Although farmers may have a sophisticated grasp of meteorological phenomena, technical capacity might be low. Thus, the program should include basic training on technical concepts. The knowledge sharing sessions will also improve farmers' knowledge in this area.

6.3.3 Sustainability and Scalability

The more information the FDP has, the more powerful it will be as a drought mitigation

tool. Attracting as many users as possible is critical to its success. Expanding awareness and adoption of the portal in the agricultural sector – through partnerships with other Government agencies, agricultural organizations, and the like – will need to be a focus in the next phase of the project. And, as mentioned, leveraging the national network of agriculture cooperatives will help achieve this aim.

There must also be adequate support from the portal's owners in order to keep it alive and keep up with necessary maintenance and technical updates.

7. Conclusion

Following the catastrophic floods that deluged central Thailand in 2011, the government took important steps to bolster its disaster mitigation plans. Building resiliency in the face of increasingly severe and unpredictable weather patterns, however, will require long-term commitment on the part of local Governments. This project proposes that access to information is a critical component of any effort to build climate change resiliency and steps should be taken to strengthen communication channels between Government agencies, community-based organizations, and citizens.

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Digital Dividends for Development: Using Distributed Ledger Technologies to Accelerate Agenda 2030

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Abstract

Global agreement on Agenda 2030, measured by the indicators of the Sustainable Development Goals (SDGs), has triggered a phalanx of initiatives to expand the scale and scope of activities and actors addressing global challenges. One area that has been increasingly scrutinized is the use of distributed ledger technologies (DLTs) in the fields of development and humanitarian aid. Experimenting with use cases including smart contracts, tokens, identity verification and cryptocurrencies, a number of international organizations in partnership with private sector actors have been, inter alia, feeding hungry families, sending aid to refugees, protecting children and women from trafficking, and enabling access to finance, education and health care. The number of such endeavors is still reasonably limited and the lessons not necessarily representative of broader global applicability; however, the international community would likely benefit from evaluating these practices with a view to learning lessons for future policy making. This paper examines a series of development and humanitarian projects that have piloted DLT use cases, including facilitation of micro-lending to social enterprises in Brazil by Moeda, enabling cash-based transfers to Syrian refugees by the World Food Program (WFP), and protecting Moldovan children from illegal trafficking by the United Nations Office for Project Services (UNOPS). While highlighting some of the incontrovertible strengths of these use cases, this paper identifies lesser-discussed limitations associated with DLT solutions and offers policy recommendations to enhance the use of this disruptive technology to accelerate the achievement of the SDGs.

Keywords: SDGs, Distributed Ledger Technologies, Blockchain, Social Impact

1. Introduction

Distributed Ledger Technologies (DLTs) have emerged as one of the most potentially transformative technologies of the past decade. The technology first emerged in the aftermath of the 2008 financial crisis as a means of facilitating financial transactions without reliance on central third parties. The most common DLT is the blockchain, which creates secure, decentralized and time-stamped ledgers that record transactions in a peer-to-peer network public to all participants. Although the blockchain was initially developed to build the cryptocurrency ecosystem (specifically Bitcoin), other uses such as tracking the flow of goods and verifying the identity of citizens highlighted its potential to improve accountability in other fields – including the humanitarian and development space. Over the past two years, aid agencies and international organizations, such as UNHCR, UNOPS, UN Women and WFP have been experimenting with the blockchain to distribute and monitor aid funding, to create digital identities, to secure land registries, and to allow women access to micro-loans. Similarly, many private initiatives, such as community development banks and other microfinance institutions, such as Moeda, Cashaa, and Sweetbridge have emerged that utilize the blockchain in order to increase efficiency and transparency in their operations.

As an open source technology, the blockchain is entirely egalitarian and can be relatively easily utilized to build transformative new tools. This inclusivity is especially of value in markets where, for example, lacking identity certification can hinder people's access to services provided by governments and financial institutions. Blockchain is also highly reliable - all transactions are immutably recorded; indeed, its immutability has been considered one of this technology's most transformative aspects, as it is tamper-proof and as such ostensibly guarantees transparency and accountability. In emerging economies, the blockchain's potential to substantially reduce transaction costs is particularly important - as one in every ten dollars sent in remittances to Africa is lost to fees from financial institutions (World Bank Migration and Development Brief 29, 2018).

Notwithstanding the substantial potential benefits summarized above, there are perhaps equally substantial constraints that may impact the uptake of blockchain-based solutions, particularly in emerging economies. Most significantly, there is the near-absence of enabling ecosystems; infrastructure and access to phones and internet on the one hand, and fit-for-purpose legal and financial regulations on the other.

As an internet-dependent technology created in and for the countries in the Global North, the limited access to internet and phones for those living in remote areas threatens inclusion for these communities, and could potentially further marginalize already vulnerable populations, exacerbating the existing wealth – and knowledge – gap.

Similarly, only the most sophisticated governments have begun to tackle the legislative and regulatory issues needed to provide appropriate governance structures that tackle issues of privacy, criminality and human rights in the age of the blockchain – and there is no global consensus on how to approach what are intrinsically global transactions.

Despite these limitations, the advantages of blockchain are great enough to deserve the attention of aid agencies and other international actors involved in the humanitarian and development sector. As such, this paper examines three different use cases of blockchain-based initiatives creating positive social impact. The first case study focusses on the WFP project piloting the transfer of financial transfers to 10,000 Syrian refugees and the attendant decrease in transaction costs. The second case study revolves around a partnership between UNOPS and World Identity Network that piloted a project in Moldova to register the identity of children in an effort to stem the high level of child trafficking in that country. The third case study looks at Moeda, a Brazilian social enterprise that has been engaged in offering micro-loans to farmers and agricultural firms in rural areas.

This paper argues that while the blockchain is not a panacea for development ills and that the not insignificant challenges and limitations require further study, it does offer substantial promise in advancing Agenda 2030 and the world's progress towards the Sustainable Development Goals. Of particular note for future researchers should be the study of the kinds of problems that might emerge in light of a technology with the potential not only to accelerate the achievement of the Sustainable Development Goals – but also to impact local, regional and international power dynamics and governance systems in ways both positive and negative, and certainly unforeseen at this point.

2. Case Studies

2.1 WFP: Fight Against Hunger

According to the most recent estimates, one in nine people around the world does not have enough food to eat (WFP, 2018). In fact, the proportion of undernourished people increased from 10.6 percent in 2015 to 11 percent in 2016, indicating that 815 million people worldwide do not have sufficient nutrition (UN, 2018). Undernourishment especially impacts children whereby 151 million children under the age of five (5) suffer from stunting, another 51 million suffer from wasting while 38 million are overweight (UN, 2018). These increasing numbers have been impacting the pace at which the international community can reach Sustainable Development Goal 2, which aims to end hunger and improve nutrition by the year 2030.

The World Food Program is the UN's lead agency in delivering food assistance to those most in need, especially in emergencies but also in relief and rehabilitation cases. It provides food assistance to 80 million people in 80 countries. More recently, WFP has increased its cash transfers in well-functioning markets in an effort to both provide people with a choice of which foods to buy and also to infuse cash into local economies. In order to come up with more innovative solutions to ending hunger world-wide, the WFP created the Innovation Accelerator, an innovation hub which has been identifying and supporting solutions that most effectively address hunger and undernourishment. One such solution was the increase and scaling up of cash transfers with the aim to reduce costs and risks, while improving

data protection and pace of delivery (WFP, 2018). Although cash transfers provide end users with more freedom and flexibility, they also create a host of new problems especially associated with the misappropriation of funds. The introduction of blockchain technology was perceived by the WFP as one way to reduce potential problems.

In January 2017, the WFP piloted the "Building Blocks" project which made use of the blockchain-based Ethereum platform to deliver food and cash assistance to marginalized people in the Sindh province of Pakistan. The food and cash transactions were recorded on Ethereum through a smartphone, which then allowed for the generation of reports to match disbursements and entitlements. "Building Blocks" demonstrated to the WFP the power of blockchain to streamline delivery of food and cash, particularly in crisis situations where speed is of utmost importance and the financial infrastructure has been disrupted and is ineffective in the delivery of life-saving resources.

The transparency and cost efficiency of this pilot led to the use of Building Blocks in the delivery of aid to more than 10,000 Syrian refugees in the Azraq refugee camp in Jordan. Commencing in May 2017, Building Blocks started with disbursement of funds in Jordanian dinars. While the WFP has been considering the use of cryptocurrencies, this will only be feasible when the countries in which WFP activities take place accept them, highlighting one of the constraints to uptake the lack of an ecosystem poses. In the meantime, refugees are being given the opportunity to utilize WFP's humanitarian assistance either by using WFP's existing optical biometric authentication technology or by the display of random one-time passwords on mobile devices, which they show at supermarkets, who in return provide the food and cash. In this transaction, a smart contract with the WFP sends the money to the shops as soon as the unique identifier from the recipient triggers the release, and the shop then directly disburses the funds – or food – to the recipient. Without banks or other intermediaries involved the transaction costs are reduced, leaving more money for the beneficiaries. The technology also reduces the risk of graft, as money is only disbursed when eligible and verified individuals present themselves to registered outlets.

The WFP has been so pleased with the efficiency, transparency, and security of this system that they have built on the lessons learnt from Building Blocks to expand the use of blockchain technology to other projects in other countries. One such project is the tracking of school lunches in Tunisia. In partnership with blockchain startup Devery and the Tunisian Ministry of Education, WFP began tracking school lunch delivery to 6000 primary school children in April 2018, with the goal of scaling up the system to track all 400,000 eligible school lunch deliveries. The technology allows WFP and the Ministry to track the delivery of the meals, ensure they are fresh, and take stock of the best way to use funds allocated to the initiative.

The efficiency, transparency and security advantages of the blockchain are evident in WFP's early pilots, and the technology clearly demonstrates the potential to open up millions of dollars that would be usually spent on intermediaries and general transaction costs. According to Robert Opp, WFP Director of Innovation and Change Management, using the blockchain aims to "cut payment costs, better protect beneficiary data, control financial

risks, and respond more rapidly in the wake of emergencies" (Gerard, 2017). Although the merits are highly visible, some limitations have been highlighted. Most alarmingly, WFP has found that the recipients' privacy is not guaranteed. Passwords on recipients' mobile devices are sent to them rather than being self-generated, which means the carrier can identify who is receiving the notifications. Also, immutability means that the payment history, and therefore potentially the identity of the beneficiaries, will remain on Ethereum forever, again potentially creating risks to the recipients' identity.

Apart from these (significant) concerns, the WFP is pleased with these early experiences and has been encouraging other UN agencies to join, arguing "the full potential of blockchains can only be realized if all humanitarian actors collaborate around this platform" (WFP, 2017) – which reinforces again the constraints posed by the lack of a coherent ecosystem, even in a relatively narrowly-focused space

2.2 UNOPS: End Child Trafficking in Republic of Moldova

In November 2017, during the Blockchain Humanitarian Summit in New York, UNOPS along with the World Identity Network (WIN) and the UN Office of Information and Communications Technology announced a call for proposals to launch an initiative that would use blockchain technology to combat child trafficking in Moldova. Part of the "Blockchain for Humanity" initiative, UNOPS and its partners announced in March 2018 that ConsenSys had won the challenge and planned to use Ethereum to create a blockchain-enabled identity system to alleviate the systemic problem of child trafficking in Moldova.

According to the 2018 UN Sustainable Development Goals Report, between 2012 and 2014 over 570 flows of trafficking in people were detected around the world. Many of these involved trafficking individuals from lower-income to higher-income countries with 71 percent of the victims comprising women and girls and 28 percent children – both boys and girls. In addition, world-wide, only 73 percent of children under the age of five (5) were registered at birth, thereby further facilitating trafficking of children. According to a 2018 World Bank report, over one (1) billion people in the world cannot prove who they are. Protracted conflicts in places such as Afghanistan, Iraq, Syria and Yemen further exacerbate the refugee crisis, adding to the increasing numbers of children at risk. In fact, globally over half of the refugees are children, with estimates of one (1) in every 200 children being a refugee (UNHCR, 2017). SDG 16 aims to promote access to justice and under target 16.9 states the goal of providing legal identity to all, including birth registration, by 2030. Thus, efforts to expand birth registration and to give legal identity to all directly advance the SDGs.

Child trafficking has been a particularly pernicious problem in Moldova, the poorest country in Europe, where close to half of the population lives under the national poverty line (UNDP, 2009). Children living in poverty are particularly vulnerable to trafficking, as many of them are undocumented and can be transported across borders using fake identification. Where

ID documents are missing, it becomes difficult for children to prove their age, where they are from and who their rightful guardians are. The absence of legal identification can facilitate the trafficking of children while hindering aid agencies in their provision and delivery of social programs. More importantly, "lack of personal ID has compound effects: children are denied access to life- and resource-enhancing activities such as education, health care and social services" (WIN, 2018).

To address the problem of child trafficking in Moldova, ConsenSys proposed a self-sovereign identity (SSI) approach that would harness blockchain technology to create digital identities to expand access to verifiable identification while improving security over personal data. This approach allows users to "store their own identity data on their own devices and provide it efficiently to those who need to validate it, without relying on a central repository of identity data" (Lewis, 2017). This approach has certain advantages. By cutting out intermediaries, this system can reduce transaction costs, as well as the number of vulnerability points. By decentralizing the process of verification and creating an immutable record resistant to tampering, the system improves data security. More importantly, an SSI allows the user to have control over their personal identification in terms of when and with whom they want to share it.

In the case of Moldova, ConsenSys has proposed an SSI that relies on biometric identifiers, including finger prints and iris scans, that can protect minors from trafficking. In order to ensure that IDs can be authenticated without a device, their approach is based on "unique, pseudo-anonymous, digital identities, with the use of cryptographically protected biomarker data" (WIN, 2018). The user's data can then be scanned at border crossings and other transport intersections while being compared to a list of registered identities on the chain.

One can easily see how storing identification documents on a blockchain could facilitate the users' verification of their identity, especially in difficult circumstances (such as sudden vacation of someone's home due to natural disasters, conflicts, etc.). At the same time, there are several limitations that might hinder the use of this system. Firstly, even a digital identification system requires trusted third parties to provide and verify the data pertinent to the individual's identity. Second, a system that focuses on personal identification is prone to data insecurity where the information can be hacked and stolen, or even potentially used by authorities for malevolent purposes of targeting and discrimination. Third, the immutability of personal data stored on the blockchain means that the information cannot be revoked, making it difficult to change the information. A final concern regards the portability of IDs, as this "depends entirely on how many organizations are willing to accept them" (Pisa, 2018).

This analysis indicates that ConsenSys and its proposed solution holds great promise for combatting child trafficking. At the same time, because of the recency of the innovation of the SSI model and therefore the limited experience of its use, it is difficult to take stock and learn any lessons from the impending roll-out in Moldova. Furthermore, while there might be technological solutions that could remedy concerns about privacy and security, it is less clear to what extent the involvement of those perpetuating child trafficking, such as

organized criminal groups or corrupt officials, can be lessened by relying on blockchain for identity registration as in the end, a system is only as good as its users.

2.3 Moeda: Microfinance in Rural Brazil

Financial exclusion is a key problem hindering billions of people from partaking in the global economy. According to the World Bank, only 62 percent of the world's population has a bank account, and 73 percent of those above the age of 15 do not have any formal savings. This means that close to two billion people around the world remain unbanked (World Bank, 2015). Microfinance – originally defined as provision of loans to the poor and small business owners without bank accounts – has long been considered a solution to the world's unbanked population. The emergence of cryptocurrencies highlighted the potential of blockchain technology to circumvent third parties and to reduce transaction costs, which is particularly relevant to people in poorer countries where many do not have the necessary identification requirements to open bank accounts – and may not even have physical access to banks.

With blockchain technology, people may be able to circumvent the need for traditional forms of identification by relying on a digital ID and their reputation – through verified transactions and feedback from third parties – to engage in the 'formal' economy. In other words, blockchain-based tools could facilitate financial inclusion for billions of people by not only enabling the creation of a digital identity, but by allowing people to directly transact with others.

Access to financial institutions is embedded in targets 8.3 and 8.10 of SDG 8, which aims to promote secure working environments and to improve access to financial services. Working towards the SDGs while making use of blockchain technology, several startups have emerged in the last years with the aim to extend trust networks and facilitate financial inclusion. One such startup is Moeda, the first cooperative microlending institution to utilize blockchain. As the winner of a 2017 UN-sponsored hackathon aimed at advancing Agenda 2030, Moeda raised USD 20 million in an initial coin offering and in January 2018 announced its intention to invest USD 1.5 million in 18 agricultural cooperatives based in rural Brazil. In a country where 200 million Brazilians have minimal access to banking and oftentimes find themselves in debt bondage – with annual interest rates up to 4,000 percent – Moeda plans to provide a much-needed service to small businesses. According to Moeda's CEO, Taynaah Reis, "Moeda's use of blockchain and cryptocurrency helps some of the challenges that microfinance often encounters: lack of transparency, middlemen, and inefficiency" (Moeda, 2018). Moeda offers impact investors the opportunity to make capital available to those in need, while being able to expect a return on their investment, and a reasonable degree of liquidity.

Impact investment projects such as Moeda can clearly make use of technology to advance

a social goal – and not just a single goal. In September 2018 Moeda took stock of the first phase of its work and concluded that the combination of financial investment with social good contributed positively to the amount of funds it was able to raise. Several analyses corroborate this perception of social impact arguing, "the young investors of today are already showing a keen interest to put their investment dollars behind projects, organizations and funds that are in the line with their own core values" (William, 2018). The promise of this type of opportunity may be able to unlock some of the 210 trillion dollars in private capital markets that is needed to fill the 2.5 trillion dollar per annum financing gap to achieve the Sustainable Development Goals. The question is whether the novelty of the technology and the negative publicity around cryptocurrencies in general could inhibit investment.

The primary advantages of blockchain technology in relation to impact investments are transparency and accountability. At the same time, there are several challenges and limitations that will require further examination. The reliance on cryptocurrencies, especially in financial infrastructures where digital money is not common use, reduces the possibility of trading and spending in fiat-based economies. There is also a question of transaction-processing capability, which needs to increase tremendously in places where cryptocurrencies are used instead of fiat currencies. In addition, there is a legal aspect to these kinds of transactions that has not been discussed in great detail. In a world where legal systems primarily revolve around identities, it is difficult to introduce and implement a financial infrastructure centered on anonymity. Finally, blockchain was created in developed countries where institutional infrastructures can be quite different from those of many developing countries. Thus, there is a question as to how blockchain-based solutions might be implemented in emerging economies. Concerns not only revolve around fit and adaptability but also long-term implications of introducing a complex technology that replaces human trust.

3. Blockchain for Social Impact Selected Case Studies Synthesis

Blockchain technology has seen an expansion of its use to areas far beyond the one for which it was originally developed. As the examination of the above cases indicates, the brief experiences that humanitarian agencies and social enterprises have had with this technology are promising; in all cases, the efficiency, transparency, accountability and security associated with blockchain have generated substantial advantages in providing food and cash assistance to those in need, in offering digital identities to the vulnerable, in giving access to microfinance to the unbanked, and in facilitating impact capital to areas of need. The transparent, immutable and distributed characteristics of blockchain make third parties mostly redundant, enabling efficient and cost-effective transactions. The open-source nature of blockchain opens up participation to all, allowing inclusivity while decentralizing governance. The immutability of this technology makes it impossible for any one person to unilaterally alter data on a chain, thereby ensuring security and presumably reducing graft and corruption.

However, there are also a series of challenges and limitations that our preliminary analysis has highlighted – predominantly issues relating not so much to the technology as to the surrounding ecosystem – although the interoperability of different platforms i.e. the ability to communicate with and transact between – remains a substantive issue still to be resolved.

Most tellingly, from a development perspective, is that the mere existence of the technology does not necessarily translate into increased inclusivity or the reduction of poverty or indeed the majority of the Sustainable Development Goals. Where people do not have access to internet or smart mobile devices, it becomes difficult – but not impossible – to include them in a new digital infrastructure. Where human behavior is not accustomed to a digital life, even the presence of the technology will not have the impact it promises. The absence of substantive structured dialogue with representatives from across the spectrum of actors from the Global South threatens to undermine the transformative potential of blockchain-based tools. Meaningful consultation is necessary to understand the needs of the communities who could benefit from this technological revolution the most. It will also be important to engage in detailed studies of use cases to better understand the costs and benefits of the blockchain in specific applications; all extant literature and the case studies reviewed for this paper highlight the dearth of robust evidence-based research in the use of the blockchain for advancing Agenda 2030. The short temporal experience in this field partially explains the lack of a substantive knowledge base of lessons learned for future applications, but if we as a global community are serious about the use of blockchain in addressing development and humanitarian challenges, there is a need to strengthen the research agenda in this area in order to benefit from current use case experience.

4. Distributed Ledger Technology for Social Impact - Policy Recommendations

Despite the short period of experience of blockchain technology and particularly its application to development/humanitarian projects, several policy implications can be drawn for emerging economy governments and the donor organizations that support them.

Firstly, there is a need to build the body of knowledge around the utility of the technology at all levels – with an emphasis on building awareness and capacity of decision makers in the Global South. Donors should be using their convening power and resources strategically to develop and pilot use cases, blending rigorous test cases and thoughtful evaluations with support for innovators and entrepreneurs in all parts of the world - but particularly in the Global South. Governments in emerging economies should be creating legislative and regulatory 'sandboxes' to encourage the development and testing of creative solutions to local problems. And a coordinated global approach to creating a repository of studies that focus on specific blockchain use cases with a view to understanding the advantages and challenges associated with them should be made a priority. While there are plenty of white papers and good ideas circulating, the authors could not find a collective – and credible –

source providing insights into blockchain and its implications in the field of development and humanitarian aid.

Secondly, the voices of the Global South must be incorporated into the countless forums, workshops, conferences, symposia, dialogues etc. taking place in London, Dubai, New York, Amsterdam, etc. While the Gartner Hype Cycle forecasts that the "plateau of productivity" for blockchain-based technologies is still 5-10 years in the future, it is the position of the authors that the pressing need evident in emerging economies in relation to, inter alia, identity, trade, finance and governance, will push the development and adoption of the technology more quickly in the Global South than in OECD countries, leapfrogging constraints posed by e.g. the formal banking institutions and current notions of free movement of people and goods. Having the creativity imposed by necessity front and center of the global dialogue will ensure a richer and probably more sustainable uptake of blockchain-based technologies.

Finally, while it's unrealistic to expect a dominant platform paradigm to suddenly materialize, the global aid and humanitarian community should invest in the development of standards within which diverse solutions can thrive. This will foster not just interoperability and the ability for transactions across platforms and use cases, but the ability for investors to understand more accurately the state of maturity of blockchain-based investment opportunities.

UNOPS in conjunction with the Dutch government has published a report that examines the legal ramifications of blockchain, and USAID has published a primer on the practical application of blockchain-based technologies in developing countries. The international community should consider the establishment of rules and procedures that standardize the use of blockchain across organizations while creating a common language and fostering the development of the entire ecosystem – the most critical constraint to the large-scale adoption of blockchain-based technologies to accelerate Agenda 2030 and the achievement of the Sustainable Development Goals.

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Web-Based Technology and Distance Learning: Lessons from a Case Study in Dadaab, Kenya

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Abstract

Information and communication technologies play a crucial role in meeting development goals such as quality education (SDG4). Web-based communication technologies offer unique opportunities for conventional and distributed education. Online videoconferencing has become a popular medium for synchronous and asynchronous distance learning. This investigation explores one case study of exemplary educational activities using online videoconferencing for formal and informal education as part of the Borderless Higher Education for Refugees project in Dadaab, Kenya. The focus of the case study is to investigate how online videoconferencing is being used for supporting distance learning and to determine the type of learning experiences afforded by this medium. The research design is a qualitative exploratory case study focusing on the unique learning opportunities afforded by online videoconferencing. Whilst more research is necessary to explore fully the potential of web-based technologies for higher education, this initial investigation provides valuable insights to educators and policy makers about the effectiveness of such technologies for meeting the increasing demands of conventional and non-conventional students (e.g., full-time workers, military personnel, child caregivers, individuals in remote regions) to gain technical and vocational skills and knowledge relevant to the labor market.

Keywords: Web-based technology, distance learning, Dadaab, Kenya, SDGs

1. Introduction

The past decade has yielded a proliferation of new and emerging communication technologies that have not only impacted the field of education but have challenged and expanded our ideas of what constitutes a learning environment. Amongst the new offerings in emerging technologies is online videoconferencing. Videoconferencing is a conference between two or more participants at different sites using computer networks to transmit audio and video data. Each participant has a video camera, microphone, and speakers connected on his or her computer. As the two participants speak to one another, their voices are carried over the network and delivered to the other's speakers, and whatever images appear in front of the video camera appear in a window on the other participant's monitor. The conference participants use the same client or compatible software. Many freeware and shareware videoconferencing tools are available online for download, and most Web cameras also come bundled with videoconferencing software. Many videoconferencing packages can be integrated with public IM clients for multipoint conferencing and collaboration. In recent years, videoconferencing has become a popular form of distance communication in classrooms, allowing for a cost-efficient way to provide distance learning, guest speakers, and multi-school collaboration projects. Videoconferencing provides a visual connection and interaction that cannot be achieved with standard IM or e-mail communications.

This investigation explores one case study of exemplary educational activities using online videoconferencing for formal and informal education as part of the Borderless Higher Education for Refugees (BHER) project in Dadaab, Kenya. Information and communication technologies play a crucial role in meeting development goals such as quality education (SDG4). The focus of the case study is to investigate how online videoconferencing is being used for supporting distance learning and to determine the type of learning experiences afforded by this medium. The BHER project provides educational programs to people in the Global South who are caught in refugee situations as an outcome of war, human rights violations, and/or persecution in their home countries. Dadaab, Kenya is the home of the Dadaab Refugee Complex, which consists of four camps and a population of approximately 235,000 registered refugees and asylum seekers as of January 2018 (UNHCR, 2018). Refugees who complete secondary school almost universally voice the desire to attend university, but to date international scholarships to schools in the Global North remain the only opportunity to pursue a higher education. These scholarships are few, and only benefit the 1% who secure them based on age, availability, and merit, among other factors. For most students, higher education remains out of reach.

To redress this situation, the BHER training program was developed with the unique challenges of refugee camps in mind. This includes providing higher education using onsite and online teaching arrangements through York University in Toronto, Ontario, Canada. York University uses Moodle as the platform for its online learning environment, and a range of web-based tools, including online videoconferencing, that have the potential to contribute to students' experience of studying in a distance education setting as well

as improving learning in their subject area. The Faculty of Education and the Geography Department at York University offer courses that are concurrently delivered onsite to students at York University using conventional lecturing and tutorial sessions and online to students in the Dadaab Refugee Complex using Camtasia video and screen recordings and videoconferencing.

2. Computer-Mediated Communication and Learning

For several years, computer-mediated communication and learning research has focused on communication and interaction in written online environments (both synchronous and asynchronous) which have been examined from cognitive as well as sociocultural perspectives. While some researchers see the effects of the introduction of computer-mediated communication (CMC) in education mainly as an increase in active participation, others claim that computer mediation qualitatively changes communication. This includes work done on interaction (Kreijns, Kirschner and Jochems, 2003), types of discourse (Weininger and Shield, 2003), and literacies (Warschauer, 2000).

With the development of communication technologies, there has been a shift in teaching towards using multimodal environments (Stockwell, 2007), including audio-conferencing as well as desktop video-conferencing applications; however, there is a lack of research that examines the impact of this combined use of tools on interaction and analyses in an online classroom. The applications available (e.g., Breeze, DimDim, Elluminate, FlashMeeting, Gong, NetMeeting, and Skype) are sophisticated tools combining different modes such as spoken and written language, visual and graphic systems, spatial systems, and body language.

Research on the use of text and audio for language learning includes Jepson's (2005) SLA-oriented study which compares the patterns of repair moves in synchronous non-native speaker text chat rooms in comparison to voice chat rooms. The author's conclusion is that "[i]nteraction patterns sway – and are swayed by – the unique social activity of the electronic environment" (Jepson, 2005, p. 80). Other comparisons of interaction in face-to-face telephone and computer mediated speaking environments have shown the influence of technological affordances on L2 communication, for example in the patterns of silence (Heins et al., 2007; Stickler et al., 2007).

Due to the free access to technology that combines text, audio, and video, teachers are increasingly likely to use desktop videoconferencing environments. Some of the issues identified in earlier studies such as time lags, lack of lip synchronization, turn-taking, and so on (Wang, 2004) persist, while at the same time the new multimodal environments pose additional challenges with multi-user virtual classrooms that encompasses synchronous videoconferencing (see Wang et al., 2010) and communication problems in a videoconferencing environment (see Cunningham et al., 2010).

There is a small but growing number of studies that focus on the interplay of modes in synchronous CMC. Blake (2005) reports on the benefits of using an application that combines sound and text chat for negotiating meaning and highlights the socio-affective benefits particularly for distance learning contexts. Another study shows how while watching online lectures via a webcast, learners were able to use both audio and text chat to communicate with their peers (Scheffel-Dunand, 2006). Ciekanski and Chanier's (2008) study serves as an illustration of working with multiple modalities by combining them to make meaning and foster collaboration. In the context of an audio-graphic environment, they show the benefits of modality switching, in this case between audio and text. "[T]he multimodal learning environment, due to its process-oriented and collaborative nature, helps learners focus more on the writing process than on the results of their writing. The integrated word processor affords a shared visible image of the writing process" (Ciekanski & Chanier, 2008, p. 180). The writing process is thus "perceived as a complex and procedural activity and as a social event" (Ciekanski & Chanier, 2008, p. 179). Finally, Kenning (2010) specifically looks at the different impact of using voice and text chat in two different environments, identifying several factors that affect discourse patterns: the level of integration with other devices and tools; tutor privileges; the number and function of icons; and the type of transmission, that is, full versus half duplex.

3. Research Design and Methodology

The author participated in the BHER project as a sessional instructor during the 2017/2018 academic year. I taught two courses in 2017: Introduction to Refugee and Migration Studies (Part 1) and International Development: Critical Geographical Perspectives. In 2018, I taught Introduction to Refugee and Migration Studies (Part 2) and Urban Social Policy. The students were refugees living in local host communities in the northeastern Kenyan city of Dadaab. There was a total of 22 students from Kenya registered in the courses, and 18 students from Canada registered in Urban Social Policy (the other two courses did not have any students from Canada). To give students maximum flexibility and opportunities for learning, the course combined asynchronous and synchronous tools. Weekly video recordings were uploaded to Moodle and accessed for viewing by the students during a time that is convenient. This was followed by a discussion session of the material during scheduled weekly online videoconferences, which was the main platform for interaction. In addition, forum, wiki, and blog, were built into the course. Lastly, I was part of team of York University educators who traveled to Dadaab in April of 2018 for a one-week remedial teaching period that ensured effective learning and quality education for the Dadaab students.

The following tools were used to collect data: (1) question and answer sessions about the students' experiences with the program; (2) Moodle feedback forms that invited students to send in their impressions at the endpoint of the courses; (3) Moodle activity logs; (4) interviews with individual students during the remedial teaching period; and (5) the author's personal journaling throughout the courses. For this article I concentrate on the

synchronous videoconferencing sessions with the following aims: first, to investigate how online videoconferencing is being used for supporting distance learning; and second, to determine the type of learning experiences afforded by this medium.

The research design for this investigation is a qualitative exploratory case study focusing on the unique learning opportunities afforded by online videoconferencing (Baxter & Jack, 2008). One case study of different but exemplary educational activities is used to illustrate some of the potential online videoconferencing affords as a medium for educational experiences. The case study is an example of online videoconferencing being used synchronously for completing university level courses as part of the requirements of a degree program offered at York University. The case study was chosen for this inquiry because it provides diverse examples of how this medium may be used synchronously for formal and informal education.

4. Speaking and Chatting Participation Patterns

4.1 Simple Initial Conversations

Online videoconferencing was deemed to be important for real-time communication and interaction in the courses as well as keeping up student motivation and community building. It was used for weekly synchronous tutorial sessions. Each session focused on thinking critically about the assigned reading materials. In the question and answer sessions about the students' experiences with the program, one student remarked that the online videoconferencing sessions were "kind of hard...the meetings at first did not seem to inspire any of us to contribute freely, but once we got used to the idea we were able to speak more openly and freely". One of the other students also commented on this, "I think that was more a thing of being still very much reliant on having a teacher there in front of you, for me anyway, that you'd interact a lot with in person, and then all of a sudden now you have to talk to a teacher online, you know, someone you can hardly see and you don't know anything about". This initial shock was difficult to overcome, especially for the women in the group. During the initial sessions (weeks 1-3 of the courses), the men dominated the conversations, in fact, it was not until three weeks into the course that a woman participated, "It was hard for the girls in the group, at first, we were kind of shy, but once we felt more comfortable we started talking just as much as the boys".

Moreover, during the initial sessions, the conversations were primarily dominated by the instructor with most students making short sporadic remarks. In the question and answer sessions about the students' experiences with the program, one student remarked that the "beginning was kind of nervous for us, we did not know what to expect and how you would be with us, so we were kind of being careful and did not want to say anything". Another student remarked about how the online videoconferencing limits one's communication abilities because it makes it more difficult to read important communication cues such as facial impressions and body language. The student put it this way, "I couldn't tell what you

thought of me and you know if what I was saying made any sense…most of the time it was hard to see how you were feeling about us".

4.2 Complex Multimodal Conversations

The break in the communication patterns did not occur until week four. The students and the instructor became more accustomed to the challenges imposed by online videoconferencing, which provided an impetus to move from simple initial conversations to complex multimodal conversations. To find out how students communicated with spoken and written language, what the audio and the text chat were used for and how the two modes interplayed, a qualitative examination of all ten tutorial sessions was conducted. When the main discourse functions of the primary (spoken language) and the secondary (written chat text) channels of communication were analyzed, the following discourse functions appear across both modes: social conversations (greetings and farewells); management of technology; negotiating meaning (related to the task); and instructor feedback.

4.3 Social conversations (greetings and farewells)

Why do participants use audio in some instances, and text chat in others? The greetings may give us an example of why students and the instructor choose text chat over audio. While the audio often served for greeting others and saying farewell to them, the text chat tended to be used more by and for students who came in late or who had to leave early and where a participant wanted to say hello or good-bye without disrupting the flow of spoken conversation. Online videoconferencing is far from ideal for making meaning through body language (e.g., waving) if one is not already speaking. To avoid interrupting the speaker by saying hello or farewell, the text chat is a useful tool, and in both the students and the instructor developed a routine for doing this.

4.4 Management of technology

While the audio was the main tool for discussing technical issues at the beginning of each tutorial (e.g., in the context of a sound check), the text chat was used as a less intrusive tool for managing the technology at other points in the tutorials. In some extreme cases, it was used as a back-up when the audio channel failed for individual students. This may be illustrated by the way students dealt with technical issues that arose throughout the sessions. On some occasions there was no audio, students would immediately revert to the text chat to resolve technical issues. In the extreme cases where they were not able to resolve the issue, the text became the back-up, however, this was a temporary solution as the text chat

limited in significant ways any meaningful conversations. The following is an excerpt from a text chat that illustrates. Student 1 (text chat): Sir we can't see or hear you. Instructor (text chat): I'm still here but I guess we are having technical difficulties. Student 1 (text chat): We will try to resolve this, just hold on. Instructor (text chat): I checked my internet connection and it looks fine…I tried going on the internet to some website and everything looks ok at my end. Student 2 (text chat): Just wait…I don't know what's going on…maybe we restart the session. Instructor (text chat): Ok. The management of the technology took precedence over all other matters. As soon as there was an issue to be resolved, all the conversations were immediately directed at technical matters. While the text chat was effective for managing the communications during the period when technical issues were being resolved, it was ineffective for continuing any course related communications.

4.5 Negotiating meaning (related to the task)

If we focus on the audio interaction, patterns of communication can be observed: initiation (instructor), response (student) and feedback (instructor). However, if we analyse the audio interaction together with the text chat, a more complex picture emerges. The text chat was used in conjunction with the audio for the following purposes: (1) to make assertions that contributed to the main spoken discussion; (2) to agree with what somebody said; (3) to make requests for clarification/confirmation/explanation regarding vocabulary used in the audio; and (4) to challenge what someone said.

The following audio and text chats illustrate. Instructor (audio): One of the important points that I wanted you to learn from this chapter is the role of the state or the government – the state is a more general term that I use – every country has a state institution of some kind, but governments can be of different sorts – in Canada, for example, we have different types of governments – the Conservatives tend to lean more to the right of the political spectrum while the NDP tend to lean more toward the left of the political spectrum, and so on – how does all this relate to development, any ideas? Student 3 (audio): You can't have development when you have corruption…in a lot of African countries there's a lot of corruption. Student 4 (audio): Some governments are also getting involved in war…how can you have development if there is war…the war in Somalia means no development and it's the governments fighting each other. Instructor (audio): These are good points you're raising. Student 5 (audio): Some governments spend money on building the roads and hospitals, also they spend money on schools and education, so governments can play a large role in making development happen. Student 6 (text chat): Yes, I agree with you, government can make a difference for development, but what about the conflicts and war, that's why we're here and not in Somalia. Student 7 (audio): Sir, what do you mean by development? Instructor (audio chat): Well development can generally mean an expansion in human capacity…humans learn more through education, live better lives because of things like health care and having clean water…it can also have something to do with having a better standard of living…or even having more choices in life. Student 4 (audio): This means there

isn't much development in Africa, because many people don't have the things you're saying they should have and I don't think the governments are doing much to change it. Student 8 (text chat): I agree.

This interaction shows the instructor addressing the students directly with a question related to the course material that the students were assigned to read. Students are asked to comment on the issue of the relationship between the state and development. Two students provide some answers related to issues such as the effects of corruption and war on development. The instructor then provides some confirmation about the contribution that the students made. While one student provides one perspective on the issue another student provides an alternative perspective. The intensity of the conversation at this point made it evident that the students were engaged in the conversation as they began to articulate very different perspectives on the same topic. This is followed by a text chat from another student, which brings the previous two perspectives together and takes the conversation deeper. As the interaction builds, another student at this point asks for clarification about the term development. It is clear from the question that the student was listening to the audio as well as reading the text chat. The instructor then provides an explanation of the term, which is followed by another point on the issue which had not been raised so far during the entire interaction. The round of interaction then ends by a student using the text chat to agree with the student making contributions.

Several important observations can be made from this interaction. Unlike spoken face-to-face conversation, the audio or spoken conversation and the text chat or written conversation, together provide a more complex form of interaction. While in face-to-face conversation it is generally not acceptable for multiple people to interact simultaneously, in the audio and text chat it is. For example, it was very common for one student to agree or disagree with another student using text chat, while the conversation is taking place. Moreover, it was also common for students to provide their opinion about an issue using text chat simultaneously while another student is providing his of her opinion about an issue using audio. This resulted in a more dynamic conversation. Typically, the students would keep an eye on the text chat during their audio interaction and respond immediately to other students that commented on their contribution. The audio and text chat allowed this sort of interaction to occur in an orderly manner whereas in face-to-face conversation this kind of interaction would be chaotic.

4.6 Instructor feedback

The instructor also used the audio and text chat for different tasks. This was done primarily in the context of giving oral or written feedback including: (1) to respond to a student's spoken contribution; (2) to respond to a student's query; (3) to recast or model language in writing; (4) to summarize the spoken discussion. This may be illustrated with the following interaction: Instructor (audio): I really like what a couple of you said about the refugee

situation in Dadaab. One important point that came out is that refuges that are in Dadaab are stateless, that is, they are not citizens of any country because they were born while they were refugees. Also, statelessness raises many issues regarding a person's development – social, cultural, physical, and son – many of the children of refuges know no other kind of existence. Thank you for sharing this. This type of interaction from the instructor provides the opportunity to respond to students' contributions and simultaneously summarize the discussion.   The audio provides an effective way to do this.   The response is quick (no need to write down anything), and the conversation can continue (allows more flow to the discussion).

Another example illustrates a different type of instructor feedback. Instructor (text chat): I got some emails from a couple of students asking about the class presentation. Everything is clearly outlined in the syllabus, however, please keep in mind that Group 1 will be presenting. Also, do not forget that you are required to submit your PowerPoint presentation for grading. I will post the rubric for the class presentation on Moodle so that you have an idea of what the expectations are. This kind of text chat is very effective because it provides students a written record of the conversation which they can return to for clarification as well as effectively and quickly respond to student queries. I found that as an instructor, I often used text chat to relay what I thought was pertinent information rather than simply using audio to address student queries.

In some cases, language was a challenge for many students since English was not their first language. The text chat was an effective method for the instructor to recast or model language in writing.   This may be illustrated by the following interaction between one student and the instructor. Student (audio): How do you say this…ah…you know when you can't find the right word. Instructor (audio): You can say 'I'm speechless', especially if the event you are describing is dramatic. Student (audio): Oh, ok…well I'm speechless because the situation in the camp sometimes can get bad and a lot of young women sometimes are the target…this is the kind of thing I want to discuss in my essay, but I don't know how to start. Instructor (text chat): Well, you can search in the York University library system for journal articles on gender issues in Dadaab or more generally gender issues as they relate to refugees. This will give you an idea about some of the topics that are discussed in the academic literature and then you can pick something more specific. Text chat allowed me to recast the student's language into more formal language which then may be used to search for articles on a specific academic topic. Text chat allows the student to have a record of the conversation, whereas audio bears the risk of the student forgetting the conversation following the session.

5. Conclusion

Information and communication technologies play a crucial role in meeting development goals such as quality education (SDG4). Obtaining a quality education is the foundation to

creating sustainable development. In addition to improving quality of life, access to inclusive education can help equip locals with the tools required to develop innovative solutions to the world's greatest problems. In the past decade, major progress has been made towards increasing access to education at all levels and increasing enrollment rates. Information and communication technologies play a crucial role as effective tools that may be used to bring access to quality education to places in the developing world where this has not been possible.

The findings from the case study substantiate several crucial observations regarding multimodal online communication and newly emerging discourse patterns in online student/instructor interaction. Online tools cannot replicate face-to-face interaction, but they offer channels of communication that bridge physical distance (Blake, 2005). Their potential for learning is they offer students multiple modes for making meaning which can be used simultaneously for reinforcement. In contrast to using telephone or written online environments as teaching media, audio and videoconferencing offer several benefits to learners, especially in a distance setting. They allow for a combination of different modes and multiple parallel representations, thus increasing modal density (Norris, 2004).

An online videoconferencing environment with its multiple modalities can be used to foster learning, catering for learner differences and preferences. For this potential to be realized, users must acquire appropriate literacy skills, and explicit training in these strategies. Also, coping mechanisms must be provided to enable students as well as instructors to successfully use multimodal synchronous online tools. To communicate successfully, students as well as instructors must take control of tools and adapt their ways of interacting. More research is needed to identify the precise skills and strategies that can be taught to instructors and students in preparation for online tutorials (see Hampel & Stickler, 2005). As Scheffel-Dunand (2006, p. 353) points out, "literacy and orality are social practices whose forms and functions correlate with context of situation, personal involvement and audience". The context includes the communication environment with its mix of modes which has an impact on how these are best used (Kenning, 2010). New patterns of communication emerge as a result, for example, the combination of modes in complex exchanges. Goodfellow and Lea (2007) describe online environments as 'sites of practice' rather than 'tools for interaction'. In this project, I have seen how the environment shapes interaction, how users adapt the available tools to their purposes, and how different modes can be used in a complementary, compensatory, and competing manner.

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Sustainable Development, Infrastructure and Digital Transformation: Encouraging Financial Innovation

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Abstract

The World Economic Forum defines Infrastructure as one of the key pillars and basic requirements for competitiveness and development. Infrastructure is a multifaceted concept, encompassing different sectors, such as education, transportation, utilities, information and communication technologies (ICT) and smart cities. Outdated infrastructure is often retro-fitted to support innovation and future development trajectories (Smart Dubai, 2018). Infrastructure, digital transformation and development are symbiotic. The 4th Industrial Revolution is enabled by, and enables infrastructure. Nevertheless, an infrastructure investment gap stifles a sustainable future. The Arab world has made significant progress in infrastructure and technological readiness, but to achieve fiscal sustainability, global and regional specific risks require policies to encourage the private sector in infrastructure finance (WEF, 2018). Financing adequate infrastructure is vital for sustainable economic and social development (OECD, 2015). However, existing investment regimes have failed to address these global challenges. This paper suggests that financial innovation is essential for responding appropriately to these persistent infrastructure policy challenges. New forms of innovative infrastructure financing, Public Private Partnerships and FinTech are discussed. UAE is a protagonist in finance and construction and appropriate policies can further enhance its regional and global leadership in infrastructure finance, digital transformation and the achievement of Sustainable Development Goals (SDGs).

Keywords: SDGs, Infrastructure, FinTech, Financing Infrastructure

1. Introduction

Investment in real estate development and construction, infrastructure in general, has recently surpassed Extractive Industries (including Crude Oil and Natural Gas) as contributors to GDP in UAE (United Arab Emirates, Ministry of the Economy, 2017). Despite the critical role of infrastructure for the UAE economy, there is a dearth of studies. Infrastructure investment is not only important domestically but also at the regional and global level for Sustainable Development Goals (SDGs). The nature of infrastructure is changing due to digital transformations and it becomes even more important for welfare, sustainability, and security.

We firstly examine how the Fourth Industrial Revolution (4IR) and Megatrends are transforming infrastructure and increase its importance. We also shortly discuss global risks associated to infrastructure. While UAE is effectively investing in infrastructure, globally there is a substantial infrastructure investment gap and deficit. This accentuates global risks connected to infrastructure, preventing economic growth and the achievement of SDGs. Many SDGs are interconnected to infrastructure and further research is necessary.

The UAE has solid domestic commitment to infrastructure development and at the international level it aims to contribute to global efforts to achieve the SDGs (UAE Ministry of International Affairs and International Cooperation, 2017). We frame a threefold persistent policy challenge for UAE concerning infrastructure i) investment in the majority traditional/ physical forms of infrastructure ii) challenge from digital transformations and creating infrastructure for innovation iii) integration of emerging technologies and infrastructure, smart infrastructure. Accordingly, we shortly discuss these challenges and present some initial policy solutions.

2. The Changing Nature and Increasing Importance of Infrastructure

The World Economic Forum defines infrastructure as one of the key pillars and basic requirements for competitiveness and development. The nature of infrastructure is changing. Some of these changes are radical and have a critical effect on security and development. What are the trends that bring about these transformations that affect infrastructure? The new Global Competitiveness Report and the Global Competitiveness Index 4.0 represent a milestone, since they mark the era of the Fourth Industrial Revolution (4IR) and the associated emerging drivers for development. The Fourth industrial revolution is at the centre and characterise of megatrends. 'It is a technological revolution that will fundamentally alter the way we live…it is disrupting almost every industry in every country'. These technological breakthroughs are interconnected and they collide and overlap with other megatrends (Blackrock, 2018). Demographics and social change, urbanisation, shifting economic power, climate change, and resource scarcity are identified as the powerful and transformative forces that could change the world and influence investment decision making (Blackrock,

2018). Many reports have identified similar trends and the World Economic Forum's Global Future Councils focus on infrastructure and investment.

These megatrends directly influence infrastructure financing and development. With an expected growth in the world's population, from 7 billion to 9.6 billion, by 2050 (Fujitsu, 2018), demographics will have a massive impact on all types of infrastructure. Regarding the Middle East and the states of the Gulf Cooperation Council (GCC), the population of the GCC states has doubled over the past 20 years (PWC/World bank) and by 2050 the proportion of senior citizens will have grown from approximately 2% to 20%, a tenfold increase, with an attendant requirement for considerably more healthcare infrastructure (PWC/UN). The Middle East has experienced the fastest growth in urbanisation in the last 50 years and the GCC area is also one of the most highly urbanised regions at 85%, and this figure is expected to rise to 90% or more by 2050 (PWC, 2016). Urban infrastructure investment is a key driver of economic growth and demand for the financing of projects, from utilities (water, electricity, etc.) to transportation and education, is continuously increasing (PWC, 2016).

It is hardly necessary to state the impact of climate change, particularly regarding the idiosyncratic environment of the Middle East. Shifting economic power also has profound effects on GCC states' and particularly UAE infrastructure. Trade, port, airline, tourism and real estate activities as well as infrastructure are largely influenced by the shifts in economic power and its changing flows. An illustrative example that demonstrates the fundamental role infrastructure plays in economic power shifts is the Belt and Road Initiative (BRI). It amalgamates infrastructure with trade and financing, and strengthens the relationship between China and 65 countries, mainly in South Asia, but also the Gulf states and African nations (World Bank, 2018). It is also essential to emphasise that these trends are intersecting, collide and shaping each other. The shift of economic power from west to east is interrelated to demographics and urbanisation. Asia's 4.4 billion population has quadrupled in the last century despite birth control policies, and it is expected the rapid urbanisation of China will give rise to more than 200 cities, each with over a million inhabitants, by 2025 (Blackrock, 2018).

Technology is the main driver of megatrends and the Fourth Industrial Revolution. The aforementioned megatrends certainly increase the demand for infrastructure and make it even more important. They can also change its nature, by creating demand for larger and more advanced projects. Building larger airports, bridges, and roads raises technical challenges. New technologies such as Additive Manufacturing (AM) or 3D printing, building automation and innovative materials transform the process of infrastructure development. Technology can be disruptive in the case of infrastructure and therefore radically transform it. Various technologies will be utilised to provide the infrastructure required to generate smart cities. The UAE focuses on developing 'fully connected and integrated infrastructure' (Hamdan, 2018). 'Smart cities put data and digital technology to work with the goal of improving the quality of life…In particular, smart technologies change the nature and economics of infrastructure.' (McKinsey, 2018).

Simply put, this can be viewed as the integration of ICT infrastructure and the traditional types of infrastructure. Integration is no easy task. While the traditional forms of brick and mortar infrastructure are developing at a relatively slow pace, ICT infrastructure is being radically transformed by technology. Within the ICT domain itself, there is a variety of smaller but still transformative and disruptive trends. Artificial Intelligence (AI), Augmented Reality (AR), automation, big data, blockchain systems, cloud technology, digitisation and the Internet of Things (IoT) connecting billions of devices and their respective infrastructures, are just some of the key emerging technologies. These technologies will converge with infrastructure and jointly interact and evolve in a complex ecosystem. For example, the Dubai Autonomous Transportation Strategy integrates technology with infrastructure and 'will support the establishment of infrastructure for the new technologies'. The future of smart solutions is holistic and will affect every aspect of life, and investment in smart solutions has far reaching benefits and raises the stakes in infrastructure, enhancing competitiveness (EY, 2016). The Fourth Industrial Revolution is characterized by the convergence of virtual and real live and new transformations in the Arab region (Salem, 2017). Recent research in the region displays that IoT and other emerging Fourth Industrial Revolution technologies are bringing radical changes to the Arab world (Salem, 2017).

3. Infrastructure Challenges, Risks and Investment

3.1 Risks

Nevertheless, the convergence of technologies with infrastructure, and smart infrastructure, present new challenges and risks and also augment existing ones. A large number of global risks are directly or indirectly associated with smart infrastructure. All environmental risks can affect smart infrastructure. Most importantly, some of these environmental risks are among the top 5 in likelihood as well as in the top 5 concerning impact. Environmental risks have also consistently remained in the top 5 for their probability of persisting for considerable periods. Smart infrastructure can provide security and resilience against these risks. It can offer sustainable development and preservation of the environment, while at the same time it can protect citizens from extreme weather events and other disasters. Technological risks, notably cyberattacks and critical information infrastructure breakdown, can cause catastrophic effects. A secure smart infrastructure is essential in order to detect, warn and prevent adverse cyber events or to speed recovery from them. In addition, other types of risks such as water crises, failure of critical infrastructure, and failure of urban planning can be mitigated with appropriate infrastructure development and investment.

Global risks are interrelated. The risk of social instability occupies a central position (WEF, 2018). Social discontent has increased, particularly in the Arab States, and some social issues are affected by considerations for enhancing local infrastructure, improving local communities, and minimise negative environmental impacts (Deloitte, 2017). Thus, infrastructure investment can play an important role in citizen satisfaction and happiness,

and social stability. It can also increase youth employment, a crucial factor in social unrest. As well as increased youth employment through infrastructure development and construction, the integration of new technologies could provide even further jobs. The increased interdependencies and complexity embodied in smart infrastructure and global risks, can generate the potential for more instability as cascading disruptions and 'sudden and dramatic future shocks' become more likely than ever (WEF, 2018). These risks and future shocks could fundamentally destabilise whole nations, regions and the world. They represent persistent policy challenges.

3.2 Infrastructure Investment Gap

The supply and often the quality and maintenance of infrastructure are highly inadequate. United Nations (UN) has estimated that the global infrastructure gap is estimated to be in the range of $ 1-1.5 trillion annually (UN, 2016). Environmental risks and disasters have caused since 2010 more than $ 900 billion in economic damage, mostly damage to infrastructure (UN, 2016). Although there would always be natural disasters and damages, there is need to make infrastructure more resilient, raising the level of the required investment. In addition, the costs related to these damages should be also accounted, normally as maintenance costs. This would further increase the need for more financing of projects. The world spending on transportation, power, water, and telecom systems is around $2.5 trillion a year, but this has not been enough to avoid significant gaps in investment (McKinsey, 2016). We estimate that infrastructure investment needs to average $3.3 trillion annually from 2016 through 2030 just to support current economic growth projections, the equivalent to about 3.8 % of global GDP (McKinsey, 2016). The problem is not only due to the current level of investment, but also the backlog of infrastructure development and maintenance - even more financing is required to make up for previous omissions. The really critical factor is the UN Sustainable Developments Goals (SDGs). The infrastructure gap is tripled if we compare current investment with what would be required to meet the SDGs (McKinsey, 2016). There are different estimates on the infrastructure gap, according to the items included and conditions.

The problems are not only traced on the current level of investment, but also on different conditions. Firstly, the backlog of infrastructure development and maintenance that largely accentuates the gap. Even more financing is required to make up for previous omissions. The really critical factor is accounting for the UN Sustainable Developments Goals (SDGs). The infrastructure gap can triple, if we compare current investment with what would be required to meet the SDGs (McKinsey, 2016). There are two additional internal factors that further widen the infrastructure investment gap. The first is the quality and maintenance of infrastructure. It requires significantly more resources to develop high quality infrastructure, for example, a road with more lanes to avoid bottlenecks and traffic jams, and to sustain it in a good condition over time. More investment is also needed in order to develop smart infrastructure, for example, the integration of sensors and processing data on highways.

Although there can be massive economic benefits from more technologically advanced and efficient operations, funding for this remains at low levels.

It should be noted that there are crucial external economic parameters that impact infrastructure development. The 2008-9 global crises had a big impact on fiscal expenditure and consequently on infrastructure investment. It highlighted the limitations of public sector funding. This was, and still is, particularly difficult for countries with large deficits and debts. Infrastructure investment has been at historically low levels and this shortage of investment is unlikely to deliver sustainable growth in the long term (EBRD, 2016). Similarly, in GCC states, oil price variation persists due to macroeconomic and political issues and consequently, governments are revising their priorities and therefore their commitments to infrastructure projects. (EY, 2016). Even energy infrastructure has experienced a period of underinvestment (CNBC, 2018). Infrastructure is perceived to have a critical role in enabling and encouraging economic growth and development. In that sense it can be argued that its demand is defined by economic growth. Moreover, economic growth and development enable governments to gain revenues and fund infrastructure. This bidirectional relationship between infrastructure and economic growth, or revenues and oil in the case of GCC, indicates sensitivity to fluctuations in growth and oil prices respectively. Prioritizing SDGs and aggregating the aforementioned factors, it is evident that there is a massive global infrastructure gap, and simply the investment cannot match it.

3.3 Sustainable Development Goals and Infrastructure

The achievement of the Sustainable Development Goals is a main focus of this paper. The 2030 Agenda emphasises the interlinkages and integrated nature of the Sustainable Development Goals (UN, 2015). SDGs are interconnected to global risks and competitiveness indicators. Global environmental risks are related to climate action (SDG 13), water crises to clean water and sanitation (SDG 6), and technological risks and failure of critical infrastructure to industry innovation and infrastructure (SDG 9). It is noteworthy that the structure of SDG 9 integrates infrastructure with innovation. Similarly, the infrastructure (pillar 2) and innovation capability (pillar 12) competitiveness indicators are related to SDG 9. There is a variety of interconnections that needs further research.

What is really important is that they can be synthesised with a nexus approach (UN, 2016). The Sustainable Development Goals constitute a global policy challenge for all nations. Nevertheless, SDGs have asymmetric effects on different states. The UAE is one of the most advanced countries in the world and it has achieved a high level of development. However, there are SDGs where the UAE does not rank so highly, such as good health and well-being (ranked 79th; WEF, 2018). The Agenda 2030 has a broad international scope, fostering a Global Partnership and strengthening global solidarity (UN, 2015).

In the context of infrastructure, the SDG target 9.1. is to 'Develop quality, reliable, sustainable

and resilient infrastructure, including regional and trans-border infrastructure… with a focus on affordable and equitable access for all' (UN, 2015). The international dimensions of infrastructure development are crucial policy challenges for the UAE, since they can relate to regional security and stability (Cordesman, 2011). The late Sheikh Zayed bin Sultan Al Nahyan 'stressed that foreign aid and assistance is one of the basic pillars of UAE foreign policy' (UAE Government, 2018). The UAE's foreign assistance policy aims to contribute to global efforts to achieve the SDGs (UAE Ministry of International Affairs and International Cooperation, 2017). The UAE focuses on building resilient infrastructure, promoting inclusive and sustainable industrialisation, fostering innovation (SDG 9), and strengthening the means of implementing and revitalising the global partnership for sustainable development (SDG 17) (MOFAIC, 2017). One of the three thematic programmes of the UAE government is transport and urban infrastructure (MOFAIC, 2017).

4. Framing Persistent Policy Challenges

Infrastructure development and investment remains a persistent policy challenge for a long time. It involves not only the current lack of infrastructure investment, but also the backlog of previous deficiencies in infrastructure development and maintenance. This has created a persistent 'infrastructure deficit' over the years. While the UAE can be considered a positive outlier nation, infrastructure gaps and deficits are the norm globally. Infrastructure deficits have accumulated and can significantly stifle economic growth. Inadequate and ineffective infrastructure is associated with a plethora of risks. A lack of infrastructure can cause security concerns and social unrest. Moreover, there are technological risks enmeshed in the digital transformations associated with smart infrastructure. There is a nexus of interconnected risks and other challenges surrounding infrastructure that requires innovative policy responses.

The UAE ranks highly in the WEF's Global Competitiveness rankings (27th), and 5th in the infrastructure pillar. Nevertheless, emerging digital transformations, and converging technologies and their integration with infrastructure, present emerging challenges. Innovation capability, business dynamism, financial systems and health are competitiveness pillars in which there is room for improvement. The infrastructure gap and deficit impede the attainment of SDGs. Although this is not an acute domestic issue, the Middle East and North Africa (MENA) region faces significant problems and associated risks in achieving SDGs. The UAE is committed to SDGs and can strengthen its regional and global position as an anchor of security, stability and prosperity. Infrastructure development is central to Nation and State building as well as being a key element of foreign aid.

Thus, there is a threefold infrastructure policy challenge:

The first part regards investment in the majority traditional/physical forms of infrastructure. In the context of the UAE, infrastructure should be high quality and sustainable. Efficiency

is a constant challenge and more cost-effective ways to invest and develop infrastructure would be valuable. At the international level the UAE is committed to SDGs and infrastructure investment. Infrastructure investment strengthens its regional and international role through both soft and hard power, and associated power projections. Innovative forms of financing can be useful in increasing investment and making it more efficient.

The second portion of the challenge stems from digital transformations. The Fourth Industrial Revolution changes every aspect of life. Innovations and new technologies are drivers of development. Nations will have to establish and encourage ecosystems for innovation. They will have to develop appropriate infrastructure, such as innovation hubs and clusters. These are often accompanied by significant investment in education, particularly in Research and Development (R&D) infrastructure. Raising finance to develop an innovation ecosystem is a major policy challenge.

The third component of the policy challenge is a closely related and natural extension of the second. New transformative technologies are integrating with traditional forms of infrastructure. The process of integration requires significant resources and sophistication. It demands more than basic innovation, namely an advanced R&D infrastructure and synergies that can link different elements into a coherent and enabling ecosystem. Innovative forms of alternative finance are needed for investment in entrepreneurial ventures and the development of such an ecosystem.

5. Financial Innovation and Smart Infrastructure Investment

5.1 Raising Infrastructure Investment

We described above how one of the biggest challenges that creates and widens the infrastructure investment gap and deficit is the inability of governments to find and commit sufficient funds. A solution is to encourage participation of the private sector. This can be done in different ways. First of all, financial innovation can contribute by introducing new forms of financing. International Organisations, mainly in the framework of the G20, have worked towards this. A prime form of financial innovation is to create capital market instruments to attract investors. The World Bank (WB), the International Monetary Fund (IMF) and the Organization for Economic Cooperation and Development (OECD), produced a report for the G20 that proposes the creation of (infrastructure) project bonds, infrastructure covered bonds and infrastructure debt funds to increase financing for infrastructure (G20, 2015). Innovative financial instruments offer variety and different options and they attract private investors.

Another policy is to develop markets and institutions dedicated to infrastructure finance. This requires the establishment and growth of infrastructure instruments and associated asset classes, as mentioned above. Infrastructure is usually a long term investment and

therefore it attracts the interest of institutional investors. Institutional investors are large funds that have the financial capacity to expand the markets in which they participate. Financial policies should be created to incentivise institutional investors to actively participate in infrastructure finance products and markets. Financial innovation, and also securitisation and standardisation of infrastructure capital market instruments would be useful in evolving infrastructure finance from a rather niche market to a fully-fledged global market. The development of infrastructure markets and institutions presents exceptional opportunities for the UAE, Abu Dhabi and Dubai as global markets. The UAE should provide the incentives, such as taxes, and a physical and financial markets infrastructure to entice infrastructure finance and institutional investors.

This bring us to the next distinctive opportunity. The UAE is a global centre for finance and especially Islamic finance. The IMF and WBG produced a G20 note on integrating Islamic finance with global finance and its potential for fostering infrastructure investment (G20, 2015). Islamic finance has many advantages, for example, it is based on real asset transactions, asset-backed securities, relative risk aversion and risk sharing, provides support for infrastructure investment. Elaborating on previous national policies, future governmental policies should change regulatory and supervisory frameworks to further open the Islamic finance industry to global capital markets, ensure there is appropriate financial markets infrastructure in place for asset-backed securities, and create tax systems that will reduce and eliminate additional layers of transactions in some instruments and double taxation, finally central banks should develop necessary inter-bank and monetary policy instruments to facilitate liquidity, and ensure efficient functioning of the payment systems (G20, 2015).

5.2 Infrastructure for Innovation

In order to enable and augment numerous forms of innovation, as financial innovation, it is essential to develop an effective infrastructure. The UAE has invested significantly in innovation, establishing free economic zones related to technology, notably the Dubai International Financial Centre, Dubai Internet City, Dubai Silicon Oasis, Dubai Science Park and Dubai Knowledge Village. The specialised economic zones are part of the unique UAE paradigm and a great opportunity for future investment and growth (Petratos, 2018). Nevertheless, there is always space for further innovation and development.

First of all, policies should boost the establishment of hubs and clusters for alternative finance. This is again a dual challenge for creating the appropriate physical and intangible (regulatory, knowledge etc.) infrastructure. While the Dubai International Finance Centre (DIFC) has seen significant development and progress, it can be argued that more capacity for entrepreneurial finance (i.e. Venture Capital crowdfunding) should be built in. Entrepreneurial finance can fund innovation and result in novice capital market instruments, processes and businesses. Closely associated, is the emerging FinTech industry and UAE

policies should further build on its capacity. Government policies to generate sufficient supply of entrepreneurial finance, for example clusters, are necessary in order not only to raise capital for start-ups but most importantly, to enable 'Unicorns' and a creative technology ecosystem.

It was discussed above, that technological transformations are integrated with infrastructure. Therefore, the development of smart infrastructure requires policies to further develop new technologies, such as artificial intelligence, automation and the Internet of things. The UAE has an effective National Innovation Strategy with well-identified tracks, key pillars and priority sectors (UAE, 2015). It is beneficial that its priority sectors: renewable energy; transport; education; technology; and water are strongly aligned with smart infrastructure development. The Strategy also supports infrastructure through innovation incubators, labs and specialised research centres in schools and universities. Among the main policy challenges, is how to better prioritise and channel investment in infrastructure and consequently impact innovation. To highlight the complexity of innovation policy instruments, Edler and Fagerberg (2017) found more than 700 related studies. A fundamental UAE policy would be to assess the cost and benefits of different types of infrastructure and innovation in relation to its economy, society and SDG objectives. Accordingly, prioritisation and investment in smart infrastructure should be adapted and carried out within the Vision 2021 framework, and beyond, in AREA 2071.

5.3 Convergence, fusion, and integration of technology and infrastructure

The greatest challenge to policy is for it to generate the enabling ecosystem and necessary conditions for the successful integration of emerging technologies and digital transformations with infrastructure. While the UAE offers a unique infrastructure of economic free zones and technology clusters, coordination problems are persistent. A proposed policy recommendation is to develop agencies for better coordination in order to realise the benefits of vertical and horizontal synergies in the UAE more efficiently and more quickly (Petratos, 2018). It should be emphasised that these agencies and institutions should not be formed as central administration but rather they should be formed in a devolved manner, facilitating agility and evolution. Another policy recommendation is to invest in deeper specialisation. A specialised initiatives research centre and facilities would analyse the complex process of 'fusion' at both the technological level with its related transformations, and the policy and governance level (Rothwell, 1982). Policies should have a holistic and systemic approach to technologies (Weber and Truffler, 2017; Smits and Kuhlman, 2004), analysing interrelations, synergies and interdependent risks, and unintended consequences (Heal and Kunreuther, 2007). This approach should not only be national but also regional and global.

Global partnerships and Public Private Partnerships (PPPs) are valuable methods for all of the above policy challenges. The UN 'seeks to strengthen global partnerships to support and achieve the ambitious targets of the 2030 Agenda, bringing together national governments,

the international community, civil society, the private sector and other actors' (SDG 19). Partnerships can generate critical mass in raising capital and bridge the infrastructure deficit and gap. They can strengthen the innovation ecosystem with more participants, positive externalities and the diffusion of innovations. But the most vital use of partnerships might be integration. Partnerships share knowledge, accountability and other resources among participants. They strengthen relationships and contribute to the reduction of risks and the avoidance of frictions. In that sense, they can be critical to foreign infrastructure assistance and SDGs. The UAE government has recently established a manual for partnership between federal entities and the private sector, regulation and a guide to PPPs in Dubai (UAE, 2017, Dubai, 2015, Dubai 2016). Policy recommendations can include the development of centres of expertise for global partnerships and PPPs, and increased capacity. Policies to increase financial innovation in PPPs and to attract more participation and funding from the private sector would be invaluable.

Conclusions

Despite the critical role of infrastructure for the UAE, at both domestic, regional and international levels, there is a dearth of studies. This paper is an initial effort to fill this lacuna and establish a future research agenda. We contribute by identifying a threefold persistent policy challenge for UAE and shortly discussing some policy recommendations. We recommend that financial innovation can facilitate infrastructure investment, improve its quality and mitigate risks. Improving the infrastructure for innovation, successfully integrating emerging technologies and infrastructure and creating global partnerships can enhance UAE's global leadership.

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Accelerating the Sustainable Development Goals through Digital Transformation
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II - Accelerating Sustainable Development Goals – The Local Landscape

IoT Importance in Construction Industry: Dubai

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Abstract

Competitive companies in the world seek for the best technologies to complete things in minimum cost and high level of safety and security within a short period of time. Companies who do not convey the updated technology always falls behind. Internet of things (IoT) is now the storm of the new technology. By 2020, it is estimated that 21 billion devices will be connected to the internet. It is not only about connecting smart phones & tablets together but almost any "Thing "can be connected together with the internet storing big amount of data and information to a cloud. The concept of IoT made it possible to manage the projects in the construction fields and make it easier to control the buildings under construction to deliver the project within time and budget. It enables the companies to introduce the internet of things system in the construction field to get the maximum benefit. One more important aspect of IoT is that it would contribute to accelerating Sustainable Development Goals (SDGs) implementation. Various qualitative methods are used to achieve the aim of this study which includes two case studies, interviews conducted at several Dubai Municipality Departments, visits to IoT providers and a survey to assess the level of use of IoT in the construction industry.

Keywords: SDGs, Internet of Things (IoT), Construction,

1. Introduction

One of the increasingly growing topics nowadays is Internet of Things. Competitive industries around the world strives to get the maximum benefit of internet usage in order to increase the level of the production line within the scheduled budget and time. IoT is simply connecting any "thing" to each other by internet to transfer, collect and exchange data between them without any human interaction. It became clear that the construction industries in UAE is still of less IoT usage.

1.1 Research Question

This paper contributes to enhance the understanding of IoT importance and its usage in the construction industry. Since the delay of supplying materials and resources is one of the major reasons leading to projects' failure. IoT is one of the solutions to avoid such delays. This study assess how IoT system is applied in construction industry to solve construction dilemmas: reduce the duration of the project and make the project be delivered within budget with high level of efficiency and without errors.

1.2 Problem Statement

Time management and cost management are major challenges in all kind of projects around the words. According to the 2015 collection of project management statistics by (Emily, 2015), only 18% of projects are completed and delivered within budget and only 19% are completed on time. Further one of the challenges is to keep the construction field at a high level of safety due to nature of this industry. Wastage of materials is also a major problem. According to (Ameh et al, 2013), material wastage accounts for 20-80% of project cost overruns. Data loss of documentation due to improper classification techniques, changing in drawings are also a challenge. IoT can definitely be used in construction industry to solve these issues.

1.3 Aims and Objectives

The aim of this research is to address the current issues of building construction in Dubai and bridge the gap between technology and ecology. The research highlights the importance of introducing IoT system in construction industry. The study of the IoT usage in Dubai construction could be later taken as a prototype for other cities and government programs. The main component of this research are to:

- Review of existing literature on IoT.

- Identify the concept of IoT, AI and smart construction.

- Identify the usage and impact of IoT in Dubai construction.

- Analysis indicators of the advantages and disadvantages in adapting IoT to construction field.

- Identify barriers of adapting IoT and smart devices from consumer perspective, government approach and market statues.

2. Literature Review

Internet of things is the new revolution of technology. What people desire more than a connected world? connected devices, objects, animals and even people. It's a connected planet where live things and non-live things are all connected to each other to make the process of life much easier. The literature review framework is given in the figure below. The main finding from the literature review is the lack of proper use of IoT in the construction industry.

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IOT in Construction Industries

IOT in Construction Industries

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Wu, Y. and Wang, Y. (2013). **A Study of Smart Construction and Information Management Models of AEC Projects in China**

Ding, L., at el. (2013). **Real-time safety early warning system for cross passage construction in Yangtze Riverbed Metro Tunnel based on the internet of things.**

Alan Sage. (2016). **How the internet of things is impacting the construction industry.**

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Zhong, R., at el. (2017). **Prefabricated construction enabled by the IOT**

Sobotka, A. (2017). **Innovative solutions in engineering of construction projects.**

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Akinade, Oat el. (2018). **Designing out construction waste using BIM technology**

Bradley, J., at el. (2018). **Building Intelligent Infrastructure.**

Juan du. et. al., (2017) **RFID & Multi-Agent Based Architecture for info.Sharing in Prefabricated Component Supply Chain**

Liu, Z,at el. (2017). **Study on smart city construction of Jiujiang based on IOT technology.**

SCHULTZ, B. (2017). **Technology Advances the "Age of Smart Construction".**

Lack of IOT use in Construction

Li, C., et al (2018). **An IOT-enabled BIM platform for on-site assembly services in prefabricated construction.**

3. Methodology

Various qualitative methods are used to achieve the aim of this study which includes two case studies, interviews conducted at several Dubai Municipality Departments, visits to IoT providers and conducting a survey to assess the level of use of IoT in the construction industry.

3.1 Case Study: Dubai Smart City

Dubai became one of the smartest cities in the world, but the goal is to transform this smart city to serve people to achieve happiness. This vision and mission are the aspirations shaped by H.H Sheikh Mohammed bin Rashid aiming to make Dubai the happiest city on earth which is the ultimate success.

Smartness of Dubai is measured by the happiness of people who live in it. In order to achieve this vision, Dubai smart city collaborates with 12 different partners: Dubai Electricity and Water Authority, the Executive council, Dubai health Authority, RTA, Dubai Tourism, Dubai Police, department of economic development, Dubai municipality, Dubai Silicon oasis authority, Dubai electronic security Centre, Dubai design district and Mohammed bin Rashid school of government. The finding of this case study is that the happiness meter index initiatives have been introduced and implemented by all government departments.

3.2 Case Study: Wastage Department – Dubai Municipality

Waste Management department in Dubai Municipality stressed that there is increasing interest in implementing a number of regulations and measures that would reduce the rate of individual waste production and curb the continuous increase in the quantity of waste produced. Dubai Municipality now has modern and sophisticated databases on the waste management system including an Intelligent Numbering System for waste storage devices. Each container is provided with a personal profile in terms of type, country of manufacture, as well as knowledge of the geographical distribution of containers. An automated tracking of vehicles transporting and collecting waste includes the installation of smart devices to track movement via satellite. By integrating Vehicle Tracking System using GPS into design, many functions such as vehicle maintenance, vehicle tracking, fault diagnosis, driver management, fuel management, health and safety management had been resolved by this real time system.

3.3 Interview: General Health Department – Dubai Municipality

An interview was conducted with Dubai municipality health services department: Internet

of Things is used in Dubai Municipality abattoir to calculate continuously information about heat and humidity in cold and freezing rooms. It helps to control switching off and on of the temperature regulators dynamically. Over increasing or decreasing temperature would have a major impact on the quality and the health of the meat. Data collection using IoT helps also many employees to use and share data. Heat and humidity sensors are installed considering the slaughtering and cleaning processes which are a risk environment for bacteria and diseases. Sometimes while storing the meats employees may forget to close the doors; Using IoT in abattoirs increases the efficiency and the effectiveness of the work due to the availability of the data and quality control.

3.4 IoT usage in Dubai Construction

3.4.1 Case Study Al Amal Psychiatric Hospital – Dubai

The Ministry of Infrastructure development of the United Arab Emirates constructed the new Al-Amal Psychiatric Hospital, Dubai up to the most recent sustainability standards. The new facility is a State-of-the-Art 270 bed mental health campus designed to recent FGI 2010 standards and to receive a SILVER LEED HEALTHCARE accreditation. The Hospital provides high quality clinical care services for psychiatric patients. The architectural environment of the hospital is surrounded by lush vegetation. In this project, environmental pollution is controlled by measuring the degree of air and noise pollution using special IoT sensors and meeting international standards. It Provides 23% reduction of energy consumption and save 19800 gallons per day of water consumption by using IoT special devices.

3.4.2 Interview: Building Control Department– Dubai Municipality

The interview was conducted with the department head of the new technologies used in the construction field and the usage of IoT in future works. The response from the interview is that several plans and future work would be implemented in the construction fields that will increase the safety and track the project execution (all steps will be under eye) which helps completing the project within time and with less errors.

3.4.3 Interview: Research and Building– Dubai Municipality

This department aims at conducting studies and research on development opportunities and adapting latest standards for new construction. It is also responsible in conducting studies in the field of specifications, materials, systems, methods, requirements and standards of sustainable buildings. It conducts field visits for real-world study and provides sufficient flexibility for investors so that they are not bound by traditional building systems

but ensuring that innovations conform to the standards and requirements of the Emirate of Dubai. An interview was conducted with Eng. Fida Alhammadi who confirmed that Dubai Municipality is already dealing with professional companies with high quality and standards to make sure that updated technologies are used in construction according to the rules of Dubai municipality and meeting the aspiration of Dubai government.

3.4.4 Visit to IoT providers in Dubai Construction Industry

A Visit to IoTx and block chain Exhibition in Dubai on May 2nd 2018, interviews were conducted with many IoT providers namely, Utimaco Company, Multiversum Company, Digital Persona NANJEL Solutions Company, CYBERTEQ Company, Machinestalk Company and Bluevision Company. All these international companies are highly interested in providing their services to Dubai smart. They had showed full faith and confidence in the vision set by the Ruler of DUBAI, H.H Sheikh Mohammed bin Rashid

3.4.5 Attended Conference on AI strategy in UAE

We had attended a conference taking place in Sharjah. The Minister of AI in UAE, his excellence Omar Al Olamaa stated that in the medical field artificial intelligence is being used in analysing images and scanning medical reports for proposing early diagnosis or recommending treatment methodologies. Whereas in law practices, numerous artificial intelligence developers seek to design computing programs that assist in reading and scrutinizing documents and contracts, predicting conflicts prior to their occurrence and endorsing strategic solutions for them. While in the educational stream, a robotic teacher has appeared who is capable of distinguishing students and interacting with them via their facial expressions and neural activity and helping them accordingly.

Furthermore, tools of artificial intelligence and their electronic is conquering the military sectors with the advancement of satellite detection and threat prediction and elimination. The transportation business is not in exile of artificial intelligence's technology as per a number of well-known automotive manufacturers are putting their final touches on the self-driving vehicles that are equipped with spatial recognition features. Moreover, big forex brands and stock exchange brokers in the financial market started utilizing artificially intelligent programs that not only analyse and predict stock market fluctuations, but can also close deals and make profitable decisions without the need of human intervention. Last but not least, the e-commerce business has noted an increased reliability on artificially intelligent technology by what is known as smart e-agents.

Despite the numerous features of artificial intelligence, it introduces another dimension of challenges that are especially a source of concern for the current legislations and the

extent of their ability to comprehend the unique features of this technology. Besides, from the technical point of view, artificial intelligence is not only far from being perfect, but also vulnerable to date from viruses and technical malfunctions that can make it behave unpredictably or perform erratically; which consequently may lead to dramatic ramifications that make us question our dependability and confidence with the allocated responsibilities for this new technology.

3.5 Survey to assess the level of IoT usage in the Construction industry

A survey was designed and targeted 15 UAE and 50 USA construction companies and intends to measure their awareness about the new technologies and IoT and to find the level of usage of IoT. The lessons learned is that most of the construction companies in USA & Dubai are not fully aware of the importance of IoT and its not used in most of the surveyed companies.

4. The Outcomes of the Methodology

Following is the outcome of the Qualitative methodology:

Case Studies	Outcomes
Alamal Psychiatric Hospital	New technologies helps in delivering the project within schedule.
Dubai Smart City	Smart technologies and IoT are going to be used in environment, health, transportation and other domain of life for a happy Dubai.
Waste Dept. in Dubai Municipality	RFID system is used to organize the waste in Dubai
Interviews	Outcomes
General Health Dept. in Dubai Municipality	IoT is used in abattoirs to measure the temperature and humidity to control the quality of the Meat.
Building Control Dept. in Dubai Municipality	BIM is going to be used in Dubai construction in the future. It's a good future plan if IoT is combined with BIM.
Researches & Building System Dept. in Dubai Municipality	The department is interested in laying the foundations and standards for new construction methods. Preparation of various studies in the field of specifications, materials, systems, methods, requirements and standards of sustainable buildings. IoT is not yet used the department.

Ultimaco Company **(IoT Provider)**	Protect and secure the connectivity and data exchange between devices, in order to protect the data, as well as the privacy of the users and to safeguard system infrastructure.
Muliversum Company **(IoT Provider)**	Securing shared data, quick and extremely reliable, both for the private client and for large companies and other established institutions.
DigitalPersona **(IoT Provider)**	The company provides security and risk solutions for IoT Devices.
CYBERTEQ Company (IoT Provider)	Build a unique IOT solutions. Boost you profits by accessing sensor data, analysing information and monitoring the organization. They act with things to deliver comprehensive IoT solutions.
NANJEL Solutions (IoT Provider)	provides a comprehensive range of cyber security and data privacy solutions and services to help assess, build and manage cyber security capabilities and respond to incidents.
Bluvision Company (IoT Provider)	Provides Real-time location system solution: Item and people tracking. Monitoring health and condition of motorized equipment Enterprise management solutions
Machinestalk	Provides IoT solutions in smart environment, smart cities, smart building, smart lighting and etc. also Provides full control of equipment, tools, documents, and weapons through cellular, satellite and dual-mode devices.
Survey	**Outcomes**
Construction IoT	Most of the construction companies in USA & Dubai are not fully aware of the importance of IoT and its not fully using in most of the companies and there a futue plan to work on.

5. Results and Findings

The main gap reported by this research is the lack of IoT fully use in the construction Industry. This study had shown that the use of IoT in building construction can be very beneficial. The case study conducted in the building control section of Dubai municipality reveal that they are the only ones that uses the building information Modelling(BIM) smart technology in construction. BIM can capture in real time the on-going project so the stockholders can know exactly the amount of work done in the site which make it easy to depict the handing over time. BIM can provide the 3D modelling of the building so that the

design and structure can be evaluated and updated. However, BIM cannot measure the energy consumption, status of the machines, quality of the materials and etc. IoT can be introduced fully in all stages of the construction works from the design to the completion. IoT can reduce energy use thus meeting green building standards. IoT technologies have positive results in cost reduction as well as in saving time and souls. An example of cost reduction is the frequent usage of a construction material which is connected to the control room in the construction site by sensors. Safety example for the labour working in the project site: the labour can control the site remotely by the devices connected to the machines and materials in the field. IoT can provide different services to take advance decisions supporting the construction processes. Interviews conducted with IoT providers shows that introducing the IoT contribute immensely to safety of human lives and material.

His excellency, Omar Al Olamaa, mentioned during the conference on Artificial Intelligence Strategy in the UAE "governments can play a powerful role in supporting artificial intelligence to maximize value both in terms of enhancing security, health, and intelligent lifestyles". UAE has already taken steps to adopt artificial intelligence in innovative ways in all sectors of government, such as using artificial intelligence to facilitate X-ray process of medical examinations - issue visas - modify transportation schedules - in response to accidents - use artificial intelligence sensors to facilitate Intelligent Traffic movement - Use facial recognition techniques to monitor vehicle driver stress levels and use interactive conversation software to improve customer service.

6. Conclusion

This study illuminates the importance of IoT in construction industry and assesses the level of use this technology. IoT is shown to contribute to the happiness of people, to the optimal use of resources and the safeguard of the environment. Therefore, we conclude that IoT contribute to Sustainability implementation. We have investigated case studies and conducted interviews of government experts in this field. Dubai municipality which is the most responsible for giving the permission to the companies to work in a smart way which follow the roles of DubaiX10 and focus to make Dubai one of the smartest cities in the world. All construction companies in Dubai have to use the new intelligent and smart technologies in order to build a smart city with the international standards. There is no doubt that IoT has a positive impact on all domains of life around the world. Introducing IoT in construction industry leads to a new era where everything is connected. Internet of things has to be introduced in the construction field among with the other technologies due to the high benefits.

This study shows that there is a lack of using the IoT technology in the construction industry in Dubai. As a future plan suggestion from this study, one of the important roles of the government is to make the companies aware of the updated technologies. Introducing IoT in construction companies can be completed by adding new regulations in making the usage

of IoT when completing construction permission process. New roles are to be implemented in obtaining approval for construction building in Dubai; starting with government projects which can be the example to follow. In projects under construction, sensors can be installed to the construction building as a trial for the first stage to measure the impact and the comparison of the results.

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Home Automation Awareness in United Arab Emirates

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Abstract

By 2020, it is estimated that 21 billion devices are going to be connected to the internet. In fact every "Thing" can be connected to internet from smart phones, tablets, watches, cars, appliances and even homes.

Internet of Things, Home Automation and Artificial Intelligence will drastically transform our homes and the way we live. Home Automation is a technology that empowers users to control and monitor their house remotely. The question is: Are we ready for this change? Are we aware of the benefits? Most importantly, are we going to adopt this technology?

One of UAE's strategic goals for 2021's National Vision is to provide sustainable housing for its national citizens. The goal is to form a new kind of modern Utopia, which are "Smart Cities", whether by renovating the existing structure or by totally building a new smart infrastructure from scratch, were smart automated homes are part of it.

The aim of this paper is to investigate the awareness of UAE nationals about Home Automation. We conducted a survey among 60 people and asked questions relevant to their awareness and to their interest in adopting Home Automation and Internet of Things technologies into their homes. We found that there is a lack of awarness of Home Automation and to raise awarness ,people should be familier with the system first and then by taking small steps to adopt this technology we suggested framework to transform any traditionl or normal house into a smart and sustainable house using Home Automation technology .

Finally, we present the results of the survey and provide recommendations to raise the awareness concerning Home Automation in the UAE.

Keywords: Internet of Things, Home Automation, Smart Cities, Smart Solutions

1. Introduction

1.1 Aims and Objectives

Home Automation is simply the technology that permits users to monitor and have a control over the operation of home appliances and devices. Home appliances are plugged with customized sensors that are connected to the internet by "IoT" Internet of Things technology in single or mesh connection. The user can pre-program the appliances automatically based on the user preferences and daily habits or even by real time remote control.

Smart Cities and also Smart Automated houses concepts are trending lately due to advancing technologies and the digital revolution of Artificial Intelligence, Block Chain and IoT. Occupants wants to have a better quality of living where things around them do tasks without much of human interaction by only commanding and monitoring, which is more convenient and saves time and effort. Home Automation gives the user the power to control home security, recycling process, lighting control, appliances automation, temperature control, renewable sources of energy etc.

According to world meters, the latest statistics of United Arab Emirates demographic numbers of 2018 shows that over the past decades there is a significant increase of the population growth rate as 1.50 %(World meters 2018). It was reported also that about 25.4% from total energy is for household consumption ("Energy consumption in households - Statistics Explained" 2018).

All of these energy consuming activities had led to increasing the carbon dioxide emission, affecting the carbon footprint making the UAE as one of the countries with largest ecological footprint challenges. Household activities are responsible for 57% of the total footprint ("United Arab Emirates - Global Footprint Network" 2018).

As mentioned previously ,What is Home Automation and How will fit the context of UAE. The purpose is to hightlight the importane of following the state-of-the-art technology of Home Automation ,be aware of it and use it to wisly. Also to discuss Home Automation technology awareness in UAE and bridge the gap between ecology and technology. Accordingly, the main objectives of this research are to:

- Identify the concept of Smart Home and Home Automation.
- Analysis the advantages and disadvantages of adopting Home Automation technology.
- Collect a survey about people's preference and energy consumption behavior.
- Design strategy or a framework to estimate of the needed resources and requirements.
- Suggest recommendations to raise the awareness and encourage utilizing Home Automation technology.

The purpose of this work is to hightlight the importane of following the state-of-the-art technology of Home Automation. Also to discuss Home Automation technology awareness in UAE. We surveyed 60 people preference and energy consumption behavior with respect to Home Automation.

1.2 Sustainable Development Goals (SDGs)

In 2016, United Nations developed a strategic plan made out of 17 main goals to be implemented by the agreement of 189 countries to improve the overall status of living by eliminating poverty and hunger, raise the standards of health and education for both genders, to get access for clean water and energy as well as protecting the environment from climate change and preserve the eco-system.

For each goal there is a target list and progress indicators for which all together should to be achieved by the year 2030 (Sustainable development goals - United Nations 2018) as shown in figure number 1.

Figure 1: Sustainable Development Goals

Source: United Nations (2018)

According to United Nation statistics, 85.3% of the global population had electricity in 2014, which is about 1.06 billion so the rest of people are living without any electricity, they still use traditional ways of cooking with fire and not using clean fuels or electrical cookers.

The seventh goal target which is about affordable and clean energy, as to attain universal

access to modern energy services of renewable clean energy resources as well as using energy efficiency appliances and light bulbs. Home Automation can provide a solution in preserving the energy consumed domestically however the challenge is about the governmental policies, acceptance level to integrate new technologies and how the local community sees the benefits and adopt it in a micro level and trust the system.

The SDG 11 draws a plan of sustainable cities and communities, which got the pillars of creating safe, resilient and sustainable cities. If combined with goal number 9, which is about industry and infrastructure preparing cities for smart infrastructure will enable the attainment of the relevant SDGs and will also reflect on goal number 8, which is decent work and economic growth technological revolution will create more jobs related to IT and smart technologies.

In 2015, about four billion people live in the urban areas and it is predicted that by 20150, this number will increase to be around five billion people. The demand for energy will increases, therefore preserving energy is a necessity which all countries should collaborates and take smart choices into consideration.

1.3 Telecommunication in UAE

The people in UAE are ranked in third place among the most connected people in the world (GfK.com, 2016). This includes connectivity of several gadgets (Tablet, Smartphone, videogames, TV, desktop, connected cars, smart home etc.). This means, to have smart automated homes it will be easier in application and integration. See figure 2 below.

Figure 2: Top 10 most connected population worldwide
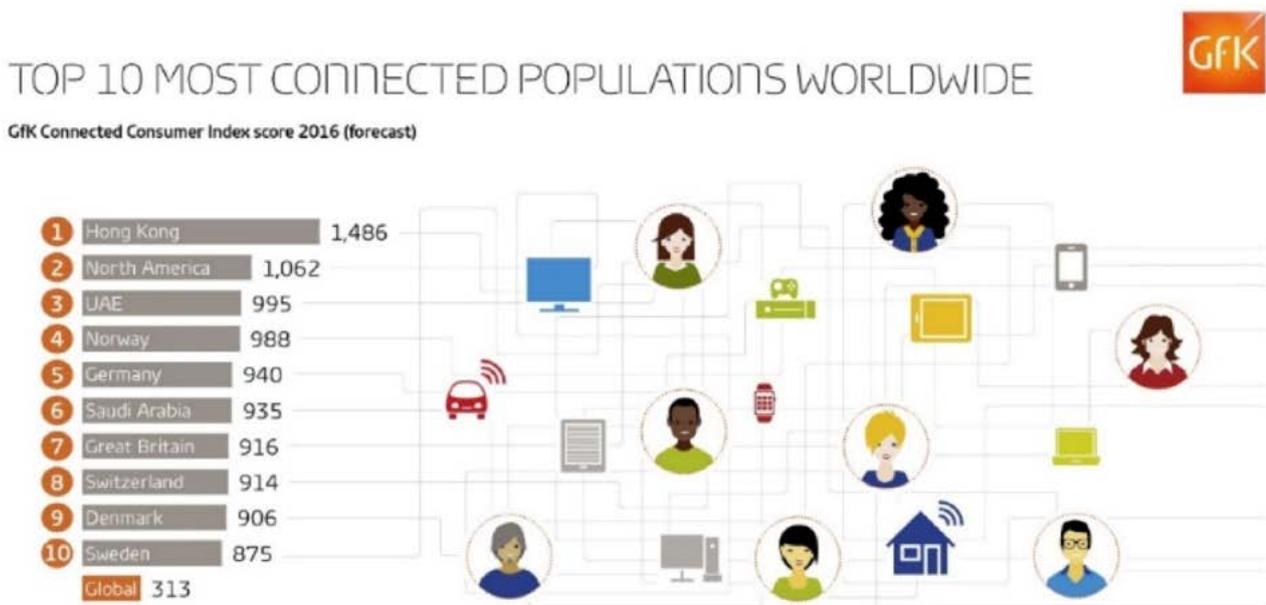
Source: GfK Connected Consumer Index – The index measures how much consumers in each country connect with other people or content or technology across 11 different device types (smartphone, tablet, mobile PC, desktop PC, wearables, smart TV, TV set-top box, videogame console, e-Reader, connected car and smart home).   © GfK 2016

Source: GFK (2016)

In UAE the penetration of the internet is 99%. The same number is for active social media users and 8.70 million uses their mobile (figure number 3).

Figure 3: Digital around the UAE in 2018,

DIGITAL AROUND THE UAE IN 2018

TOTAL POPULATION	INTERNET USERS	ACTIVE SOCIAL MEDIA USERS	UNIQUE MOBILE USERS	ACTIVE MOBILE SOCIAL USERS
9.47 MILLION	9.38 MILLION	9.38 MILLION	7.31 MILLION	8.70 MILLION
URBANISATION: 86%	PENETRATION: 99%	PENETRATION: 99%	PENETRATION: 77%	PENETRATION: 92%

Source: Hootsuite (2018)

Results show that the internet users in UAE spend 7hours and 49 minutes per day on the internet. The average daily time spent using social media is almost 3 hours (figure 4 below).

Figure 4: Time spent with media

TIME SPENT WITH MEDIA: SURVEY-BASED DATA

7H 49M	2H 56M	2H 18M	1H 03M
AVERAGE DAILY TIME SPENT USING THE INTERNET VIA ANY DEVICE	AVERAGE DAILY TIME SPENT USING SOCIAL MEDIA VIA ANY DEVICE	AVERAGE DAILY TV VIEWING TIME	AVERAGE DAILY TIME SPENT LISTENING TO STREAMING MUSIC
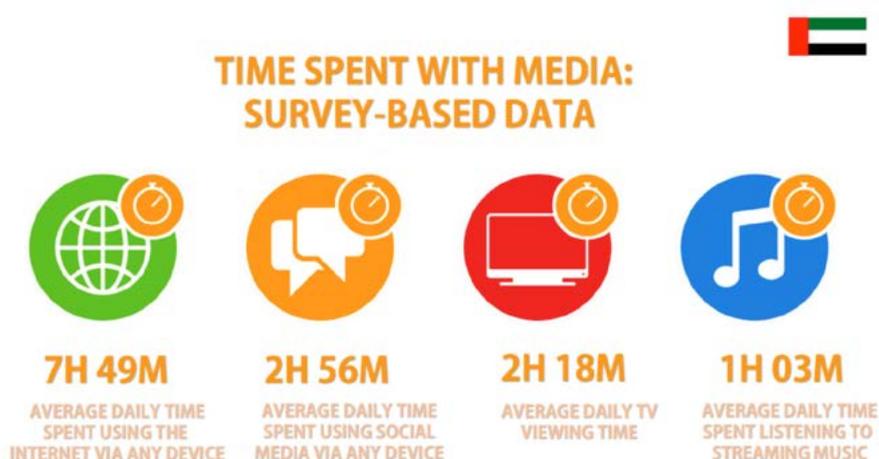
Source: Hootsuite (2018)

Most of the people are optimistic about technology and feel that it offers more chances than risks. In addition, they tend to prefer doing tasks digitally if they can rather than traditionally. Privacy is important to people in UAE, that is why 40% of them deletes cookies for extra protection or use blocking tools to stop spam of unsecured web pages see figures 5 and 7.

Figure 5: Attitudes toward digital in UAE

ATTITUDES TOWARDS DIGITAL IN UAE 2018

76%	72%	80%	40%	34%
BELIEVE THAT NEW TECHNOLOGIES OFFER MORE OPPORTUNITIES THAN RISKS	PREFER TO COMPLETE TASKS DIGITALLY WHENEVER POSSIBLE	BELIEVE DATA PRIVACY AND PROTECTION ARE VERY IMPORTANT	DELETE COOKIES FROM INTERNET BROWSER TO PROTECT PRIVACY	USE AN AD-BLOCKING TOOL TO STOP ADVERTS BEING DISPLAYED

Source: Hootsuite (2018)

Figure 6: Device usage survey-based data

DEVICE USAGE SURVEY-BASED DATA

MOBILE PHONE ANY TYPE	SMARTPHONE	LAPTOP OR DESKTOP COMPUTER	TABLET COMPUTER
99%	96%	71%	28%
TELEVISION ANY TYPE	DEVICE FOR STREAMING INTERNET CONTENT TO TV	E-READER DEVICE	WEARABLE TECH DEVICE
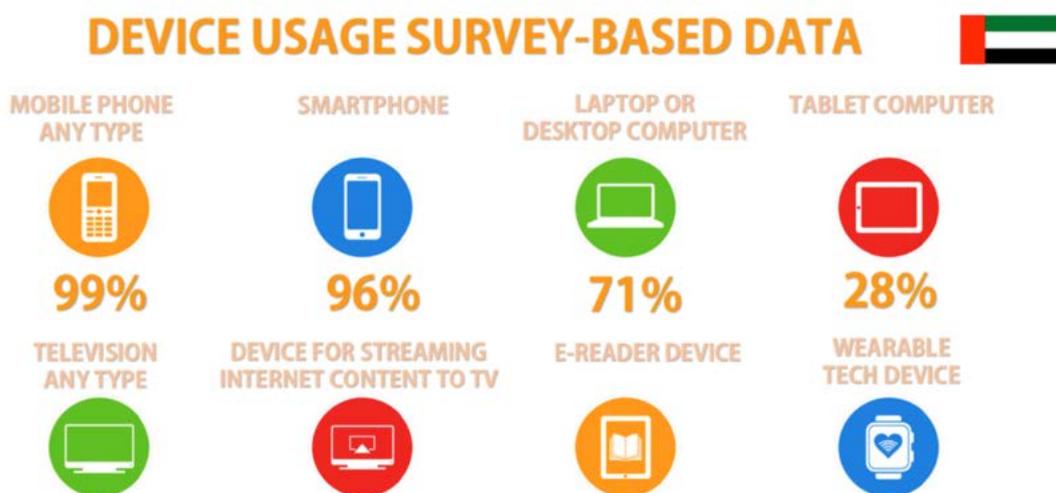
Source: Hootsuite (2018)

Figure 7: Home Automation

Source: PNG download (2018)

1.4 The benefits of Home Automation

There are so many benefits to home automation such as:

- Home automation allows to assign tasks for machines to increase productivity and provide convenience to the user for example: automatically set a timer for rice cooker and washing machine to non-peak hours.

- Increasing security by fixing internet connected surveillance cameras and motion sensors to report any suspicious behavior or any accident.

- Improve security by installing automated door locks.

- Personal identification can provide peace of mind.

- Improving the quality of life when appliances are easy to use and be remotely controlled by a dashboard with simple tabs for example closing all lighting at night from one single place.

- Saving energy by using "Smart Meter" for monitoring consumption rates more efficiently which leads to cost saving.

- Adds thermal comfort and convenience through room temperature controlling.

- It is user friendly specially to people with physical limitations.

1.5 Concerns about Home Automation

The government has an important role in managing and controlling the open big data (cloud computing), it should also preserve the national security by blocking any unwanted access or hacking to cloud storage. In smaller scale, to individuals and especially in UAE, privacy is a sensitive manner/ some of the concerns of Home Automation application are:

- Invading the privacy

- Hacking smart TV or surveillance cameras.

- Encrypted data failure.

- Bad internet connection or lost in connection means that the system is not as reliable.

- Some systems are complex to use.

- Technology is ever changing.

- Programming all devices needs expert fixing and maintenance for better performance.

- Systems are subjected to failure and error with potential lack of accuracy adding to that smart appliances efficiency drops with time.

2. Survey of Home Automation Awareness in UAE

The research is a survey of UAE residents and locals aiming to test the awareness of participant's level in Home Automation, in addition to know if UAE locals and residents are going to take action and adopt Home Automation. The methodology map is explained in figure 8.
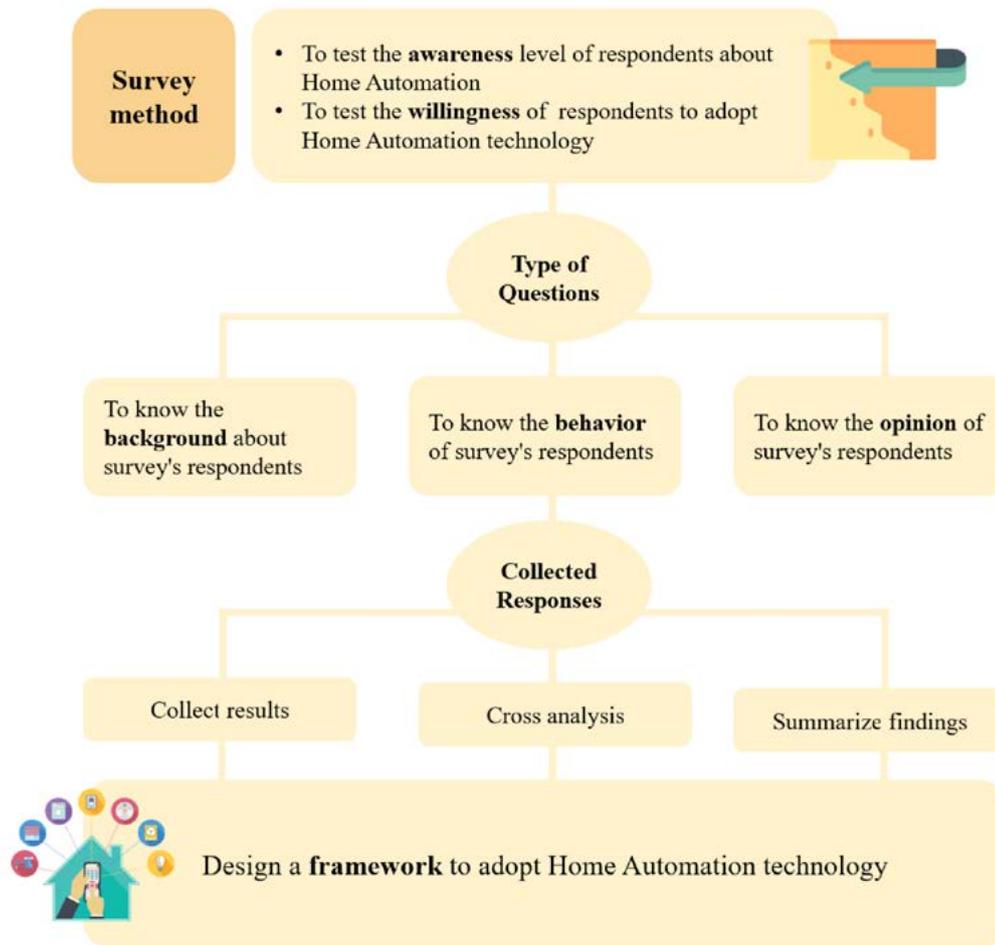
Source: Authors (2018)

It was found that the participants' Households' average monthly electricity bill for locals is around 1,500 AED and the maximum is 3500 AED and the minimum is 200 AED. As for non-locals, energy cost ranged from 200 AED to 3000 AED on electricity. While, water bills cost about on average 600 AED monthly, as shown in the figure below 9.

Figure 9: Electricity and water bills in AED of the survey's respondents

What is the average monthly cost of your electricity consumption bill in AED? (local)

Max. 3500
Min. 200
Average 1438
Standard
Deviation 663

What is the average monthly cost of your electricity consumption bill in AED? (non-local)

Max. 3000
Min. 200
Average 1185
Standard
Deviation 628

What is the average monthly cost of your water consumption bill in AED? (local)

Max. 2000
Min. 100
Average 798
Standard
Deviation 407

What is the average monthly cost of your water consumption bill in AED? (non-local)

Max. 200
Min. 1500
Average 604
Standard
Deviation 330

When it comes to home appliances purchasing, people look for several special features. About 43% of the participants prioritize quality, the second thing that they look is energy efficient appliances which indicates a sense of awareness toward energy conservation and saving the environment as shown in the figure 10.

Figure 10: Home appliances preferred features by survey's respondents
What is the most important thing you are looking for when you buy home appliances?
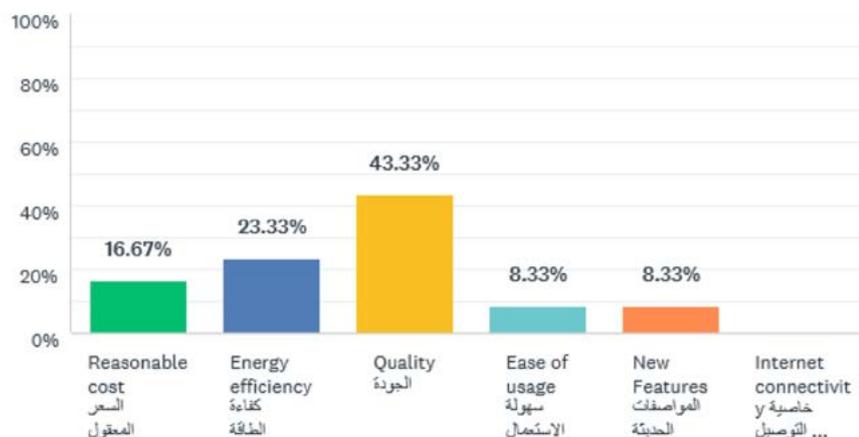
Knowledge about IoT was clearer among the younger respondents with higher education level, the rest were not familiar with the term, as shown in figure 11.

Figure 11:Survey's respondents awarness level about "Internet of Things"
Do you know what "IoT" Internet of thins means?
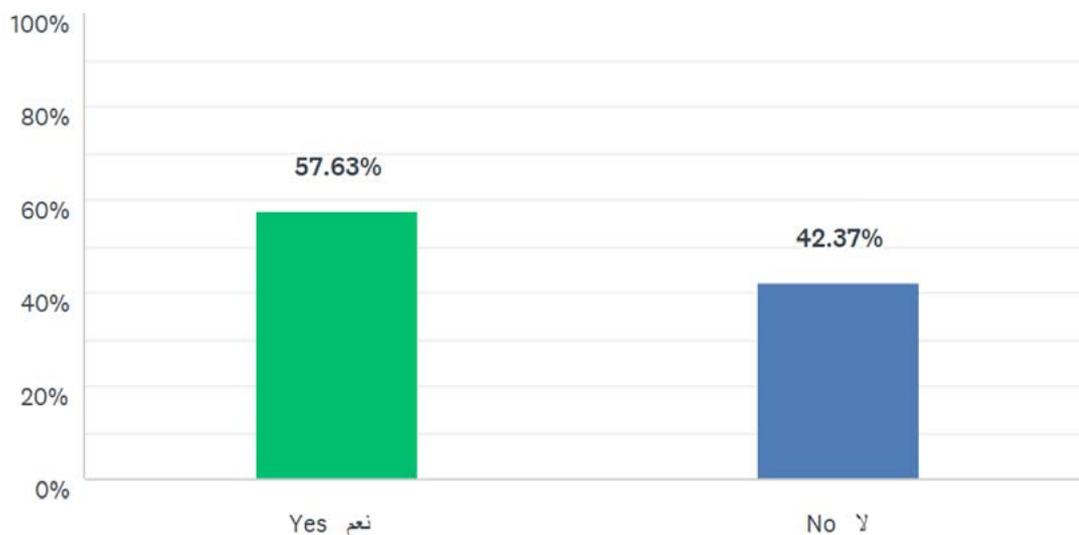
Some of the responses expressed that Internet of Things is a technology that will serve peoples' need, and would like to apply it to their lifestyle, from another perspective they see it as a technology that saves effort, time and money. In addition, they had a concern about safety and confirmed that it should offer anti-hacking protection system, as shown in the figure 12.

Figure 12:Survey's respondents opinion about home automation
Internet of things "IoT", the interconnection via the Internet of computing devices embedded in everyday objects, enabling them to send and receive data. What do you think about it?

When asked about if they are aware of Home Automation system, 68% answered yes as shown in the figure 13.

Figure 13:Survey's respondents awarness level of Home Automation
Are you aware of Home Automation system ?
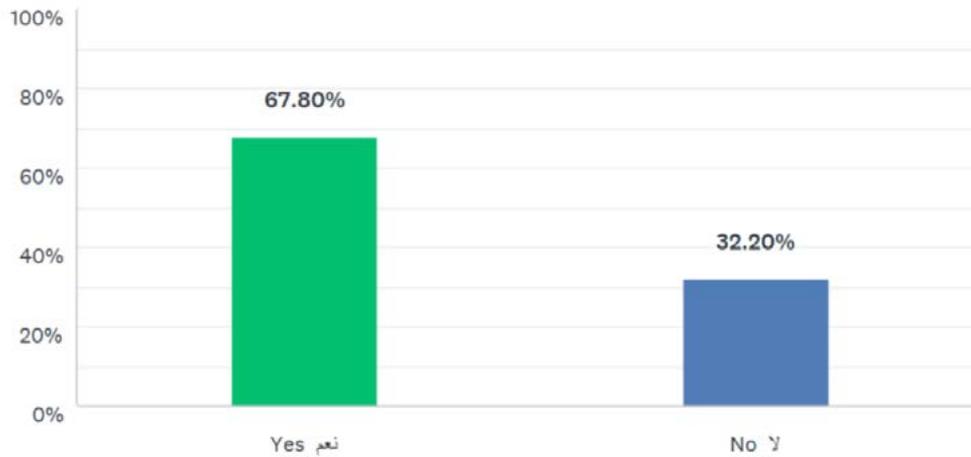
Respondents mostly agreed on shifting their homes into smart automated homes to have the ability to control lighting, heating, ventilation, appliances and other systems as shown in the figure 14.

Figure 14: Survey's respondents interest level to transfer their home into smart automated home
Home Automation may include centralized control of lighting, heating, ventilation, appliances, to provide improved comfort, convenience, energy efficiency and security, would you be interested to shift your home to a smart automated home?
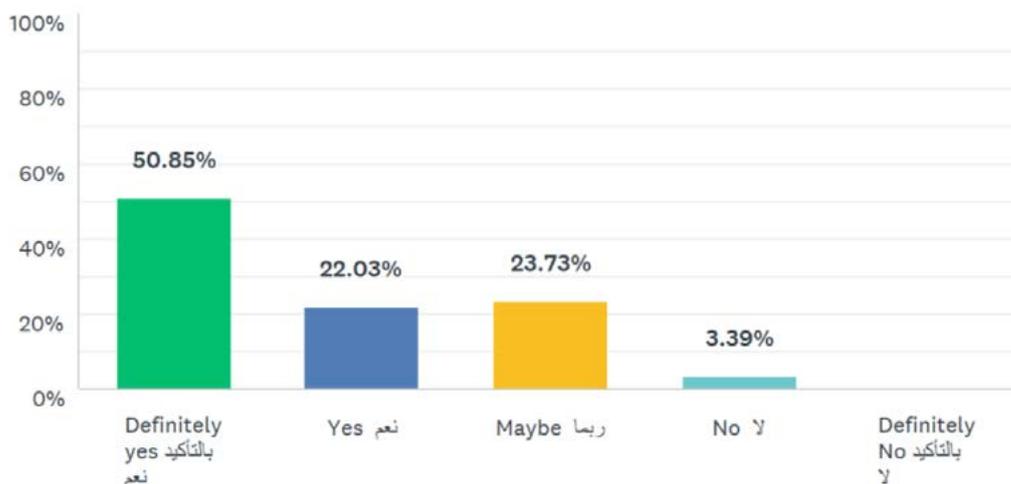
Household are positive to the concept of saving electricity and water through Home Automation system and they are willing to invest in it. The majority 44% are willing to pay around 5000 AED. About 20% are willing to invest 1000-2000 AED. Others will invest more with the range of 5,000-10,000 AED as shown in the figure below 15.

Figure 15: Home Automation pudgect of survey's respondents
How much are you willing to pay for Home automation system?
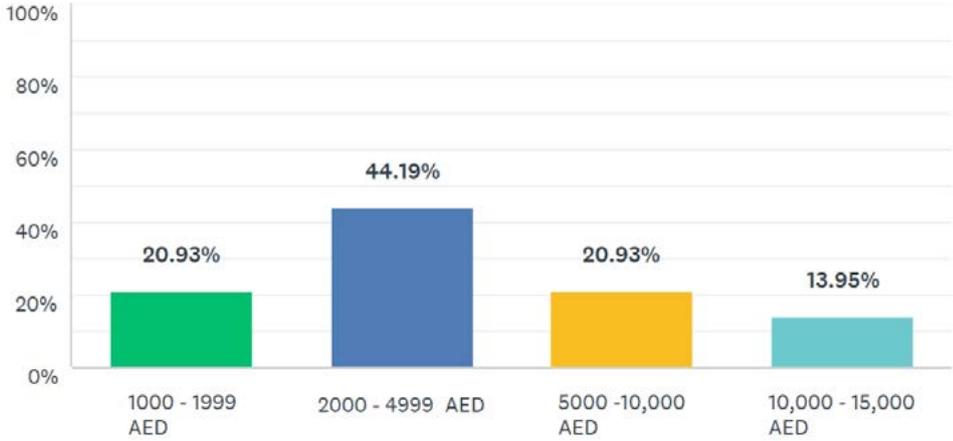
Purchasing smart Home Automation appliances alone is not sufficient to save energy consumption but also the behavior of the occupants should change to double the benefit of the system. In addition, it is important to know the mindset, opinion and general knowledge about energy consumption and the willingness level to transfer their home into automated homes. 48% of the participants are strongly willing to replace their home appliances to more energy efficient types. Approximately 14% neither are willing or unwilling to make that change as shown in the figure 16.

Figure 16: Survey's respondents opninion about replacing their appliances to more effecinet types
Are you willing to replace your appliances to more energy efficient types?
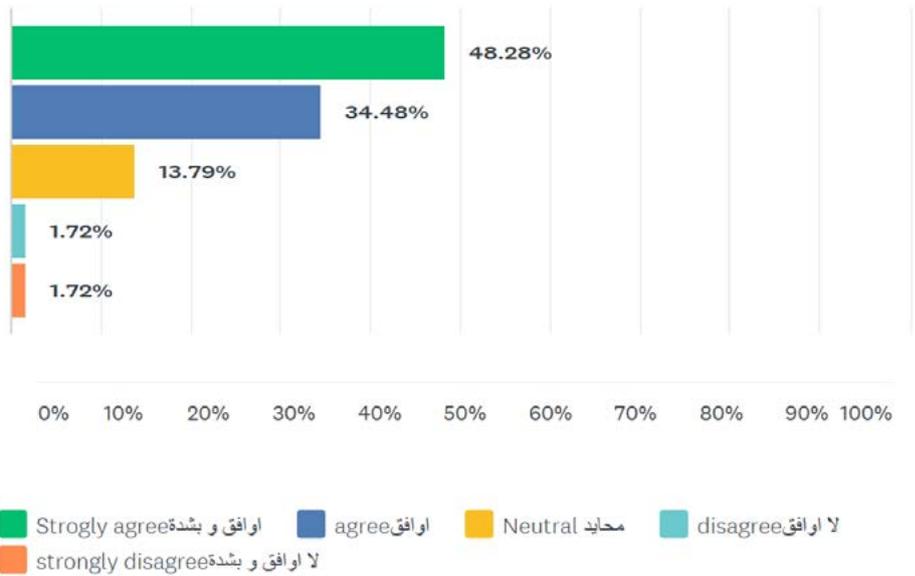
Smart home devices are beneficial in assisting home occupants with their daily life style,

by controlling and monitoring the system, which leads to saving time and effort as well as energy costs. 40% of respondents strongly agree to thinking that using latest smart home devices could help in saving energy and time, as shown in the figure 17.

Figure 17: survey's respondents opninion about using latest smart home devices
Do you think that using latest smart home devices will help you save energy and time?
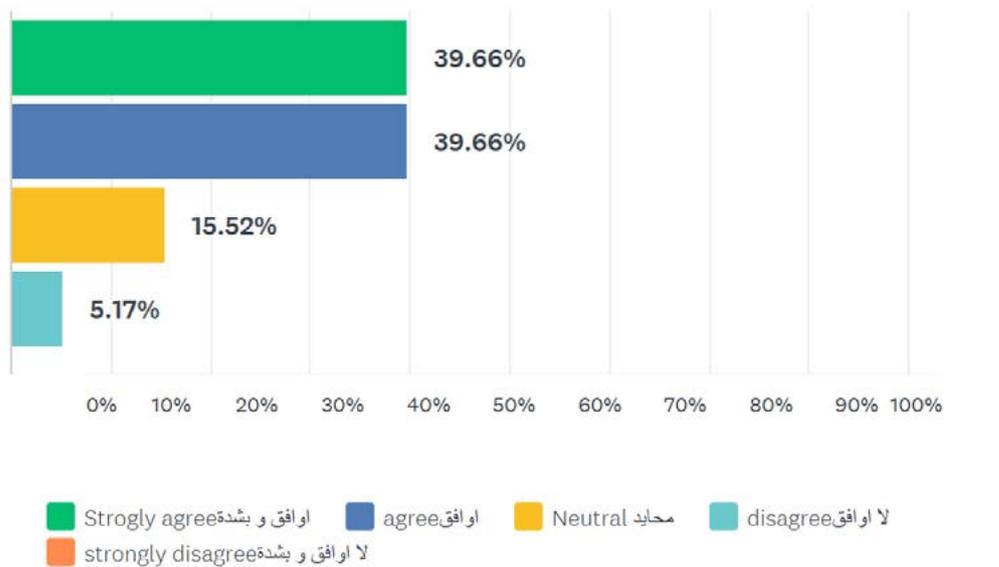
Half of the respondents are interested to have an internet-connected appliances, 27% were not as interested and about 23% did not want to have internet-connected appliances, as shown in the figure 18.

Figure 18: survey's respondents willingness level to buy internet connected appliances
Would you want your appliances to be connected to the internet?
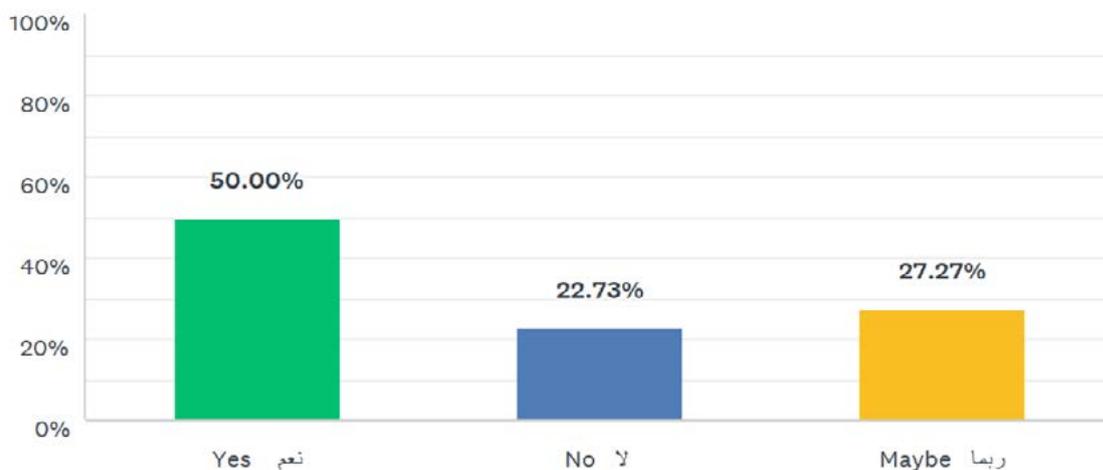
Privacy is a major concern with internet connected devices. Hacking could be made to invade personal and home privacy. So about 24% of the survey's respondents are certain that home automation system could invade their privacy as shown in the figure 19.

Figure 19: Survey's respondents opinion about home automation and privacy
Do you think   Home automation system will invade your privacy?
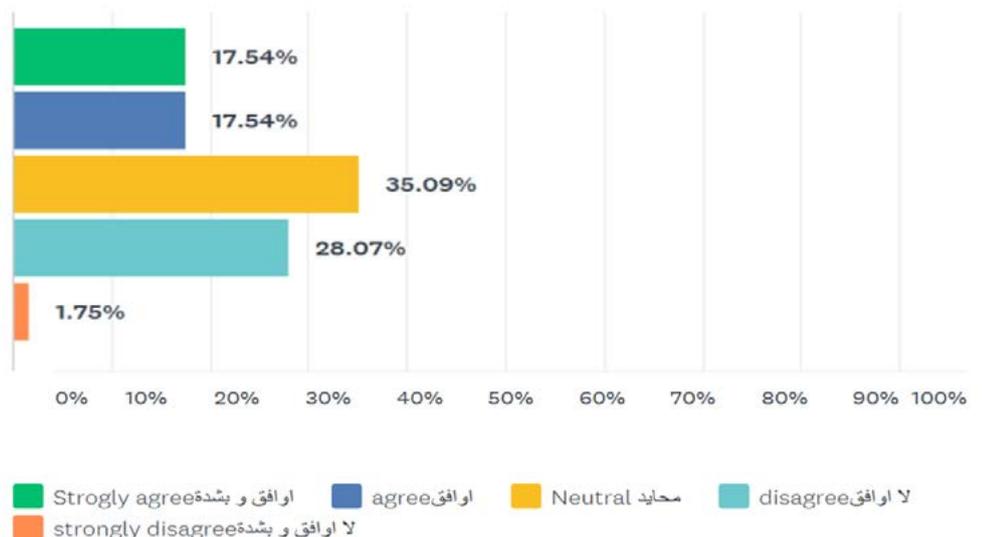
Close to 84% of the survey's respondents are interested in downloading an application to their smart phone or tablet to track home energy consumption as shown in figure 20.

Figure 20: Survey's respondents about using phone application to track energy consumption
Are you willing to download and use smart electricity monitoring application to track your home energy consumption?
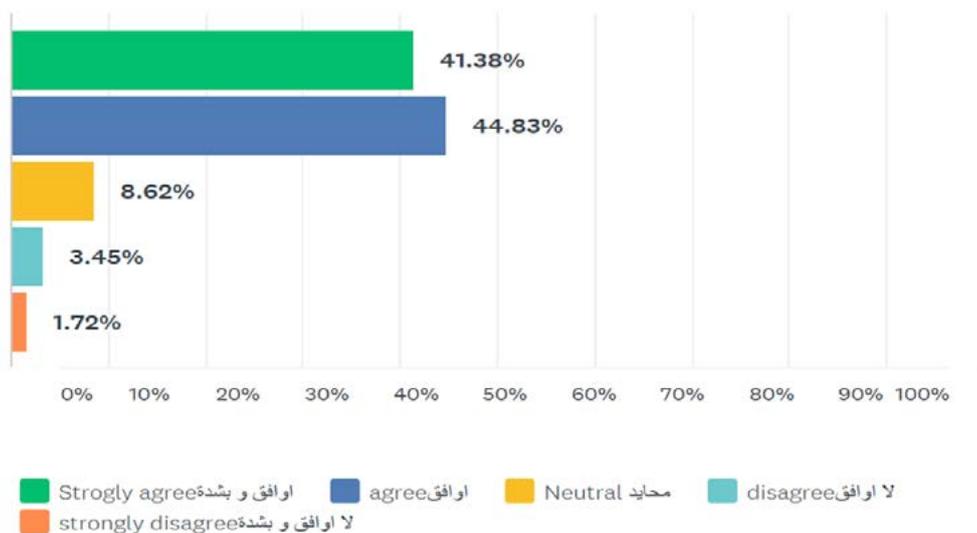
A question was proposed to participants if they will be interested in internet-connected devices to remotely control and analyze energy consumption. 75% of the survey's participants voted for wanting to use internet-connected appliances as shown in the figure 21.

Figure 21: Intrest level of survys respondents about interent connectiviy of appliances
An internet-connected appliance can be controlled remotely, and its energy usage can be analyzed, would you want to use internet-connected appliance?
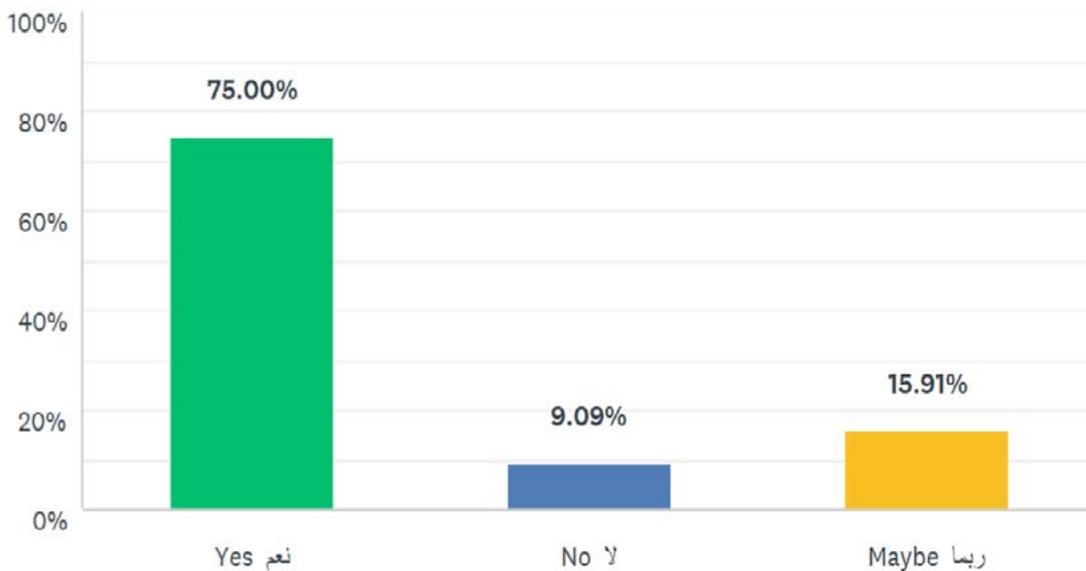
2.1 Survey's Summary and Important Findings

The analysis of the survey's findings revealed couple of points and observations. The respondent is highly educated, also the majority are young bachelor and master degree holders living in two vibrant metropolitan lifestyle cities in Dubai and Sharjah. Those participants showed good knowledge about the importance of conserving energy although some people thought it was the government role to take charge into saving the energy. From the feedback, it is clear that people are aware of the importance of saving energy.

In addition, there were three stages of the awareness level, at first they did not give a priority to purchase appliances with internet connectivity they focused on the quality and no one voted for internet-connectivity feature. Midway through the survey they were asked if they would want their appliances to be connected to the internet and half of the respondents agreed. Finally, after explaining the benefits of connecting appliance to the internet 75% were motivated to use this feature, as shown in the figure below 22.
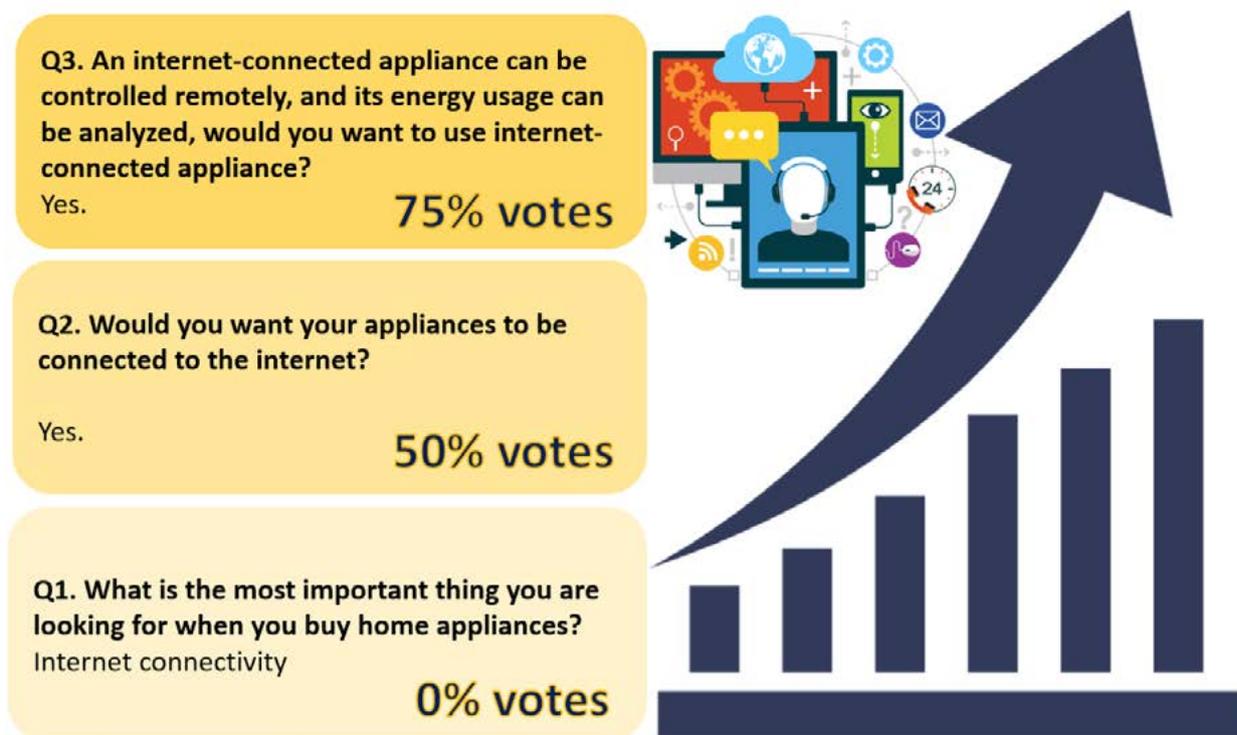
3. Framework design for Home Automation

Based on the survey's findings most of the participants spend 12 hours or less at home and were interested to have a Home Automation system and were willing also to download an application in their smartphones to track and monitor home's energy consumption rates and overall home security even when they are away. Therefore, a suggested user manual will be as a framework designed to help them understand the system better.

Home Automation system is a combination of different components from user interface, to connectivity, to appliances. Any appliances that is plugged to electricity can also be connected to each other and to the internet, which should be constantly working with functional uncorrupted internet speed. The required components consist of Central Management Unit (CMU) which is a combination of an operating system along with database center supported by Artificial Intelligence technology and a well-designed User interface (UI) or a display medium like screen dashboard on computers or tablets or smart phone.

There are mainly two approaches to transfer any home into a smart one, either by whole-home transformation from appliances, water management, lighting, entertainment system,

security system to heating and cooling, or to partly equip certain appliances with sensors or smart power outlets depending on the user's needs.

To assure remote control and real-time follow up to the household consumption rates of water and electricity through relative applications downloaded on mobile phones, the system should be constantly connected to the internet from mobile phones to smart appliances.

To maintain privacy, the system is programmed with personal identification of the family users (mostly parents) to avoid any intruding action or hacking from strangers by either voice or face recognition technology or a passcode known by the user and through the use of encryption technologies.

As for the appliances or home devices, wire or wireless internet connectivity property and a common protocol must be an embedded feature. Plus, it should have a senor and switch control which all shall be compatible with the smart meter to save and operate the data and send it to the cloud so that the occupant can rely on the interactive user-friendly graphical representation to ease the readings from the system even if they are not experts. The system language and notification messages can be programmed and tailored according to the nationality background of end-user.

Other than that, the devices should be reliable, fast which receive and perform commands in few seconds only, and easy to use satisfying the user by performing tasks with high percentage of accuracy, moreover efficient in reducing energy consumption.

According to the International Energy Agency, changing lighting type to LED more efficient lights could save the energy by 10% of the world total electricity consumption, automated lighting also saves about 10% as well, when home appliances are in standby mode having an automated system to switch off unnecessary standby appliances can contribute into 20% saving to the household energy consumption.

So the layers of IoT and Home Automation start with user layer with an application, then a network gateway to where the data transfer from private to public network with Cloud managed by government servers, see figure 23.

Figure 23: IoT Layers
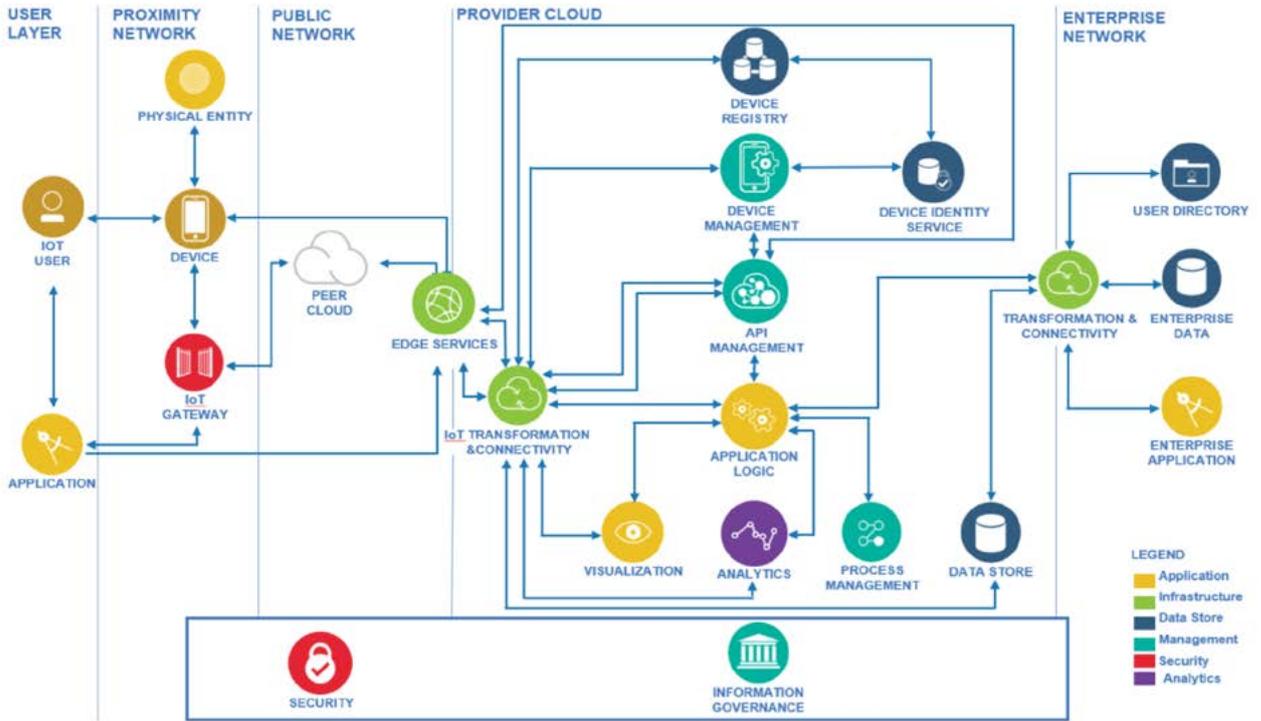
Source: IBM Corporation (2016)

According to the research on Smart Home based on component technologies and Internet of Things (Li & Yu 2011). Using SOA (Service Oriented Architecture) software, which assist with the design on smart home system based on IoT, it helps with realizing changing dynamic. SOA allows for designing family oriented services such as Security, Medical services, Family data services, Entrainment and family business services. As for the network selection from smartphones like 3G or homes network base like Wi-Fi and Blue Tooth, see figure number 24.

Figure 24 : The Architecture of SH Application based on IoT and Component Technologies
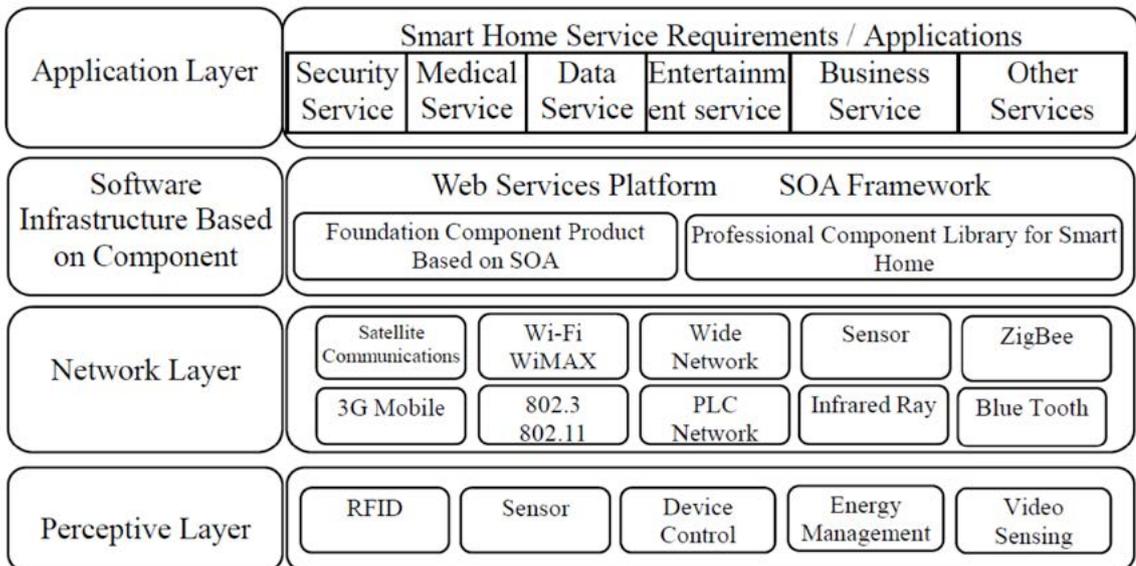
Source: Li & Yu (2011)

3.1 Summary

Positive responses about adopting Home Automation indicates that even if respondents are not fully aware of the system they accept to give it a chance as shown in Figure 25.

Figure 25:Research Summary
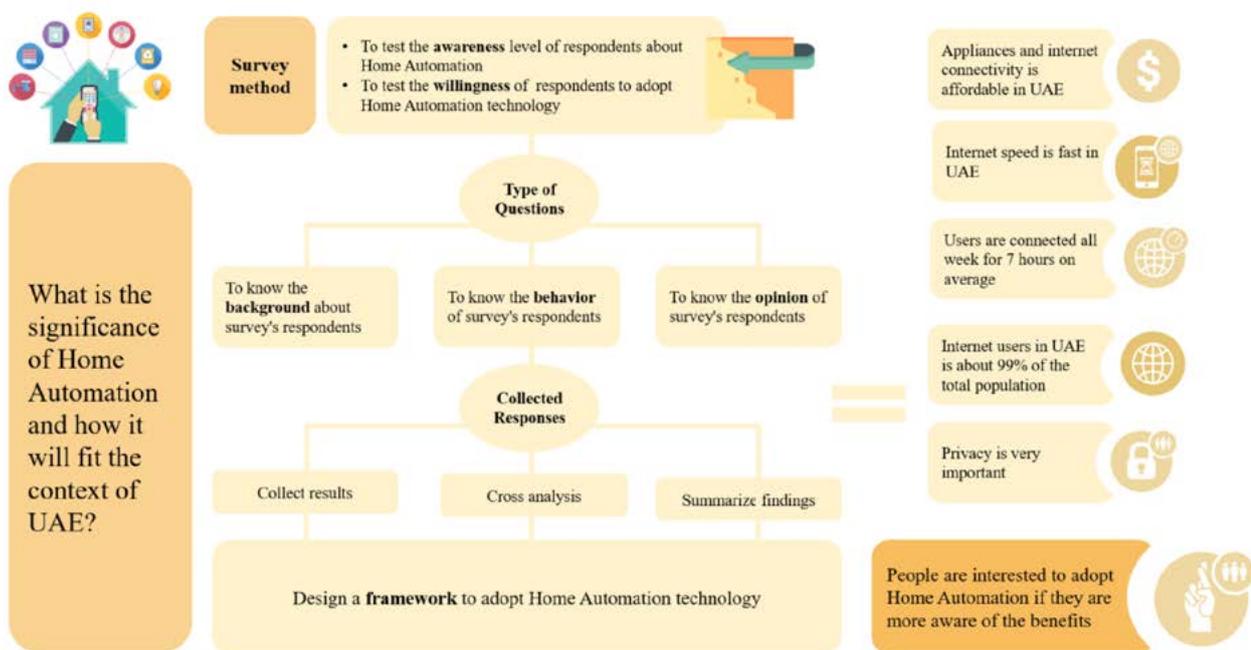
Source: Authors (2018)

3.2 Recommendations for Future Work

Before we rush into integrating Home Automation to our life, we should understand that it is a network of effort from government to sectors to individuals so some of the recommendation to effectively use Home Automation are:

- Involve the local government to work on set of initiatives and particularly secure local data as the privacy is and always is a priority.

- Build a local centralized cloud data storage which is monitored locally to raise the trust level of residents of UAE toward data management.

- Create a special hub as a research lab dedicated for Home Automation technology to work with the targeted sectors like housing programs and provide consultation to design the system for homes.

- Attract and train national talents for jobs based on AI, IoT and Home Automation in the future.

- Improving the skills of graduates in the fields of science, technology, engineering and mathematics is the quickest solution that can be applied in the short term to increase the number of experts in the field.

- Encouraging and supporting government and private sector to adopt and invest in new technologies to be used not only to housing projects but also to offices to support growth.

- Encouraging individuals and users to use smart technology to improve the lives of individuals and government works.

- Establishing information campaign to promote, demonstrate and explore the possibilities of smart technologies and Home Automation.

- Organise conferences and exhibitions to promote for Home Automation and at the same time raising the awareness through seminars.

4. Conclusion

From the conducted survey it was found out that there is a gap between what people wants in their appliances and truly switiching their current ones to connected devices.

Home Automation technologies have positive results in cost reduction as well as saving time and possibly lives. Home Automation can raise the quality of life. To be realistic, there is always threat or risk of invading the privacy of home ocuppant.

The future city is a smart city which consists of smart infastructure, transportation and smart homes. The ideal situation is to perform many tasks with maximum control, effeciency and security with minimum errors, risks, efforts, time and cost.

This study shows that there is a lack of awarness of Home Automation in UAE. To raise the awarness, people should be familier with the system taking small steps to adopt this technology.

As an implementation strategy, the government should focus on:

1. Establishing a local authority for smart technology.

2. Encouraging the local and federal government and societies to use modern AI technology.

3. List all the related challenges and suggest some tangible solutions.

4. Prepare human resources specialized in this field.

5. Gain experiences for world's best AI companies.

6. Encourage locals under housing program to purchase smart appliances and collaborate with gadgets companies to make discounts and attractive offers for them.

7. Local Telecommunication sector like Etisalat or Du should promote and encourage the adoption of Home Automation technology for example by giving occupants more phone data to use for remote controlling purposes.

8. Local authorities of electricity and water should collaborate in developing a smartphone application for example FEWA (Federal Electricity and Water Authority) can let users follow their home consumption rate.

UAE is a very ambitious country it will invest in great ideas for the benefit and happiness of its residents, so selecting the "right" kind of Home Automation technology that respects the culture and privacy of people is not to be compromised toward smarter homes and smarter UAE.

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Rethinking design: responsible production processes for sustainable consumption in the UAE

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Abstract

Millions of tons of waste are generated annually in the UAE, reflecting the increasing global pattern of consumption and unsustainable productions. This challenge presents an opportunity for governments, academics, and the private sector. For designers, it entails rethinking what we design and how we design it, through responsible choices of materials, and a shift from commercial design to systemic design.

Using a human centered design thinking approach, this paper puts forth a set of interventions aimed to complement existing efforts by the government to reach the Sustainable Development Goals through the production and supply of environmentally friendly consumer goods. We discuss the role of design at several points along the supply chain. These include the input materials, packaging, and promotion of a circular economy through reusable packaging and smart recycling points targeting electronics and technology retail; and the design of new systems for customer flow. These designs and innovations integrate traditional practices inspired by the past with similar consuming opportunities in harmony with today's digital world, such as self-service container filling for multiple consumables, using digital weighing and pricing mechanisms.

Keywords: Circular Economy, SDGs, Design Thinking, sustainable consumption and production

1. Introduction

While the global pattern of consumption and unsustainable production has been studied by scientists worldwide, less is known about sustainable challenges and opportunities in the Gulf region. In the United Arab Emirates alone, millions of tons of waste are generated annually (Al Braiki, 2017). In particular, plastic waste and microbeads resulting from the washing of fabric containing polymer fibers are severely affecting the flora and fauna, and the damages to marine life have been observed by the Abu Dhabi Marine Conservation Group (Todorova, 2017). In Dubai, waste production is expected to be ten times greater by 2020 than it was in 2013, according to Alradhi in an interview with Tesorero (2018), that it will quickly require more landfill space and ultimately reach saturation. This challenge presents an opportunity for governments, academics, and the private sector. For designers, it entails rethinking the design process, through responsible choices of materials, and a shift from commercial design to service design, experiential design, and systemic design.

This paper puts forth a set of design interventions aimed to complement existing efforts by the government to reach the sustainable development goals, with a focus on the reduction of domestic municipal waste. Using a human centered design thinking approach, we leverage these existing initiatives to multiply their effect through the production and supply of environmentally friendly consumer goods.

We discuss the role of design at several potential levers of change in the consumer goods life cycle. These include the input materials, such as sourcing and utilizing linen- cotton- and silk- based clothing as an alternative to polyester; packaging, such as utilizing smart packages which can either be reused in a circular economy or disintegrate naturally producing zero landfill waste; promotion of a circular economy and smart recycling points targeting technology retail; and the design of new systems for customer flow, including reusable bags and containers, return service for packaging, and other ancillary components of the consumer experience such as dining.

2. Existing Sustainable Actions in the UAE

2.1 Government and institutions

For decades, the protection of the natural environment has been part of the national dialogue, as reflected by its integration into the Abu Dhabi Vision 2030 (EAD). New government bodies, environmental protection laws and policies, cultivation programs, natural preservations, and renewable energy initiatives have been created to respond to the requirement of a sustainable country (UAE State of Green Economy Report 2017 and 2018, and UAE Government Portal). As an example, since 1977, the Abu Dhabi Compost Plant has supported local agriculture as well as provided the country with an effective way of utilizing organic waste. In 2011, the Dubai Health Authority (DHA) launched the 'Clean your Cabinet' campaign on medication

collection from citizens to distribute unused medicines to charities, and to discard expired medication in a non-hazardous manner. In 2016, the Ecological footprint in the UAE is still one of the highest in the world, but measures are being taken to reduce it. As an example, the rate of waste recovery was 22.6% in 2016, but is targeted to reach 75% in 2021 (UAE State of Green Economy Report 2017, pp. 76-79).

2.2 Commercial outlets and products

Early attempts at reducing waste have begun to emerge. Amruta Kshemkalyani, founder of the 'Sustainability Tribe', shares practical information on where to find package-free foods and eco-friendly products in the UAE. A number of supermarkets across the country sell package-free grains, pulses, nuts, and spices, and customers could bring their own containers for hot food, salads, juices, and dairy products. Some supermarkets such as Waitrose started to charge for plastic bags and as such, encourage customers to bring their own reusable bags. Some fashion outlets give reusable bags instead of disposable ones.

2.3 Services

Services have also started to form to provide support for waste reduction in the private sector. The Dropit initiative, launched in 2016, brings awareness to the dangers of single-use plastic in the UAE and the benefits of switching from bottled water to filtered water. Companies that install domestic water filters, provide repair services for home appliances, or assist in the safe disposal of old electronics support the mission as well.

2.4 Communities

Masdar city in Abu Dhabi and the Sustainable City in Dubai are examples of initiatives taken to promote sustainable community living. In the hospitality sector, new hotels are attempting to build sustainable communities, such as the plan put forth by Jumeirah hotel in Saadiyat to be plastic bottle and straw free when it opens (Maceda, 2018). In universities, the sustainable campus initiative has put together guidelines, manuals, and initiatives to encourage and support sustainability on UAE campuses.

2.5 Sustainable design efforts

The design sector is also beginning to see sustainability initiatives emerging. Al Ghadeer empowers local craftswomen to produce high-quality handmade traditional products and

gift items using sustainable materials such as khous (handwoven palm leaves), telli (hand-braided metallic and silk threads), sadu (handwoven wool), and clay pottery. In the printing industry, Print Central utilizes 100% recycled paper, plantable seed paper, with eco-friendly vegetable based ink and chemical-free plates.

In short, citizens of the UAE have witnessed an increased awareness on the impact of abundant waste on the environment, with several initiatives that aim at raising awareness on sustainability. However, awareness does not seem to be enough to change producers' and consumers' largely unsustainable practices.

3. Challenges to some of the Existing Sustainable Actions in the UAE

In spite of the positive initiatives stated above, several challenges remain. In Abu Dhabi, similarly to the other Emirates, the general waste is expected to further increase due to population growth and a rapid economic development that is not paralleled by an increase of waste treatment infrastructure (Al Braiki et al, 2017).

Residents of the Emirates do not know how to or have difficulties composting waste, especially apartments dwellers with no outdoor space. A convenient solution has yet to be developed to avoid organic waste going to the landfill when it can be utilized for soil nourishment.

The DHA pharmacy initiative, mentioned above, has yet to be applied to all emirates. The majority of the population discards hazardous material (such as medications, cosmetics, batteries and electronic waste) with the rest of their trash, mostly for lack of awareness on their harmful effects, but also for the lack of knowledge of appropriate places to discard them. Similarly, the practice of recycling old electronics is not vastly promoted, however, measures are being taken to overcome this problem with the recent establishment of the first recyclable collection station in Abu Dhabi that collects e-waste and other materials (Ahmad, Gulf News, 2018).

While plastic bags can be replaced with reusable bags, an increasing mass of fruits and vegetables is wrapped with plastic at supermarkets. An abundance of plastic toys and gadgets turn quickly into post-consumer waste. Similarly, to the majority of sportswear and daily wear, most abayas are made from polyester and spread microbeads when washed, severely affecting marine life. Delivery and take-away foods present an additional challenge with disposable packages and cutlery.

In addition to the highly frequent use of plastic at supermarkets and stores, weight labeling and receipt printing add to the paper waste; digital receipts have yet to be widely adopted. Many schools still use an abundance of notebooks that are discarded even when they are still half full. Eco-friendly paper and ink are more expensive, making it difficult for designers

to convince clients to utilize them for commercial printing with cheaper options available.

In short, given the current design of everyday products and systems in the UAE, taking sustainable actions presents an inconvenience to consumers, along with additional costs and time burden. This invites the opportunity for designers to create new products and systems that facilitate sustainable consumerism in the local and regional context.

4. Design Opportunities for a circular economy in the UAE

We put forth a set of considerations to be tested for the purpose of supporting waste reduction and sustainability efforts in the UAE.

4.1 Education on Sustainability

With every decision impacting the planet, school education can contribute by introducing aspects of sustainability for various ages in a thorough manner. Social or digital games can be effective design responses, as children are more likely to respond to them than to a textbook or manual. The games could educate children and teenagers on the negative effects of single- use plastic and encourage them to reuse paper, cloth, or glass-based materials, as well as to use second-hand books at school and to reuse bags, uniforms and materials from the previous year. In art and design classes, saaf baskets workshops and the re-use of safe waste in the creation of projects would act simultaneously as awareness vehicles and as waste reduction activities while fostering creativity. As for adult citizens, living sustainably would mean adapting to lifestyle changes. The design of an instructional easy-to-use app or home-kit distributed across the country could be suitable for educating the consumer on sustainable consumption venues (with live maps) or possible actions for waste reduction. In developing these educational materials, a critical consideration is that sustainability must go hand in hand with production and consumption; it must be mainstream, not simply an alternative.

4.2 Sustainable production

When creating a product, a particular attention must be placed on the choices of substances and materials utilized while aiming for positive environmental effects, suggest Braungart and McDonough (2002). This can be applied to all design fields but with different applications. For fabric, Khairat (2011) discusses fabric embellishment techniques that enhance the product's recyclability and suggests a central recycling facility of plastic bottles from the GCC to create abayas from the recycled material. The issue remains however that when these fabrics are washed, microbeads are spread into marine environments. Another alternative would be to

utilize traditional materials at different price ranges as an alternative to the contemporary polyester-based abayas. For shoes, bags and other, Al Khaznah tannery produces camel leathers that are "tanned using the most advanced environmental friendly technologies, guaranteed metal-free, sustainable and biodegradable". As materials and processes must be carefully considered, establishing a local facility for paper manufacturing from either utilizing old cotton rags that can be collected from recyclable collection stations, or from other residue fibers such as oil palm leaf fiber as formulated by Kassim et al (2016) present one option for consideration, pending studies evaluating feasibility and environmental impact. With the current means of production, the only way to ensure more printing is being done sustainably is to impose high taxation fees on unsustainable printing to oblige all printing companies to find more sustainable means of production.

4.3 Responsible consumption

Placing smart packages on the shelf, ones that can either be reused in a circular economy or can disintegrate naturally (such as those offered by the Swedish design studio Tomorrow Machine), should be part of the social corporate responsibility of every manufacturer. Carton egg crates can be standardized in two sizes (for chicken eggs and for quail eggs), 'borrowed' by the consumer who would take it back to the supermarket on subsequent visits for the company to refill it and place it back on the shelf. The same goes for shoeboxes, which could be borrowed from the store and then returned for the next purchase for a small refundable fee.

Perhaps the largest opportunity to stop plastic bottle waste would be to replace the industry altogether by putting in place a highly regulated and more affordable drinking water filtration system, with a digital automatic water tester at all residences and public spaces to ensure drinking water is clean at all times. Glass bottles could still be on the shelves, however, a return policy can be put in place to buy these bottles at a cheaper price when they are returned to the production company, to be reused. This procedure would ensure minimal waste except in the rare instances of the bottles breaking. A short term opportunity is for substituting plastic containers of cow and camel milk with carton, as done by Al Ain Dairy Farms. For the long term, milk vending machines can be considered as "short food supply chains can generate positive economic, environmental and social effects" (Pereira et al, 2018). Ideally large containers working like a vending machine based on volume could replace current dairy shelves at supermarkets. Alternatively, a delivery system to residences using stainless steel containers – as was done in the past – labeled for each user and refilled on a regular basis, could be attempted and would drastically reduce the number of plastic bottles wasted annually. The use of plastic wrapping at supermarkets can be discouraged by imposing a fee on nylon wrapping and replacing it with reusable linen bags which customers could either buy or bring their own. For all types of dry, cold, and hot foods, at supermarkets or takeaway from food outlets, customers could be encouraged to bring their own reusable containers and cutlery by assigning an additional fee for single-use

food and drink containers. This approach leads to design opportunities of different types of reusable containers made from appropriate safe and durable materials such as stainless steel, for multiple uses. Moreover, single-use batteries could easily be replaced with reusable batteries that come in a charging box with digital indicators, such as the battery chargers sold at Ikea. More and more resources on zero waste lifestyles are available, such as Bea Johnson's 5R's, that can be adopted by individuals, however, would have greater impact if adopted by governments and applied directly onto retailers.

4.4 Upcycling

First, a 'fix it rather than throw it' ideology should be encouraged, but the only way of doing so is by providing maintenance services for electronics and appliances at an affordable cost, lower than the price of a newer item. Second, in addition to state-of-the-art recycling facilities, the promotion of a circular economy can be achieved through the reuse of various materials, as in the following examples: Turning cardboard from used packages into sketchbooks, transforming used paper from sketchbooks and notebooks into origami or paper structures, utilizing the backside of posters or banners for children to paint on, remolding glass or fabric containers into art pieces or sculptures, transforming leftover fabric from factories into innovative designs, or even testing ink removal for paper reuse using the sun's abundant energy. As Damian Carrington said about plastic: "we rely on it too much and value it too little. The real problem is not plastic, it's us. We need not reject the wonder material, but should regain our sense of wonder, learning to treat it as a treasure instead of trash" (p. 22). The same applies to all other materials that the earth has generously provided us with.

5. The Role of Graphic Design in a Changing Landscape

5.1 Graphic Design Education

Globally, higher education curricula in graphic design have been introducing students to sustainability in varying degrees through research and hands on projects. Eric Benson and Peter Fine (2011) suggest an 'eco-modernist' design education that puts a greater focus on design theory, history and contemporary issues, coupled with expertise in materials and processes of design and their impacts. Luciana Nunes and Claudia Mont'Alvao (2019) further discuss the potential of sustainable interaction design, connecting usability and the user experience within the context of social, economic, and environmental needs. We recommend that sustainable design becomes a more substantial component of the curriculum through the formation of courses or programs on locally sourced eco-friendly materials and on sustainable interaction design, with a greater overall focus on the environmental impact of various design choices.

Below are some examples of how an introduction to sustainability is embedded in courses at Zayed University's College of Arts and Creative Enterprises. In Fall 2016, students in the AGD 451 Graphic Design III course were asked to design an infographic poster on the topic of waste. Each of the 12 students choose a different subtopic: microbeads, air pollution, chemical waste in cosmetics, medical waste, marine dumping, electronic waste (e-waste), cigarettes, paper waste, motor vehicle waste, and zero waste as a lifestyle. Safeya Al Ameri and Jawaher Al Hosani chose respectively the topics of plastic bags and plastic bottles and produced the following infographics.

Following the project, students worked in teams and launched on-campus campaigns: Sustain, Toxic Beauty, Try to Replace It, and Beat the Beads (the latter was led as part of the same course but by a different group of students on the subsequent year). Each campaign started with a mass email to other students and ended with a one-day campus event. Students came up with a diversity of innovative design solutions, as shown below by Mariam AlMansoori, Tasnim AlHosani, Alaa AlSayari, Anood AlMerri and Latifa AlSheraifi for recycling electronics and reusing paper and plastic for Sustain; Fatima Saleh and Nasrah Alawi for the customized cutlery sets in tailored pouches for Try to Replace It; and Mazoon Al Ghafri, Naiemeh Zareie, Noora Al Kathiri, Fatima Al Afeefi for homemade scrubs in glass jars placed in small canvas bags for Beat the Beads.

This Fall 2018, students in the AGD 351 Graphic Design I course were asked to select a topic under the umbrella of 'waste', and to visualize a problem, solution, and outcome. Out of 20 students, 7 chose the topic of plastic (example below by Aliya AlMheiri), 3 chose e-waste (example below by Anood AlSareeri suggesting a separate bin for e-waste), 2 chose oil spills, 2 chose paper waste, 2 chose lifestyle, 1 chose organic waste, 1 chose glass waste, 1 chose cosmetic waste, and 1 chose salt from desalination processes.

In the subsequent project, they were provided with information from various sources on solutions and sustainable practices and asked to design a booklet featuring the entire content. They also had the chance to attend a presentation by the Sustainable Campus Initiative. While students were working on the project, when asked if they made any recent sustainable lifestyle change, 6 out of 18 answered with yes. More specifically, 1 started to bring her own water bottles for refill on campus (compared to 3 who have been utilizing reusable bottles before the project), 4 started utilizing the two sides of the papers (in addition to 8 who have already been implementing this practice), and 2 started taking reusable bags for shopping. None of the students said they have started to buy unpackaged items, however, their mothers are usually the ones doing the grocery shopping. On the other hand, 7 students had water filters already installed at home, and 8 had reduced their use of cosmetics prior to starting this project due to skin sensitivity. One recently refrained from

throwing batteries and e-waste in the trash, and 4 recently started reading clothes labels. Finally, when asked about whether they perform any other sustainable practice, one said she reuses boxes to store other items than the ones originally made for, inspired by her father, and another said she re-utilizes different waste material to create art project with her children (as does her brother).

Table 1: The numbers of students performing sustainable consumption practices prior to and during the 'awareness on waste' project in AGD351

Do you perform any of the following actions?	Yes	No	Since when?	
			a while ago	Recently
Bring your own reusable water bottles for refill on campus	4	4	3	1
Utilize the two sides of the papers	2	6	8	4
Carry reusable bags to the market or to the store when shopping	3	4	1	2
Buy some unpackaged items	1	17	1	0
Refrain from throwing batteries and e-waste in the trash	5	3	4	1
Read labels on clothing to check if they contain polymer fiber	5	3	1	4
Have a water filter installed at home	7	11	7	0
Reduced your use of cosmetics	8	10	8	0

While the above awareness initiatives had some influence, a more structured approach and inclusion in curricula starting with advanced training of design educators on sustainable design would be expected to yield a greater long-term impact.

5.2 Systems thinking

"Without responsibility, talent is too easily wasted on waste", say Heller and Vienne (2003) who urge designers to commit to social, professional and artistic responsibility. It is time, echoes Berman in 2008, to commit to three actions: being true to the profession, being true to oneself, and spending at least ten percent of one's professional time helping repair the world. The same is even more applicable today with a greater focus on an ethical design cycle, the growth of social design and the close ties of design with production processes and consumption patterns (Fine, 2016). Game-changing equitable solutions that empower people and redefine happiness can greatly contribute to reducing waste and improving communities and the environment worldwide (Leonard and Sachs, 2013). New systems for customer flow are imperative for positive change, with innovative approaches put in place such as return services for packaging, which mimic nature's regeneration processes.

5.3 Past, present and future

Many sustainable designs and innovations are inspired by nature, and integrate our modern society with traditional practices. Upon its opening, the Zayed National Museum will showcase the history of the people of the UAE and their practices. The historical artifacts and traditions would provide valuable information to guide future sustainable practices. Recently, in the AGD 452 Packaging Design course at Zayed University, David Howarth advised his students to consider local materials, in forms that could be repurposed or reused. For the project, Mariam Al Beshr utilized local palm leaves with sadu and khous for a modern packaging of dates, Maha Al Hosani utilized reusable glass bottles closed with cork and placed in a wooden six-pack for Karak drink, and Nouf Al Mazrouei packaged maamoul pastry in a compact cardboard package that could also be used as a serving tray and then closed to ensure freshness. The miswak is a biodegradable traditional Arabic toothbrush and toothpaste in one, but the issue is that most of it comes wrapped in plastic packaging. This creates an opportunity for new types of packaging, if any packaging at all.

In today's digital world, digital labeling and a digital record of receipts becomes a must to avoid the large amount of paper waste that can be avoided. Several companies offer this service, but the importance would be for the country to utilize a standard format across all outlets, starting with large companies that would have more impact, and eventually covering the entire scope of stores if successful.

Traditional materials can be combined with digital technologies to reduce waste and improve efficiency. The potential of biodegradable computer chips, mixed with local materials such as palm stem can result in reusable packages with digital indicators where the information on the content can be updated each time the product is replaced with a new one. Benson and Perullo (2017) cite Gavin Munro's work –planting trees that transform naturally into chairs– and suggest seeking equivalent concepts for graphic design practice to 'renourish' the earth.

6. Conclusion

Awareness of ecological issues and sustainable practices certainly has an impact, however change needs to happen across the regulatory and supply chain from government to factories and retailers, in order to create enough impact on consumer behavioral changes. For design, this translates with de-cluttering, and a larger focus on services and experiences, and considering the use of reusable and returnable packaging for products. Innovations in design education worldwide have illustrated the potential for designers to play a leading role in influencing manufacturing, production, and consumption patterns. In Abu Dhabi and the United Arab Emirates, the field is ripe with opportunities to leverage increasing interest on the part of consumers, to create new means of educating and implementing alternative production and consumption patterns. This paper presents an overview of the opportunities and challenges, to guide and inform further research and testing of the ideas presented.

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Transforming the Board's Thinking to Steward the Future Sustainability Strategy for an Organization: Promoting a Robust and Resilient Future Business

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ABSTRACT

The role of organisations must be to create shareholder value but now equally as critical to generate long term sustainable value over longer periods of time. To attract and retain investment from shareholders, stakeholders today play a much greater role in shaping the future of the business. The impact of employee engagement or employee happiness for example, is a much more significant driver for many organisations in the world today. Likewise, the suppliers/vendors and service providers of raw materials, goods and services for a business within the supply chain have not only greater bargaining powers, but can also set certain expectations that relate to the code of conduct, ethical expectations, social accountability requirements as well as demonstrable enterprise risk management.

This more complex coupling of business supply chains has made it incumbent upon organisations to align their overall long-term sustainability policies and practices with the rest of the supply chain both upstream and downstream of their enterprise. Institutional, private and public funding parties have also in the wake of significant failing corporate governance episodes all over the world, made risk management and governance drive sustainability at the heart of the due diligence processes created to protect from enterprise value erosion and reputational impacts.

The relationship between corporate governance and sustainability is extremely critical for organizations because of the negative impacts including both direct financial effects with immediate losses and the longer term business effects such as shareholder confidence, public distrust, class-action and so on. Today sustainability plays an important role in defining the long-term viability of an organisation.

This paper addresses the key issues that drive the sustainability agenda, in line with the United Nation's Sustainable Development Goals (SDGs), or at least should drive the senior executives and the Board of Directors alike. It addresses the key links also between social accountability, financial stability and environmental stewardship. It also addresses these

aspects from the wider sustainability debate which come about with the transformation from economic value maximization and shareholder value maximization theory to the stakeholder theory.

It concludes with a discussion on the direction in which boards and executive leadership of the future shall need to in the wider global context in general move and gives seven separate recommendations to the policy-makers. The change shall come with a renewed look of leadership towards stewardship, rather than compliance to regulations and even codes of best (and corporate governance) practice.

1. Introduction

The creation of shareholder/stakeholder value must be the primary responsibility of any organisation, regardless of it is a profit-making, not-for-profit or otherwise a non-profit organisation. It is equally as critical and important to generate long term sustainable value over longer periods of time. Organisations must attract and retain investment from shareholders. Organisational or enterprise stakeholders today play a much greater role in shaping the future of the business. Employee engagement or happiness, for example, is a much more significant driver for many organisations than it was even a decade ago. Likewise, the other stakeholders that may include suppliers (and service providers) of raw materials and goods for a business within the supply chain can be leveraged not only for greater bargaining powers but can also set certain expectations that relate to the code of conduct, ethical expectations, social accountability requirements as well as demonstrable enterprise risk management.

The growing complexity of business supply chains has made it incumbent upon organisations to align their overall long-term sustainability policies and practices with the rest of the supply chain both upstream and downstream of their enterprise. All funding parties have also, in the wake of significant failing corporate governance episodes all over the world, made risk management and governance drive sustainability at the heart of the due diligence processes created to protect from value erosion and reputational impacts.

So, what then should be the role of Boards and Executive Management in ensuring they protect their businesses from such exposures? Surely they must be at least aware, and manage those risks within risk governance frameworks which set those operational boundaries and define the risk appetites.

2. Current Global Realities and Changes

Sustainability has moved from the 1990's after the sustainability agenda focused mainly on environmental matters (i.e. the Rio de Janeiro Conference when the term sustainable development was first used). The focus was on resource preservation, pollution control, waste recycling and managing water scarcity, water and air pollution, and desertification and so on.

Sustainability today focuses on the socio-economic value of an organisation as much as it does on environmental management. The risk of a lack of a more holistic approach to managing the organisation's societal value cannot be underestimated. However, these developments have become too complex for directors and business managers to understand at times.

Globalization has had an impact on many national economies. Traditionally these economies have been centrally controlled, but with a breakdown of economic boundaries have come an increase in power of markets driven by multinationals, technology and changing economic factors. This has led to the need for a more informed leadership within the major industries within the national companies who now look more to move to a multi-national company model, with perhaps, we hope, more engaged and informed boards (Major, 2005).

Major benchmarking studies undertaken in the past 1-2 decades in the O&G sector shows even very large National organizations such as the Abu Dhabi National Oil Company (ADNOC) has seen great development of reform in terms of corporate governance (Booz & Co, 2010). ADNOC has been seeking in the past three years to expand both organically and inorganically globally as much as it has been in even more recent times, looking for Foreign Direct Investments (FDI) in to major projects in the UAE. Their retail operations also moved towards creating a public offering as they moved ADNOC distribution to a listed company. With this comes a transformation in the management approach and board/committee constitution which would involve a greater number of senior independent (expert) directors and advisors.

In 2010 the GCC - Board Directors Institute (GCC-BDI) was established as a not-for-profit organization dedicated to making a positive impact on the economies and societies of the GCC states and region through promotion of professional directorship and raising the level of board effectiveness. The founding members were from both the financial and industrial sector companies as well as professional content partners representing four of the most well-known international business consultancies. Their workshops focus on raising Board Directors' awareness on matters including strategic risk management, legal imperatives for board directors and leadership matters (GCC Board Directors Institute, 2018).

More globally, Carey and Patsalos-Fox (2006), explain that after many serious corporate governance standards have come into effect such as the US based Sarbanes-Oxley Act (SoX) the demand for academics, non-profit organization executives, and retired executives

to be engaged as Board Directors has increased dramatically (Carey and Patsalos-Fox, 2006). The Organization for Economic Co-operation and Development (OECD) in 2012 developed a voluntary standard on Corporate Governance and Process Safety Management (PSM) that focuses on high risk industries (Organization for the Economic Cooperation and Development (OECD), 2012). The document concludes with a model in which leadership is the heart of the model. Progressive companies now seek to fill 30% of Board seats with seasoned professionals and those with some expertise and knowledge in sustainability/CSR.

3. Role of Boards in Attaining Sustainable Development Goals (SDGs)

Boards have a very complex role of being simultaneously entrepreneurial and exercising prudent control; sufficiently knowledgeable about the business whilst standing back from the day-to-day workings in order to retain an objective and long term view; sensitive to the short-term pressures whilst being informed on the longer-term implications; knowledgeable of the local issues whilst maintain clear understanding of the more global matters; and focusing on the financial performance whilst acting responsibly towards all stakeholders (Institution of Directors, 1999).

Thus, care and diligence is expected from all directors who must carry out their functions with reasonable skill as they may be liable if they are negligent and higher standards of performance is required of a director who may possess skills or professional qualifications.

To this end, the boards' knowledge of the UN's 17 Sustainable Development Goals (SDGs) (refer to UNDP, 2018) must be more than adequate. Strategically, boards must understand the global drive towards the transformation which started many decades ago in Rio de Janeiro with sustainable development. At the time, more focused on environmental sustainability, today the SDGs are more encompassing and try to tackle more holistically major matters including poverty, education, gender equality, clean water sanitation, climate action and other socio-environmental related goals. The SDGs have also gartered goals that focus on the sustainable socio-economic growth, clean energy, responsible consumption, cleaner cities, industry innovation and infrastructure and a focused goal on creating and sustaining partnerships for the goals themselves.

Boards and executives must work together firstly to understand the intent and the drivers for the goals, then see what they can collectively as an organisation contribute and this creates a focus for them perhaps on a few goals. The organisations, depending also on their global footprint may select many goals but create a focused set of programs depending on the geographies they work in. For example, if they are working in an emerging economy they focus on industry innovation, focused education and upskilling programs for the local population through knowledge transfer etc. and infrastructure development. In less developed geographies a more rudimentary focus on water sanitation, poverty eradication, education and gender equality programs maybe more important. Even when operating in

developed states within cities where pollution is a problem, a focus on clean energy, climate action and more responsible consumption and production many be more significant for focus.

Figure 1: Sustainable Development Goals (SDGs)

CEO's should be allowed to demonstrate their leadership whilst the board should be able to "interfere" should they feel this is part of the prudent corporate control and strategic realignment (Health & Safety Executive & Institute of Directors, 2008). Whilst many examples may be cited especially when it comes to financial decisions, our focus in this paper relates more on both the operational and non-financial performance of organizations with long term sustainability in mind and with an overarching global framework in the form of the SDGs. Thus, an even balance between short and long term investments, and environmental and social investment projects are all matters for Boards to discuss with the CEO, CFO and the rest of the executive team.

To ensure the long-term viability and sustained value generation, the Board and Executives must position the organisation's future as part of the global positioning and sustainable aspirations. However, the real challenges which exist today is how will these new boards help transform organisations towards sustainability and the support of the global strategic development goals.

4. Transparency and Sustainability Reporting

Sustainability reporting traditionally relates to reporting on the triple bottom line on matters relating to organisational environmental protection, social value development and economic

development. Today there are many different frameworks that organisations can use and leverage in their development in their policies and internal processes. Perhaps one of the most prominent is the Global Reporting Initiative (GRI) Standards which have over the years become more prescriptive and further reinforced with clear guidance. A reflection we believe of the maturing of the global reporting standards and practices.

Voluntary reporting has increased in more recent years as organizations want to present themselves as good corporate citizens and charity must start at home – when protecting their own assets, employees, environs they operate in, and their investments. There is significant literature which addresses the involvement of leadership and company boards in driving initiatives, endorsing the reporting and enhancing transparency within organizations, industry and the public. This is also becoming very important in the rapidly transforming context borne by the new socio-economic realities and in fact the SDG's as organisations align with the national and international agendas of the geographies they operate in.

The inception of the ISO 9001 Quality Management System Standard in the early 1990's followed by the ISO 14001 Environmental Management System (EMS) and OHSAS 18001 Occupational Health & Safety Management System Standards have all brought about change in organizational behaviour towards self-driven compliance. This perhaps reflects the appetite for demonstrable compliance when organisations feel it adds value. These standards created a culture in the industry towards developing standards and conforming to international best practices.

The latest ISO 45001 standard, issued in April 2018, goes beyond many of the previous ISO environmental, quality and OHS standards in that it impinges much of the standard on the leadership and strategy of organisations to fully align their business performance with good OHS matters. In its inherent philosophical grounding, it also is much more performance-based (and risk-based) as opposed to being very prescriptive and standardised. The creation and promulgation of this auditable standard reflects the more advanced maturity stage at which industry finds itself today with respect to greater self-governance and integration of their operating systems with their long-term strategy. It is refreshing to see that the more recent ISO standards have started to place a greater emphasis on leadership commitment towards stewardship.

The "Rewarding Virtue" document recommended 6 areas to reinforce the UK's Combined Code. These included (1) setting of clear values and standards by the leadership; (2) Thinking strategically about CSR; (3) Being constructive about regulation by being self-regulating and supporting the authorities; (4) Aligning performance management systems to encourage rewarding a more longer term out-look/behaviours rather than shorter term and narrow financial targets; (5) Creation of a culture of fairness and integrity in which the tone is set right at the top; and finally (6) Using internal controls to secure responsibility and thus through effective governance systems (Health & Safety Executive, 2006).

Kotler & Lee (2005) explain the shift that has taken place in the past 50-60 years has been from an obligation to a strategy. The links between the profit-making organizations and the more philanthropic ones has matured and emerged to become more symbiotic supporting the greater development of resources such as marketing, technical and employee volunteerism. This meant more personal involvement of the organization's staff with support from their employers rather than just paying into NGO's cash contributions (Kotler & Lee, 2005).

Good companies continue to fail to do what is perceived to be the right thing. They fail to be able to clearly prevent things happening and things or situations deteriorating and Schwatrz and Gibb conclude their book "When good companies do bad things" (Schwatrz & Gibb, 1999) with the reasons why companies fail in Table 1.

Table 1: Reasons for Organisational Failure

Aspect	Underpinning Reasons for Failure
Organisational Culture	They fail to create a culture that tolerates dissent or one in which the planning processes are encouraged to take nonfinancial risks seriously;
Financial Performance	They focus primarily on financial performance;
Positive Employee Engagement	They discourage their employees to thinking about their work as whole people, from using their moral and social intelligence as well as their business intelligence;
Selective Hearing	They focus on people and organizations that think and behave the same way and avoid those who do not agree with them or criticize them.
Lack of a Balance in their Approach	They let their commitments to certain projects and products overwhelm all other considerations and decisions; be they financial, ethical or social etc.
Lack of Effective Stewardship	The senior management consider social issues as those for others to have to worry about as this is not part of their necessary operability and existence.

The notion that such companies do not have a long-term vision in a socio-environmental or socio-economic context and they expose themselves to more bad incidents occurring is evident.

Maclagan (1998) explains that trust in organizations by all its stakeholders including the employees, customers and the public is essential for its longevity and sustainable existence and growth. This has led to the development of audit committees, codes of ethics and CSR-type policies etc. The value of corporate governance goes beyond control; in that it creates an environment of enterprise and best professional practice to extract the long term-value from a commercial enterprise (Bain and Band, 1996).

In 1997 a standard was issued (latest edition 2014) as a guide to companies in addressing worker rights. The SA 8000 Standard which was developed by Social Accountability International based in NY, USA (Social Accountability International, 2017). The standard has had to change to higher standards to address the growing social disparity issues, OHS,

gender equality, pay equality and simply the exploitation of more destitute labour markets. Compliance with such a standard would help with the alignment with the SDGs.

The main foundation of the issues relating to the lack of commitment to sustainability matters even at the higher management level in organisations remains deeply grounded in the lack of proper executive education and development.

With the pressures from regulation and legal compliance in developed countries, the movement of the traditional secondary industry including manufacturing, agriculture, extractive industries even electronics and apparel to poorer geographies where the labour market is available with lesser bargaining powers and weaker environmental regulations/ standards was inevitable. Naturally, this means the focus on the SDGs should be different depending on the company global operational locations.

However, organizations, especially the multinationals, are being blamed more and more for exploitation of both people and the environments and some being subsequently boycotted. Epstein (2008), explains that whilst the Global Compact has helped in shaping human rights expectations of employers it has had its fair share of criticism due to the failing or lack of monitoring, accountability and enforcement. Perhaps this has been overwhelming for organizations who wanted to comply as they understood the importance, but in all fairness, perhaps did not expend enough effort in initiating/inducting (also sometimes called "on-boarding") effectively the leadership teams, starting with the Board of Directors.

Bell and Morse (2008) explain that "Greening the Strategy" is essential for many organizations today. This means things including risk reduction, reducing environmental stresses and in turn the human vulnerability to environmental stress and in fact if not mitigated and controlled at source, risks in general impact greater on the societal and institutional capacity to respond to EHS challenges notwithstanding the ethical need for global stewardship.

As such the creation of a quantitative value in the form of an Environmental Sustainability Index (ESI) was created several years ago. The index is perhaps more subjective although represents itself as an objective figure – its value lies in the awareness it brings about (especially to executives who frequently work with numbers), brings about some specific rationalization of a globally complex issue to digest, and at the very least can help if used effectively to get leadership in organizations to make better informed/aware objective judgments.

Today on various stock exchanges such as the Dow Jones Sustainability Indices "serve as benchmarks for investors who integrate sustainability considerations into their portfolios, and provide an effective engagement platform for companies who want to adopt sustainable best practices". This helps investors make a choice with the long-term investments in to organizations who have a better performing sustainability index. With this level of transparency especially in the listed markets, organization boards will be expected to consider sustainability in their strategy as now it can have a direct impact in long-term investment strategies (Refer to http://www.sustainability-indices.com/about-us/)

Therefore, company leadership must start to think of their sustainability strategy moving forward. Consider for example Hart (2008) who talks of the new "sustainable global economy". He proposes that organizational leadership may consider three stages of implementing a green strategy starting with pollution prevention; followed by product stewardship and looking at product lifecycle impact; and then the investment in cleaner/environmentally sustainable technologies. This commands a longer-term view-point on risks and opportunities, especially for organisations involved in manufacturing and production.

The above is consistent with the growing notion of the shift from "traditional industrialism" to "natural capitalism" as described by Lovins, Lovins, Hunter and Hawken (2007). A real financial value in optimization of resources with available technology improvements and the rising price of both raw materials and waste management/disposal means that Environmental Stewardship goes beyond doing the right thing – it makes business sense.

In a thought provoking publication by Luikenaar and Spinley (2007), sustainability matters in organisations and the issues associated have led to the emergence of a new profession; "Chief Sustainability Officer". Significantly high level issues that organizations must address and the pressures for change are driven by EHS, sustainability and the regulations which put greater organisational vicarious liability. Conversely, there are good incentives to change which include: enhanced brand image/reputation; decreased costs associated to insurance, losses and fines; a greater protection of assets; and increased efficiency in both plant and people.

In conclusion, matters that relate to the organisation demonstrating that they are a sustainable organisation and adding social value by protecting people and the environment and in fact providing for opportunities to improve the standards of living, education, the eradication of poverty and other SDG goals as discussed in this paper. With greater globalisation of business in general around the world, it seems that the standards or better still the expectations for implementation of the programs and initiatives related to the SDGs are becoming a must.

5. The Road Ahead – Recommendations for Policy Makers

In corporate governance, what has been shaping the change in the past decade, shall not be necessarily what shall shape the corporate governance practices in the decade to come. The fact that the world is moving more from an asset based economy to a services-based economy, shall drive a "naturally sustainable" future in some ways where less will be owned by organisations and customers. The change will be driven by other factors such as electronic currencies (Cryptocurrencies), rent-and-use rather than buy-and-own which leads to greater asset redundancy, the changing way we communicate information and the global transparency imperatives etc.

However, this move will also mean that consumerism will demand less in terms of the long-lasting durability of assets. Mobile phones are a simple case-in-point where the average owner of a new phone will change that phone within 12-24 months and upgrade to the next model. This consumerism will have significant stress impacts on resources which are being consumed at a much higher rate with an increased population whose demand for resources continues at a much faster and higher rate than the rate of being able to reuse and recycle resources. This should drive the need for a better managed circular economy.

Recommendation 1: Policy Makers must integrate circular economy as a key tenant in their sustainability policies and create incentives for the same, and perhaps, penalties otherwise in way of levies, taxes etc.

From a resource perspective, food security, energy demand and the need for shelter and safety will remain the basic human needs and these are the fundamental SDGs. The population explosion in the world and the increasing gap of wealth between the rich and poor shall drive many more acute macro-socioeconomic changes. All these matters will shape more the move towards a different model of supply of goods and services to populations and thus the

Recommendation 2: Policy Makers must expect of both the public and private sector organisations to provide clarity in how they have made considerations with respect to a progressive sustainability strategy.

In this post-globalisation era, the major and largest economies are moving towards greater protectionism and protectionist policies. One key factor is the fast-growing populations who have more access to information and will demand greater job, food and energy security. Organisations require to take this into consideration in their design of future strategy and operationalisation.

Recommendation 3: Policy Makers must set their policies in such a way that it makes public and private sector organisations are more resilient and create socio-economic value imperatives to create for better opportunities for society.

But the question will be how will this impact the future boards? Considering the SDGs in which nations such as the UAE and other emerging and fast growing economies, boards will be expected to play a more leading role in shaping the organisations approach towards sustainability. This will only be possible when they are personally aware of how sustainability issues and their organisations long-term growth and development strategies connect. Major factors in the impact on business in the future will be aspects like security matters, retained organisational talent and industry knowledge with aging populations of experienced talent and disruptive technologies.

Directors must understand climate change, SDGs, sustainability indices and all these other associated "semi-technical" aspects, if they are to help demonstrate effective directorship.

Knowledge and awareness is one thing, but being familiar with the connectedness and causal models that connect the environmental, and socio-economic factors together in the industry and the societies the organisations operate in is going to be imperative.

Recommendation 4: Policy Makers should at the very least strongly recommend to listed and non-listed organisations to upskill directors on boards to better understand Sustainability Issues. They may also regulate the engagement of independent directors with sustainability knowledge to support boards in effectively delivering on long-term sustainability in organisations.

This different knowledge and awareness is what will shape the demand for a different board and executive talent bench. More progressive thinking directors will be the source of the change. This can come with the relatively younger generation of executives moving into board positions or otherwise the intensification of training and development of current directors, either way the change in the mind-set of directors as individuals and the collective wisdom of the board as a group must transform to transform organisation to being more long-term looking and to ensure that the value-proposition sustains.

Recommendation 5: Policy Makers must influence Institutes of Directors in the region to develop programs which raise the awareness of directors on SDGs and more generally sustainability issues.

Recommendation 6: Policy Makers should also influence and encourage the "Board Apprenticeship" programs and programs for the development of young independent directors to get them qualified to add value on the regional boards.

Recommendation 7: Policy Makers may encourage the set-up of an independently governed list of registered trained and competent independent directors. This would help organisations access that expertise for their boards and advisory committees.

6. Conclusion

Whilst there shall be a very important role that regulations and best corporate governance codes to evolve to create structured compliance and minimum standards that in turn maintains economic stability; it is not so much the standards that will shape social investment and corporate responsible behaviour as much as it will be the demands of the more aware stakeholders. These stakeholders may feel they are better informed as today the quantum of information out there is massive, but the ability to analyse and make effective decisions may not be as straight-forward as it was in the past. Directors must face a future in which the external pressures and expectations of stakeholders will place as much, if not more, pressure to continually consider reforms as from those from shareholders. With the SDGs being driven at State level, sustainability is becoming an important factor. The balance of

power has been shifting in the past decade from the traditional shareholder commanding with wealth to the stakeholders commanding with expectations.

As such policy makers, must appreciate this and play an active role in helping drive the inertia towards the sustainability agenda in both the public and private sectors.

It is high time that even Board Director development programs and interventions started to transform towards getting executives to understand the SDGs, sustainability, corporate social responsibility and environmental stewardship. It is not even the triple bottom line approach that will prevail, it is integrated reporting rather than the traditional financial investment metrics that will be demanded as shareholders especially of listed organisations expect for their investments – and thus for these shareholders to remain committed, organisations will need to demonstrate long-term commitments to sustainability. The new stakeholders will demand to be better sold on more socially and environmentally responsible products and services that have more holistic societal value which is sustainable, and thus leaders must prove they are stewards of sustainable businesses rather than leaders of organisations.

Finally, it can be argued that even state owned businesses and family businesses shall have to support the nations they operate in with respect to the global compacts and the strategic development goals.

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