The Built Environment's contribution to the progress of the Sustainable Development Goals

Umar, Tariq; Opoku, Alex; Umeokafor, Nnedinma; and Ahmed, Sa'id.

Introduction

There has been continuous effort since the humans started their life on the earth to make the earth a better place to live. The history indicates the humans went through several stage including stone age, bronze age, and iron age before reaching to the current modern lifestyle where life is more facilitated and comfortable (Jørgensen, 1989). This development has however, changed and affected the natural system of the earth, resulting the issues of global warming and climate change (Weart, 2003). The humans have witnessed some greater natural disasters that are viewed as a result of the humans' activities are the earth (Guo, 2010). The main reason for these disasters in many instances was the rise of the earth temperature. There have been many studies and analysis which demonstrate the rise in earth temperature, which is very sharp since 1970, the era also known as third industrial revolution figure 1 (NASA, 2022; Cohen, 2018). These consequences of the human's activities on earth have forced us to think about the negative implications of these development and, how to avoid them or reduce these consequences. The whole idea is this is quite simple. We have one earth to live, and even it is not only us, but also the generation who will be coming after us will only have this earth to live, therefore, we need to protect and use the earth resources wisely, so that it can be remain a better place for the future generation a better place to live. While currently, there are scientific investigation for the settlement on other planets, but this appears to take a significant time, thus the only available option so far is the earth (Arnhof, 2016). While there has been concern about the sustainability of the earth since long, the concept of sustainability was first truly appeared in the Brundtland Commission Report, published in 1987. This report was submitted to the United Nations 42nd General Assembly session. This report truly aimed to warn the countries about the negative environmental impact caused by economic development and globalization. The report further aimed to provide solutions to the problems arising from industrialization, urbanization, and population growth (Brundtland Commission, 1987). The idea of sustainability developed in the early 1980s as reported in the International Geosphere-Biosphere Programme can be defined as "meeting fundamental human needs while preserving the earth natural environment" (IGBP, 1999). Since the earth's population is increasing, it is putting pressure on the earth's resources. According to the World Economic Forum, it is estimated that food production will need to double by 2050 to feed 10 billion people on the earth (WEF, 2018). Today, sustainability has three essential pillars including environmental protection, social development, and economic growth and sustainable development can be defined as a development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Sachs, 2015). This is something which cannot be achieved alone, therefore, collective commitment and efforts are needed, which has been evidenced at global level in the form of Paris Agreement and the United Nations seventeen Sustainable Development Goals (Paris Agreement, 2015; UN SDGs, 2015). In the past there were having the eight Millennium Development Goals (MDGs) – which

range from halving extreme poverty to halting the spread of HIV/AIDS and providing universal primary education (MDGs, 2000). These Millennium Development Goals are now replaced by the seventeen Sustainable Development Goals. The principle of Sustainable Development Goals is very simple. The overall aim is to reduce the negative impacts of human activities on the environment without compromising the socio-economic development. If we look into from the lese of the main pillars of sustainability, then environment sustainability includes biodiversity conversation, efficient land use and physical planning. The social sustainability focus on decent work, quality education, good health, and ensuring the rule of law and human rights. Finally, the economic sustainability involves the reduction of the negative impact of humans' activities on the environment (Opoku, 2022; Mensah, 2019). Hopwood et al. (2005), viewed sustainable development as human-centred where sustainable development allows to balance environment and social dimensions provided that there is a strong commitment to social issues, for instance ensuring good health for all. In other words, the society depends on the environment, while the economy depends on society.

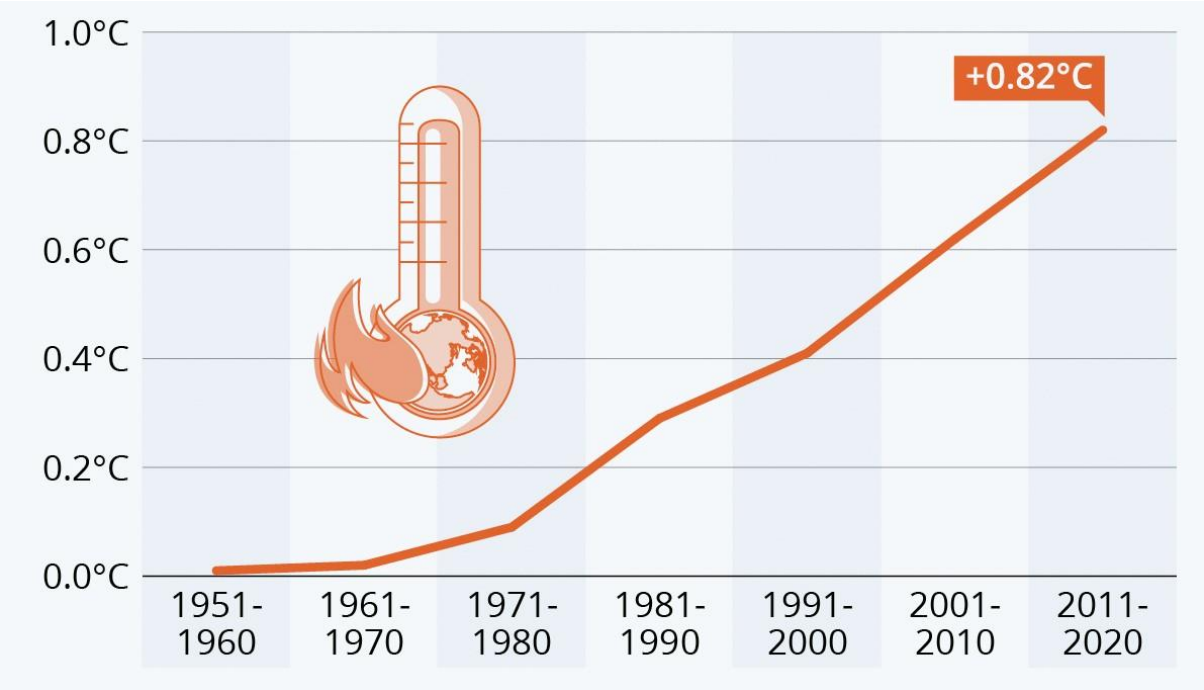


Figure 1. Rise in Earth Temperature Since 1951 – 20220 (WEF, 2021)

At one side, there is a great realization of sustainability and sustainable development, but on the other side there are evidence which demonstrate the world is not meeting its commitment and promises. The earth has more challenges than before, therefore, to transfer the earth to the coming generation in a good liveable condition, all efforts at individual, societal, organizational, governmental, and international levels should be undertaken realizing the key elements of sustainability and sustainable development. If the world the is not progressing the way it should progress towards sustainable development, this mean that the efforts for that are derail at one or another level. Keeping the importance of the sustainable development and the world commitment to make the earth a better place to live, this chapter aim to focus on the contribution of built environment sector, its overall impact on the sustainability, its contribution of sustainable development and finally, how its contribution can be further increased. Generally, the built environment discipline has direct or indirect impact on several aspect of sustainable development, obviously, all of them are not possible to be covered in a

single chapter, therefore, the focus will be on those elements where most of the developing countries have significant challenges towards achievement. The next section shed light on the built environment, its role for the society, its operation, and possible future expansion with a specific reference to developing world.

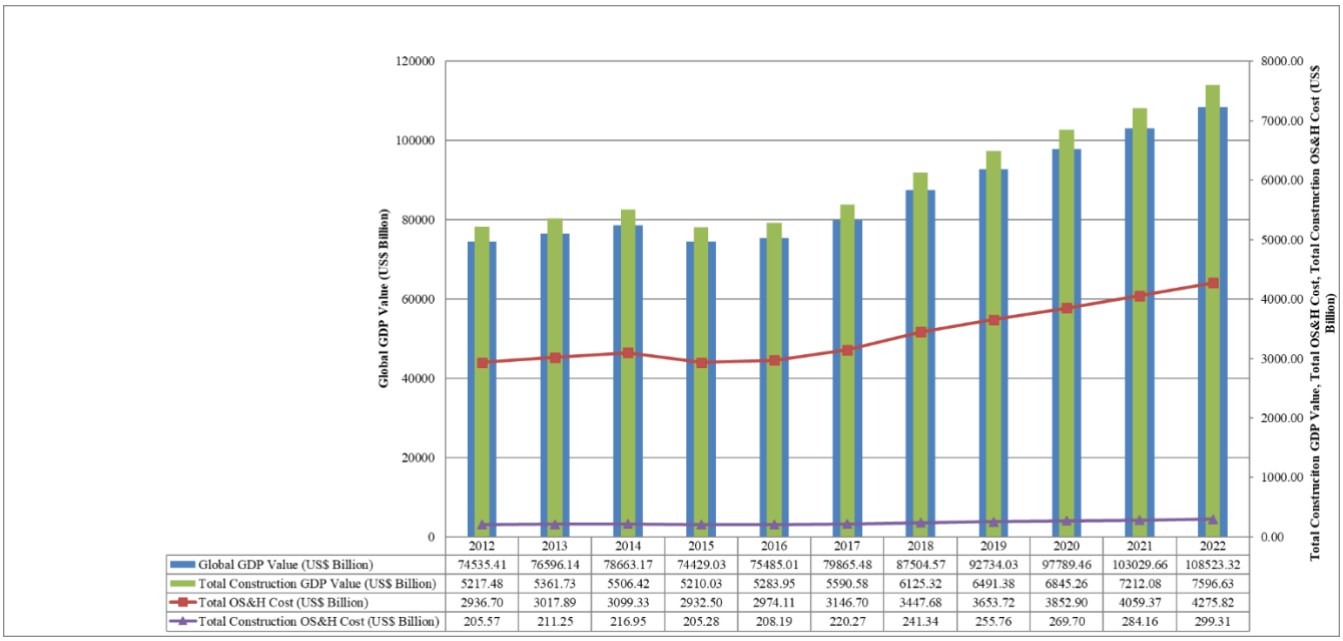
The built environment

The built environment consists of the physical places where we live and work such as homes, buildings, streets, open spaces, and infrastructure etc. and it has a long-term impact on quality of life, prosperity, health, wellbeing and happiness of people and communities in terms of how planning, design, management, and maintenance of the built asset (House of Lords, 2016). Although, the built environment activities such as construction impact negatively on the environment simply because the activities involve to change the natural environment to build environment. As the earth population is going to reach to 9.7 billion by 2050, with approximately 70% living is cities, which will result in 80% rise in energy use with 3.9 billion people facing water-insecurity (United Nations, 2019; OECD, 2012; Guppy and Anderson, 2017). There has been reduction in the built environment activities in 2020 due COVID pandemic, but the statistics indicates that this sector still generated almost 50% of the annual global emissions, where building operation is responsible for 27% and the building materials and construction take a share of 20% annually. Only three materials that include steel, concrete and aluminium which are used extensively in the built environment activities are alone responsible for 23% of the global annual emissions. These emissions are expected to be increased significantly as it is projected that the global building floor area is expected to be double by 2060 (UNEP, 2021). The global solid waste which is expected to reach to 2.2 billion tons per year by 2025, half of it will come from the construction and building materials waste (Transparency Market Research, 2017). One the main reasons for the high amount of solid waste generation around the world is the current boom in built environment sector after ease of COVID restrictions (Umar, 2022; Umar, 2021). It is expected that the Global construction market to grow US$ 8 trillion by 2030 which will be mainly driven by China, United States, and India (Robinson, 2015). The Royal Institute of Chartered Surveyor also predict that the global construction output will continue to increase (RICS, 2021).

Built environment sector is also regarded a major employment providing sector around the world. While there is consolidate global statistics which indicate how many people are employed in construction sector, some prediction indicates that these employments stood at 273 million as of 2014 when the sector GDP was estimated at 13% of global GDP and was expected to raise to 14.7% by 2030 (ICED, 2014). In the United Kingdom, the Office of National Statistics indicates that currently (2022) a total of 2.20 million peoples are working in construction sector (ONS, 2022). Likewise, construction sector employment in the United States in 2021 stood at 11.27 million (Statista, 2021). It is worth mentioning here that the construction is one of the sub sectors of the built environment, thus the total employment in built environment will be far more than the employment in construction sector alone. Since, most of the jobs in construction and other built environment sectors are physical demanding jobs, thus the main requirement for employment in the sectors is that one should be able to perform such activities irrespective of any other requirement such as basic qualification. This, however, results in a number of issues including ill treatment of workers, health and safety and low wages (Umar et al. 2020; Umar et al. 2018).

Construction industry as one of the key built environment sectors is also regarded a major hazardous industrial sector. Construction workers are expected to be open to different types of risk during their works such as dust and condensation; stiff working situation; handling heavy load; hot climatic condition; working at heights; excessive noise; vibration and heavy machinery; and different chemicals. The international Labour organisation statistics indicates that at least 108 thousand workers are killed on site every year, which is equal to 30% of all the occupational fatal injuries around the world (ILO, 2015). This can be translated in to 300 workers deaths every day. The global statistics further indicates that construction workers are 3-4 times more likely than other industrial sectors to die from accidents at work. This risk raises to 6 times when it comes to developing countries. Recently, the deaths of construction workers in the construction of a stadium for the football world cup 2022 have attracted the attention of media and international organizations. Some of these reports show the number of construction workers that died in the project has already reached 1,200. Some of the reports estimate that the number of deaths in this project was expected to reach 4,000 by the end of 2020 when it is completed (ITUC, 2014; Ganji, 2016). Clearly, the Qatar world cup football stadium is a major project which is going to host an international event in 2022 (this year), obviously, have attracted to the attention of media and other organizations. There are other small, medium, and large construction projects where workers might be killed in accidents, but these sometimes do not get the attentions of media and other organisations. If the cost of occupational safety and health in construction is considered to be the same as other industries (~3.94%), which apparently is expected to be more, the cost of occupational safety and health in construction was expected to reach to US$ 299.31 billion in 2022 (figure 2).

The above discussion clearly reveals that built environment and at associated sectors have a major role in our society. There are some positive and some negative aspects of these sector, but overall, the built environment is considered as a key player in sustainably meeting the future expected growth through the planning, design, construction and management of urban environments, buildings, and infrastructure (Opoku, 2019). This role of the built environment is expecting to be growing to meet the requirement of increasing population. The next section provides an overview of the United Nations Sustainable Development Goals with a specific reference to built environment and developing countries.



	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Global GDP Value (US$ Billion)	74535.41	76596.14	78663.17	74429.03	75485.01	79865.48	87504.57	92734.03	97789.46	103029.66	108523.32
Total Construction GDP Value (US$ Billion)	5217.48	5361.73	5506.42	5210.03	5283.95	5590.58	6125.32	6491.38	6845.26	7212.08	7596.63
Total OS&H Cost (US$ Billion)	2936.70	3017.89	3099.33	2932.50	2974.11	3146.70	3447.68	3653.72	3852.90	4059.37	4275.82
Total Construction OS&H Cost (US$ Billion)	205.57	211.25	216.95	205.28	208.19	220.27	241.34	255.76	269.70	284.16	299.31

Figure 2. Global GDP and Cost of Poor Occupational Safety and Health Practices (Deloitte, 2017)

Sustainable Development Goals

The United Nations current Sustainable Development Goals were prepared in the United Nations sustainable development conference that was organised in the city of Rio de Janeiro, Brazil in 2012. The purpose of this conference was to arrive on set of universal goals, connecting the environmental, political, and economic challenges that are faced by the world. Later in 2015, the United Nations officially adopted the 17 Sustainable Development Goals, replacing the eight Millennium Development Goals and setting 2030 as a target of achievement for them (UN SDGs, 2015). Most of the countries around the world have adopted these goals as their national development goals and trying to achieve them through a collaborative way of working. These goals are guided by the principle of universality, which means that all countries and citizens have a role to play in their achievement (Fei et al., 2021). Each goal is further supported with several number of target and indicators as noted in table 1.

Table 1. The United Nations Sustainable Development Goals, its Descriptions targets and indicators

Goal Number	Goal Name	Goal Description	Goal Targets	Goal Indicator
1	No Poverty	No Poverty: End poverty in all its forms everywhere	7	13
2	Zero Hunger	Zero Hunger: End hunger, achieve food security and improved nutrition, and promote sustainable agriculture	8	14
3	Good Health and Well-being	Good Health and Well-Being: Ensure healthy lives and promote well-being for all at all ages	13	28
4	Quality Education	Quality Education: Ensure inclusive and equitable quality education and promote life-long learning opportunities for all	10	12
5	Gender Equality	Gender Equality: Achieve gender equality and empower all women and girls	9	14
6	Clean Water and Sanitation	Clean Water and Sanitation: Ensure availability and sustainable management of water and sanitation for all	8	11
7	Affordable and Clean Energy	Affordable and Clean Energy: Ensure access to affordable, reliable, sustainable, and modern energy for all	5	6
8	Decent Work and Economic Growth	Decent Work and Economic Growth: Promote sustained, inclusive, and sustainable economic growth, full and productive employment and decent work for all	12	16

9	Industry Innovation and Infrastructure	Industry, Innovation and Infrastructure: Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation	08	12
10	Reduced Inequalities	Reduced Inequalities: Reduce inequality within and among countries	10	14
11	Sustainable Cities and Communities	Sustainable Cities and Communities: Make cities and human settlements inclusive, safe, resilient and sustainable	10	14
12	Responsible Consumption and Production	Responsible Consumption and Production: Ensure sustainable consumption and production patterns	11	13
13	Climate Action	Climate Action: Take urgent action to combat climate change and its impacts	5	8
14	Life Below Water	Life below Water (Oceans): Conserve and sustainably use the oceans, seas and marine resources for sustainable development	10	10
15	Life on land	Life on Land (Biodiversity): Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	12	14
16	Peace, Justice, and Strong Institutions	Peace, Justice and Strong Institution: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels	12	24
17	Partnerships of Goals	Partnership for the Goals: Strengthen the means of implementation and revitalise the global partnership for sustainable development	19	24

Statistics indicates that on overage there has been good progress towards Sustainable as shown in figure 3 but clearly the line goes flat mean there is no improvement since 2019 (Sachs et al., 2022). The current (2022) Sustainable Development Goals report provides a global overview of progress on the implementation of the 2030 Agenda for Sustainable Development, using the latest available data and estimates. The report clearly indicates that many countries are not on track towards achievement of these goals by 2030. While there are many factors which are affecting the progress of Sustainable Development Goals, COVID is the leading factor which has wiped out more than four years of progress (SDGR, 2022). The

situation over the progress is not satisfactory which is well observed by the United Nations Secretary-General António Guterres in his remarks stating, "We must rise higher to rescue the Sustainable Development Goals – and stay true to our promise of a world of peace, dignity and prosperity on a healthy planet".

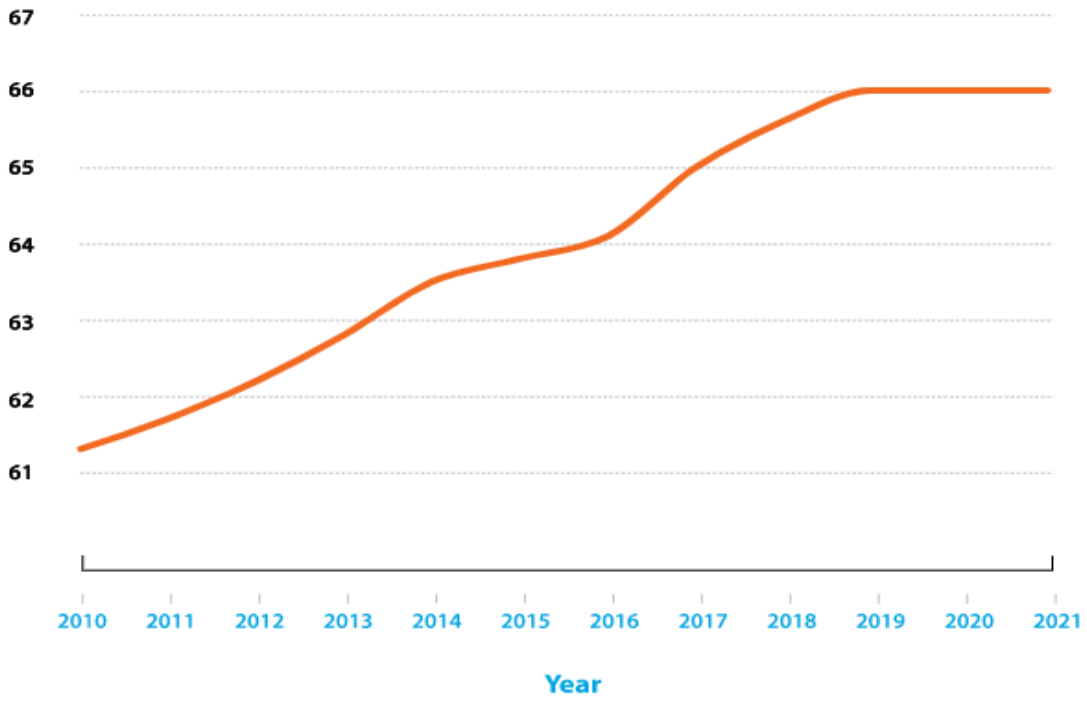


Figure 3. Sustainable Development Goals Index Score over time (Sachs et al., 2022)

It is a fact that there was major interruption in the progress of Sustainable Development Goals for the last three years starting from the 2019 due to COVID, but statistics indicates prior to COVID indicates that most of the countries were not on the track to achieve these goals (Umar and Umeokafor, 2022). The successful achievement of all the goals is only possible when all the element of society and all governments organizations embed these goals in their relevant regional, national, and local policies and make an effective system of monitoring and cooperation among the organizations because in some instances it is possible that the effort of one organization can derail on efforts of the other, affecting one or many goals. This is also because the Sustainable Development Goals and targets are interlinked to each other where one can affect other both in a positive or negative way (Nilsson et., 2016; Griggs et al., 2013; Fei et al., 2021; UNSC, 2019; Roy and Pramanick, 2019) – figure 4.

Figure 4. Interlinking of Sustainable Development Goals (Nilsson et., 2016; Griggs et al., 2013; Fei et al., 2021; UNSC, 2019; Roy and Pramanick, 2019)

The collaborative way of working to achieve these goals is well appreciated by many researchers. For instance, Adam (2017) that the fulfilment of the Sustainable Development Goals can be difficult without collaboration between governments, private and public sector, and civil society organisations. Fei et al. 2021) argued that the 17 Sustainable Development Goals can be divided in to five "P" which stands for People, Planet, Prosperity, Peace, and Partnership as shown in table 2. All these five Ps of the Sustainable Development Goals need the effective involvement of all the stakeholders, such as governments, institutions and businesses effectively implemented. The built environment is also an important stakeholder; therefore, it needs to develop approaches and align its activities to Sustainable Development Goals. Likewise, Sustainable Development Goals require the transformations of different societal element including education and skills; health and well-being; clean energy and industry; sustainable land use; sustainable cities; and digital technologies (Sachs et al., 2019). The built environment sector appears to be the main contributor of these elements where it is expected to contribute one step ahead when compared to other businesses Ebekozien et al., 2021). The problem arrives when it comes to developing countries where due to several factors including financial and manpower capabilities, the contributions of built environment to Sustainable Development Goals is not clearly evident but there is a great scope and role for the sector to play (Ofori, 2016).

Table 2. Five "P" of Sustainable Development Goals

P1	P2	P3	P4	P5
People	**Planet**	**Prosperity**	**Peace**	**Partnership**

SDG 1: No Poverty	SDG 6: Clean Water and Sanitation	SDG 7: Clean and Affordable Energy	SDG 16: Peace Justice and Strong Institutions	SDG 17: Partnership for Goals
SDG 2: No Hunger	SDG 12: Responsible Consumption and Production	SDG 8: Decent Work and Economic Growth		
SDG 3: Good Health and Well-being	SDG 13: Climate Action	SDG 9: Industry, Innovation, and Infrastructure		
SDG 4: Quality Education	SDG 14: Life Below Water	SDG 10: Reduced Inequalities		
SDG 5: Gender Equality	SDG 15: Life on land	SDG 11: Sustainable Cities and Communities		

Progress of Developing Countries on Sustainable development Goals

According to the United Nations, a developing country can be defined as a country with a relatively low standard of living, undeveloped industrial base, and moderate to low Human Development Index (HDI) (UNDP, 2022-a). The Human Development Index was introduced in 1990, by Pakistani economist Mahbub ul Haq. The aim of the index emphasize that people and their capabilities should be the ultimate criteria for assessing the developing of a country not the economic growth alone (UNDP, 2022-a). The Human Development Index is a simple composite measure of a country's longevity, education and income and it is widely accepted in the development discourse. The first pillar of the index is the long and healthy life parameter include life expectancy at birth, contributing to the life expectancy index. The second pillar is the knowledge, which consider that the expected years of schooling and means year of schooling, forming the education index. The last pillar is the decent standard of living which mainly consider the Gross National Income (GNI) forming the GNI index. The United Nations Human Development Reports Office compute the Human Development Index for around 190 countries and territories along with the global and regional averages. The current report (2021/2022) of the United Nations Human Development indicates that for the first time the human development has declined for 9 out of 10 countries due to several issues. The report stress on the investment in people capabilities, ensuring the protection of everyone in uncertainty and innovate technologically, economically, and socially to respond to whatever challenges are coming next. The report indicates that the recovery of countries is uneven and partial particularly in the regions of Latin America, the Caribbean, Sub-Saharan Africa, and South Asia, where most of the countries are classified as developing countries. Human development has fallen back to its 2016 levels, reversing much of the progress towards the Sustainable Development Goals (UNDP, 2022-b).

To demonstrate the progress of the developing countries towards Sustainable Development Goals, one country from each region of Latin America and Caribbean, Sub-Saharan Africa, and South Asia is selected focusing on the key goals where built environment has a great role to play. While selecting a country form a specific region, it was noted that there is enough data available to reflect on the goals performance. The countries selected form these regions include Venezuela from Latin America and Caribbean, Nigeria from Sub-Saharan Africa region, and Pakistan from South Asia region have been selected.

Goal 6 (clean water and sanitation)

Gaol 6 of the Sustainable Development Goals aims to ensure availability and sustainable management of water and sanitation for all around the world. The United Nations statistics indicate that the earth water related ecosystems are degraded at an alarming rate. More than 85% of the earth wetland have been lost in the fast 300 years. Stress on water resources in Northern Africa and Western Asia is already at dangerous levels. Northern Africa and Western Asia had a critical level of water stress (= 84.1%) reflecting an increase of 13% since 2015. Currently around 733 million people, which is equal to 10% of the earth population, are living in countries that have high and critical levels of water stress (≥ 75%). Many countries have lack cooperation agreements on shared water resources, resulting conflict between the countries. while the proportion of the world population using safely managed drinking water has increased from 74% (in 2020) which was 70% in 2015, still, 2 billion people are without such water facilities, including 1.2 billion people lacking even a basic requirement of water. Currently, the 54% of the world population have access to safely managed sanitation services and if the progress continue at the same pace, this percentage will reach to 67% by 2030 that means 2.8 billion people will still have no access to safely managed sanitation.

The current ranking of Venezuela on SDG index is 120 out of 163 with a SDG index score of 60.30 (out of 100). Likewise, Nigeria has a ranking of 139 with a total score 54.20, while Pakistan is ranked at 125th with a total score of 59.30 (figure 5). Venezuela moderately improving with goal 6 but has significant challenges which mean the country will not be able to achieve the goal by 2030. Nigeria and Pakistan progress is also moderately improving but has major challenges with the goal. The situation is the same as of Venezuela. If the progress in not improved, all these countries will not be able to achieve the goal by 2030. All the three countries need to explore sustainable ways to utilizing water resources. The built environment sector needs to focus on discoveries and adopt methods to increase the water use efficiencies. With help of cooperation among the built environment sectors and other industrial sectors, all the correlated environmental concerns must be addressed, for example reducing water consumption in agriculture activities without causing any physiological stress in staple crops and paying attention to any probable adverse effects of using genetically or biotechnologically modified crops for more water-efficient crops (Royand and Pramanick, 2019). All the built environment sectors need to work with the natural resource planning authorities to develop a decision support and policy management tool that can reflects the trade-offs between various components of the SDG 6 and monitor the progress in a more accurate manner. Some of the built environment sectors is the main consumer of water in many countries (CPA, 2015). For instance, at construction site, apart from usual use, water is required for different operation such as concrete Batching, grouting, hydro-demolition, drilling and piling, landscaping and pond filling, chlorination, soakaway testing, and dust suppression. Water efficiencies strategies need to be used to reduce the use of such water where possible. It is important that used

water is not discharged without treatment to avoid contamination of clean surface and subsurface water.

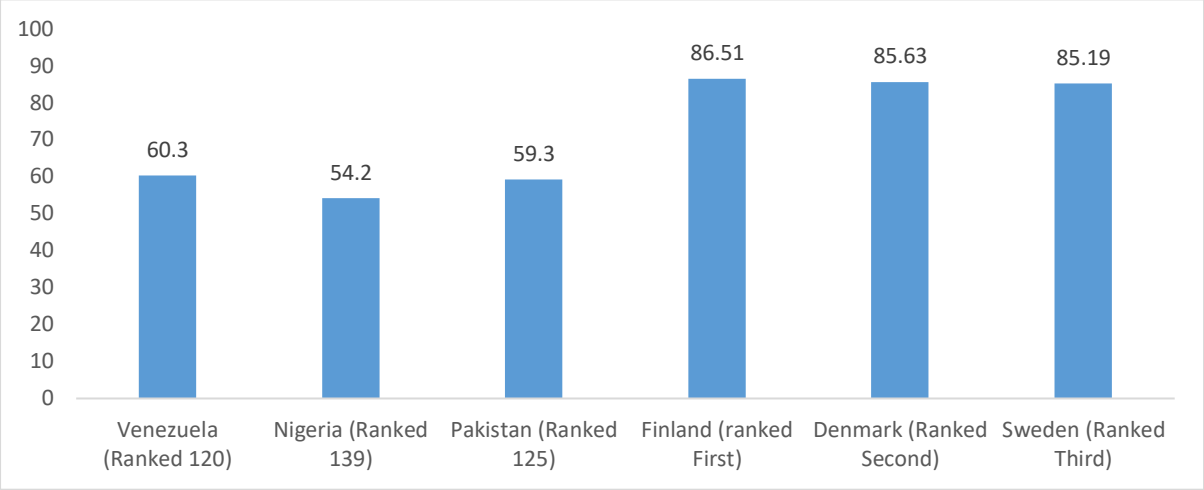


Figure 5. Comparison of Venezuela, Nigeria, and Pakistan with the top Three Countries (Sachs et al., 2022)

Goal 7 (affordable and clean energy)

The aim of goal 7 is to ensure access to affordable, reliable, sustainable, and modern energy for all around the world. There are different renewable resources available throughout the world, but still much of the electricity in different regions and countries is produced from conventional resources - fossil fuels. First of all, these resources are not sustainable, and secondly, the emissions produced by using these resources affect other goals such as goal 3 (good health and well-being), goal 13 (climate action), goal 14 (life below water) and goal 15 (life on land) – Umar et al., 2020). The statistics indicates that access to electricity around the world has gradually increased to 91% (2020) which was 83% in 2010. Majority of people with no access to electricity are from developing countries. For instance, 77% of the world population without access to electricity live in sub-Saharan Africa. As shown in figure 6, there has been a gradual increase of 12% in the proportion of people with access to clean cooking fuels and technologies between 2010 to 2020, reaching to 69%. With this increase, there are still 2.4 billion people with inefficient and polluting cooking systems. Much of this improvement has been noted in progress was concentrated in five countries: Brazil, China, India, Indonesia, and Pakistan. this means the situation in other developing countries is not much changed. Since the share of renewable energy total final energy consumption has only reached to 18%, there is a need of a major push in the deployment of renewables, with massive finance mobilization for meeting world energy and climate objectives. There has been a major interruption on the progress of goal 7 due to pandemic, however, despite the growing urgency of climate change it is worth noting that international public financing for renewable energy had already slowed before the COVID.

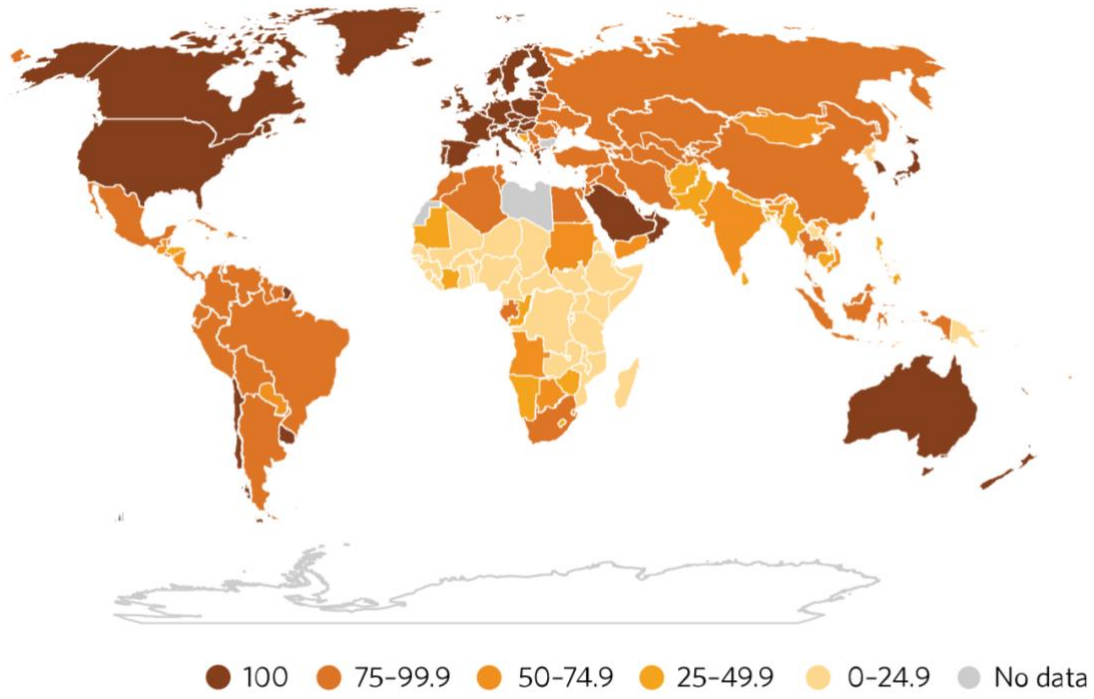


Figure 6. Global Population with Access to Clean Cooking Systems as of 2020 (DESA, 2022)

The current progress of Venezuela indicates that the country has challenges in goal 7 but it is on track to achieve this goal by 2030 provided that the progress in not interrupted in the coming years (Sachs et al., 2022). Nigeria and Pakistan, however, have major challenges in goal 7 and the progress is stagnating, means they will not be able to achieve the goal by 2030. There are variety of way in which built environment can contribute the to the goal 7. For instance, building as one sector on built environment accounts for approximately 40% of carbon emission, determined by their direct energy use (Nässén et al., 2007). Supply and demand should eb important elements of consideration for the built environment, especially when creating regional level planning strategies and policies. This should be supported that energy efficiency measures, on-site generation technologies, demand side management and storage systems, reshaping energy infrastructures and energy market, together with innovative business models (Tronchin et al., 2018). Optimal design and operational choices in buildings are required to be adopted ensuring reduction in energy consumption per capita. both the industry and government need to work together to develop polices for implementing renewable resources such as rooftop solar panels in all housing projects as will as to develop procedure to install the same system on the existing buildings increasing the renewable share at local, national, and global levels. The government of developing countries need to facilitate these initiatives by providing required supports and reducing the bureaucratic procedures.

Goal 8 (decent work and economic growth)

The global unemployment rate was 5.4% in 2019, which increase to 6.6% in 2020 for which the main reason was the COVID pandemic. The unemployment rate in 2021 was recorded as 6.2% which indicate a positive recovery sign. Based on the International Labour Organization statistics, the unemployment rate in Nigeria, Pakistan and Venezuela is 8.53%, 4.08% and 6.6% respectively. The same situation happened with global gross domestic product (GDP) per capita which increased 1.4% in 2019, dropped suddenly by 4.4%. the current growth rate of global GDP is expected to continue at 4.4%. The labour productivity has affected small

firms and the developing countries which is again mainly linked with the COVID pandemic as shown in figure 7. 2 billion people around the world which is approximately 60% of the world employment were working in informal sector, however, this (informal sector) was not the option for many workers displaced at the start of the COVID pandemic. The 2020 statistics indicates that globally, 160 million children where 63 million are girls and 97 million are boys were engaged in child labour showing an increase of 8.4 million children since 2016. Many developing countries have not rectified different convention of International Labour Organization including minimum age convention and worst forms of child labour convention (ILO, 2022). For instance, in Pakistan, both ILO conventions "C015 - Minimum Age (Trimmers and Stokers) Convention, 1921 (No. 15)" and "C059 - Minimum Age (Industry) Convention (Revised), 1937 (No. 59)" are not in force. There is no information available on the International Labour Organization about the same convention for Nigeria and Venezuela reflecting a serious issues of data sharing with global organizations.

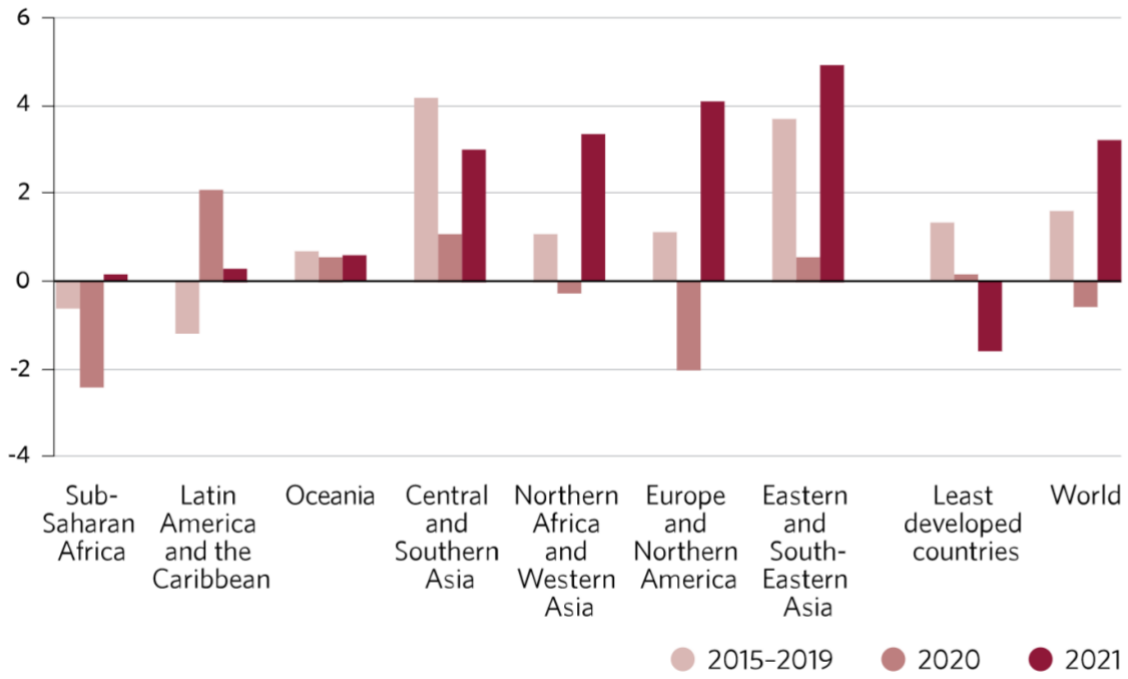


Figure 7. Growth in output per worker during 2015-2021

The current progress of Venezuela in term of goal 8 indicates that the country has significant challenges with this goal where the progress in moderately improving but not enough to achieve the goal by 2030. Nigeria and Pakistan both have major challenges with goal 8. Nigeria progress is stagnating while Pakistan progress in moderately improving (Sachs et al., 2022). Same as Venezuela, both Nigeria and Pakistan will not be able to achieve goal 8 with current progress. Different sectors on built environment can significantly contribute to the goal and can improve the current progress leading to the achievement of the goal by 2030.

Reform in construction sector, which is one of the sub sectors of built environment can bring positive change to current situation of goal 8 in these selected countries as this sector has a great contribution to the economy. For instance, the construction sector in Nigeria accounts for up to 10% of the GDP, more than 50% of the domestic fixed capital formation, and one of the largest industrial employers (Du Plessis, 2002). The construction sector is often seen

as a driver of economic growth, and it used extensively by policy makers as a tool for economic development (Olanipekun and Saka, 2019).

Likewise, construction is one of the main industrial sectors in Pakistan contributing 2.53% to its GDP and provide jobs to 7.61% of the employed worked force (BOI, 2022). It is expected that construction value which was 5.34 billion US$ in 2020 will reach to 15.32 billion US$ in 2029. Likewise, based on the road network of 263,775 Km, Pakistan is ranked at 22nd position globally (The Global Economy, 2019). Currently, Pakistan is facing a housing shortage of around 11.4 million homes which is expected to increase to 17.2 million units by 2025. Such expansion of industry is expected to attract international construction organizations which is good for Pakistani economy, but at the same time such expansion poses several sustainability issues, including health and safety issues for which Pakistan will needs to have robust and up to date regulations supported by a vigorous implementation system. The contribution of built environment in the economic development will only be possible when the investors will have a trust on the government organizations, therefore, government in developing countries need to develop procedure which can support the investment. At the same time the built environment sectors need to ensure the delivery of projects on time making it sectors aligned with the new technological tools such as 3D printing and applications of drones etc. which have delivered improved performance in other industrial sectors.

Goal 9 (industry innovation and infrastructure)

Globally there are some positive indicators which show that positive performance of goal 9. In this regard it is worth mentioning that the manufacturing value added (MVA) in total GDP increased from 16.2% in 2015 to 16.9% in 2021. Strong global demand for manufacturing and exports in the region has expanded the Eastern and South-Eastern Asia share from 25.5% to 26.1% in the same period. However, as shown in figure 8 the share in least developed countries in 2021 was only 12.5%. on the other hand, the share of manufacturing jobs in total employment declined from 14% in 2019 to 13% in 2020 globally. There was a greater impact of COVID pandemic in the middle-income countries. statistics indicates that the reduction in employment for example in manufacturing sector in middle-income countries was 9% compared to 3.4% in low-income and 4% in high-income countries. The garment sector and it supply chains which provides employment to a large share of women worker have observed a greater effect. The total number of passengers travelled internationally in 2020 stood at 1.8 billion which is 60% lower from 2019. The total air traffic was down to the level of 2003 resulting a financial loss of UD $370 billion in 2020. On a positive side most of the world's population are covered by a mobile-broadband signal, but blind spots remain mostly in developing countries.

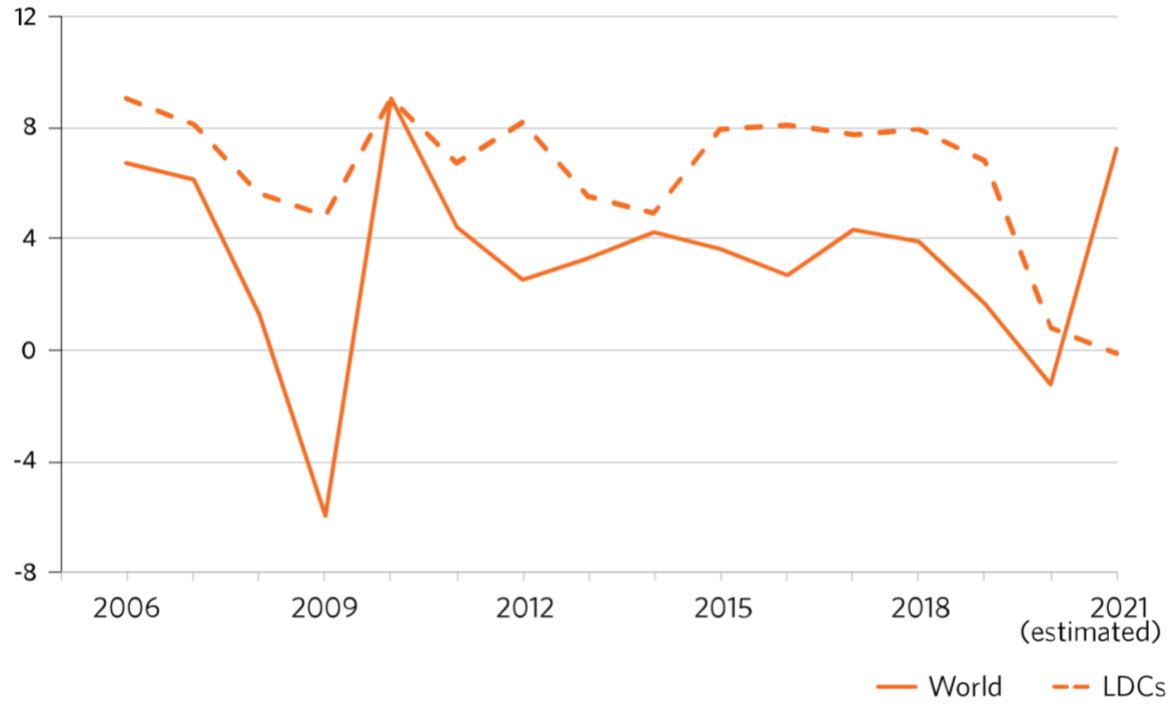


Figure 8. Manufacturing growth from 2006 to 2021

Statistics indicated that global construction (a sub sector of the built environment) output was expected to fall by more than 3% in 2020 with similar expectation for 2021 (Marsh, 20212. Some of the key areas that built environment sectors can consider to manage the situation include resilience, contract structuring, and collaboration, supply chain management, balance sheet and liquidity, and diversification and innovation. In terms innovation in the built environment sectors, it was clear the sector as whole is far behind in the race when compared with other industrial sectors. One of the reasons is the nature of its environment and projects but this is sometime used as an excuse to oppose change and adopt. The technology also sometimes is not well aligned to meet the changing requirements of the built environment. The innovation in built environment will, however, will not possible if the relevant sectors and its business do not address the issues with technology, cost, environment, and organization.

Looking to the selected countries and their performance with the goal 9, the Venezuela, Nigeria and Pakistan statistics indicate that they have major challenges with the goal. The progress in stagnating which mean these countries will not be able to achieve the goal by 2030 (Sachs et al., 2022). Construction industry role will be crucial for the industry innovation and economic growth. There has been demand of the development of Construction Industry Development Board in these countries as the countries with such board have demonstrated significant progress in the industry (The Guardian, 2018; MPDSI, 2022). In Nigeria, building professionals and organizations demanding for Construction Development Board since 2018. Bhutan which a relatively small and low-income country has established the Construction Development Board and comparatively its performance in goal 9 is better than Venezuela, Nigeria, and Pakistan (CDB Bhutan, 2022; Sachs et al., 2022). Pakistan has developed a draft legislation bill to be presented in the National Assembly, but this is still pending due to political destabilization, economic situation, and recent flood (MPDSI, 2022; UNICEF, 2022).

Goal 11 (sustainable cited and communities)

As the world population increasing day by day the burden on our cities also increases because they provide better life facilities. Currently more than half of the world population live in cities which will increase to 70% by 2050 (UN, 2018). Cities plays a major contribution to countries and world economic growth and thus constitute 80% of the global GDP. Because of the populations and business activities in cities, they are responsible for more than 70% of the total greenhouse gas emissions. It is therefore important that the growth of cities need to manage in a sustainable manner because poorly planned cities can result to several issues including the affordability of housing, infrastructures that include public transportation and basic utility services, open spaces, increased air pollution, and climate and disaster risks. The current statistics indicates that 25% of cities populations are living in in slums or informal settlements which mean more than 1 billion inhabitants (WEF, 2019). 85% of the this (1 billion people) are living in Central and Southern Asia (= 359 million), Eastern and South-Eastern Asia (= 306 million), and sub-Saharan Africa (= 230 million) (WEF, 2016). The highest percentage of slum inhabitants is in sub-Saharan Africa, where more than 50% of urban population live in slums. The main reasons of slum formation in developing countries include rapid urbanization, ineffective planning, lack of affordable housing options for low-income households, dysfunctional urban, land and housing policies, a dearth of housing finance, and poverty. Many of these issues are directly linked with the built environment.

Globally, air pollution is responsible for 4.2 million deaths annually (Roser, 2021). The exposure to fine particulate matter of 2.5 microns or less (PM2.5) and other pollutants put people at higher risk of stroke, heart disease, chronic obstructive pulmonary disease, lung cancer and lower respiratory infections. Currently 99% of the earth's urban population live in areas that exceed the new World Health Organization guidelines on air quality (WHO, 2021). There is also a lack of public transportation in cities globally. It is expected that the global number of passengers will increase by 50% by 2030, however, the current data indicates that in more than 1,500 cities on the earth, only 37% of the urban areas are served by public transport. The built environment can play vital role to transform the transportation sector and meet the current and future demand of transportation infrastructure in a more sustainable manner.

Municipal Solid Waste (MSW) generation in cities is another global issue where a great contribution is made by the construction waste. It is estimated that the global construction waste volume will reach to 2.2 billion tons by 2025 (BDC, 2018). The issue of MSW become more serious of such waste is not collected and not manage properly which then can cause several issues such as infections and contribute to the greenhouse gas emissions. As shown in figure 9, in 2022, an average of 82% of MSW globally was being collected and 55% was being managed in controlled facilities (World Bank, 2022). There is also a lack of public spaces in most of the cities, reflecting on poor planning element of built environment sector. For instance, data from more than 900 cities around the world indicates poor distribution public spaces such as parks, boulevards and playgrounds.

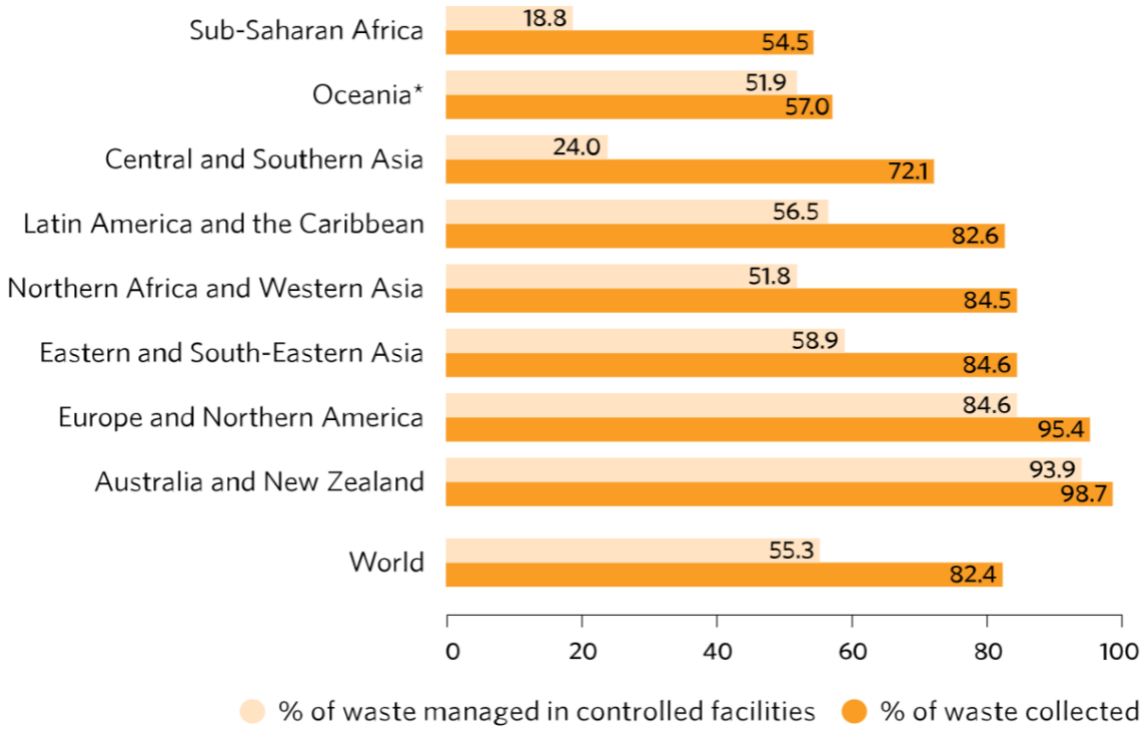


Figure 9. Municipal solid waste collection and management in controlled facilities, 2022 (percentage) - (*excluding Australia and New Zealand)

In relation to the selected countries performance in goal 11, all the three selected countries (Venezuela, Nigeria, and Pakistan) have major challenges with the goal. Nigeria progress in decreasing while Venezuela and Pakistan are in state of stagnating (Sachs et al., 2022). The current progress of all the three countries reflect that they will not be able to meet goal 11 if they continue in the same way.

The built environment and its allied sectors can contribute in variety of ways to improve the performance of goal 11. For example, there is a great scope of to adopt sustainable materials in the infrastructure and housing projects that can have the potential of reducing carbon footprint of the built environment. For instance, the production of 1 ton of cement emits the same amount of greenhouse gases. Ceramic waste can be used a partial (up to 30%) replacement in cement product including concrete. This can also help to reduce share of construction waste in the MSW because the ceramic waste normally goes to landfills which create a number of environmental issues. likewise, there is great scope to improve the planning and design elements of the built environment projects and make sure the new developments have the required public spaces which is the main element of goal 11. The built environment professionals also need to think how the reduce to current slum by contributing to availability of affordable housing to inhabitants of these slum. Obviously, this cannot happen with the support and commitment of government in these countries.

Goal 12 (responsible consumption and production)

The way we are using the earth resources is not sustainable and thus one earth is not enough to meet the current populations. For instance, to meet the current consumption of natural resources, the United States need more than five plants to meet their requirement (Global Footprint Network, 2022). Because the built environment sectors change the natural environment to build environment, which required the use of natural resources, thus the

sectors are responsible for a significant consumption of natural resources. This clearly mean we would not be able to transfer our earth to the coming generation is a sustainable shape where they will be able to live the same way as we are living. The scientists are exploring the possibilities of taking human to other planets, but it seems this would take a significant time keeping in mind the Mar environment is still considered non liveable (NASA, 2022). The Domestic material consumption (DMC) is used to calculate the total amount of materials directly used by country to meet the demands for goods and services from within and outside a country (Baynes and Musango, 2018). From 2000 to 2019, the global Domestic Material Consumption (DMC) rate rose by 65%, reaching to 95 billon metric ton in 2019 which is roughly equal to 12 tons per person. Asia, Europe, and North America are responsible for more than 70% of the world Domestic Material Consumption (DMC).

While the world is facing food challenges insecurity, statistics indicate that a major portion of the food (13%) is wasted is lost. This food is lost at different stages that also include the transportation of the food for which good infrastructure and roads are mandatory – again directly link to the built environment sectors. The food waste has significant environmental, social, and economic consequences. If this waste end in the landfills, then it is accountable for 8~10% of greenhouse gas emissions. There is also a great concern over the E-waste, which has raised to 7.3 kilograms per capita in 2019. Although this is not directly link to the built environment sectors, but it does not mean the built environment sectors can not play a role to reduce the burden of E-waste. There are great opportunities for built environment sectors to reduce its contribution in the global MSW generation. Some statistics indicates that if annual construction waste continue in the same rate, it will reach 2.2 billion tons by 2025 (Big Rentz, 2021).

Renewable energy is a main component of goal 12, where the role of built environment cannot be ignored. While there was a good progress in the annual growth rate of renewable energy in developing countries over the five years from 2015 to 2020 which stands at 9.5%, there are still issues in the building performance in energy consumption and not utilising the day light at its full potential (Clarke et al., 2008). This is something which built environment sectors need to address in the planning and design of new building and find the ways to make existing building more energy efficient (Ambrose, 2009). There has been a great example of India where rooftop solar panel were installed on the existing buildings and the residents were allowed to sell the extra energy produced back to the government (MNRE, 2022). Such initiative can help motivate to invest on renewable energy – enhancing the profile of country in renewable energy production. There is also a great scope of for built environment to reduce the dependencies of fossil fuels and develop strategies to generate energy from renewable resources for its operation. There is also a need of realization of Sustainable Development Goals in the activities of built environment for which training of existing persons associated with the sectors are important. In long terms these goals need to be incorporated in the school and universities programmes so that we these professionals will join the built environment sectors, they will have the awareness of these goals in the context of their discipline.

In terms of the performance of the Venezuela, Nigeria and Pakistan, the current statistics indicates that only Venezuela has challenges with goal 12 but its progress is on track and will be able to achieve the goal by 2030. The Nigeria Pakistan have already achieved the goal and their performance are maintaining the achievement of goal (Sachs et al., 2022). While this appears to be a positive indication, but in reality, this is not very helpful because the industrial activities in these countries proportional with its populations and requirement. As noted earlier, the goals are interlinked with each other and once these countries will progress in other goals

such as goals 8 and 9 which are related to decent work, industry innovation, and economic growth, then this will affect the performance of goal 12. It this therefore, important that these countries keep a close eye on goal 12 so that its performance is not derail by the progress of other goals. They key areas where built environment sectors can contribute to goal 12 include the reduction of waste, improving energy efficiencies in building, incorporating renewable resources in the existing and new projects, and reducing dependencies on fossil fuels in its own operations.

Conclusion and Recommendation

This chapter cover the United Nations Sustainable Development Goals in the context of developing countries focusing on the goals where built environment sectors have great contribution. Generally, built environment sectors can contribute to many goals and there is evidence for that, but there are some particularly Goal 6 (clean water and sanitation), Goal 7 (affordable and clean energy), Goal 8 (decent work and economic growth), Goal 9 (industry innovation and infrastructure), Goal 11 (sustainable cities and communities) and Goal 11 (responsible consumption and production) where these sectors can have significant contribution compared to other goals. Keeping this in mind the chapter only cover these specific goals. The latest reports of the United Nations indicate global progress towards sustainable goals is derail by several issues and many of the countries are not on the track to achieve these goals by 2030. COVID has play a major role to putting the countries backword on the progress track. The situation is more worse in the developing countries. this chapter therefore consider the progress of progress of selected developing countries towards United Nations Sustainable Development Goals focusing mainly on goal 7, 7, 8, 9, 11 and 12. a developing country can be defined as a country with a relatively low standard of living and undeveloped industrial base. The United Nations Human Development Index was used to identify such developing countries of the purpose of this chapter. The developing countries are mainly located in Latin America and Caribbean, Sub-Saharan Africa, and South Asia regions. While it was not possible to cover all the developing countries in a single chapter, therefore, only one country from each of these regions were selected. the chosen countries include Venezuela from Latin America, Nigeria from Africa, and Pakistan from South Asia. The current ranking of Venezuela on SDG index is 120 out of 163 with a SDG index score of 60.30 (out of 100). Likewise, Nigeria has a ranking of 139 with a total score 54.20, while Pakistan is ranked at 125th with a total score of 59.30.

In relation to the status and progress of goal 6 (clean water and sanitation), Venezuela moderately improving with goal 6 but has significant challenges. Likewise, Nigeria and Pakistan progress is also moderately improving but has major challenges with the goal. This clearly indicate that these countries will not be able to achieve the goal by 2030. All the three countries need to explore sustainable ways to utilizing water resources. The built environment sectors need to increase the water use efficiencies. All the built environment sectors need to work with the natural resource planning authorities to develop a decision support and policy management tool that can reflects the trade-offs between various components of the goal 6 and monitor the progress in a more accurate manner. this will require water efficiencies strategies to be used to reduce the use of such water where possible. It is important that used water is not discharged without treatment to avoid contamination of clean surface and subsurface water.

The current progress of Venezuela on goal 8 indicates that the country has significant challenges where the progress in moderately improving. Nigeria and Pakistan both have major

challenges with goal 8. Nigeria progress is stagnating while Pakistan progress in moderately improving. It is not possible to achieve goal 8 with current status and progress. Different sectors on built environment can significantly contribute to the goal and can improve the current progress leading to the achievement of the goal by 2030. Construction is one of the main industrial sectors in Venezuela, Nigeria and Pakistan contributing to local economy with a reasonable contribution to the GDP of these countries. it is expected that construction industries in these countries will be expanding in future to meet the housing and infrastructure requirements. This expansion will result in a number of sustainability issues which can affect the goal 8 as well as other connected goals. The contribution of built environment in the economic development will only be possible when the investors will have a trust on the government organizations, therefore, government in developing countries need to develop procedure which can support the investment. The built environment sectors need to ensure the delivery of projects on time. The sectors also need to align with the new technological tools such as 3D printing and applications of drones etc. which have delivered improved performance in other industrial sectors.

Venezuela, Nigeria, and Pakistan statistics indicate that they have major challenges with goal 9. The progress in stagnating, mean these countries will not be able to achieve the goal by 2030. Construction industry can play a vital in industry innovation and economic growth. There has been demand of the development of Construction Industry Development Board in these countries. Bhutan which a relatively small and low-income country has established the Construction Development Board and comparatively its performance in goal 9 is better than Venezuela, Nigeria, and Pakistan.

All the three selected countries have major challenges with goal 11. Nigeria progress in decreasing while Venezuela and Pakistan are in state of stagnating. The current progress will not allow these countries to deliver the targets and indicators of goal 11. The built environment and its allied sectors can contribute in variety of ways to improve the performance of goal 11. For example, there is a great scope of to adopt sustainable materials in the infrastructure and housing projects that can have the potential of reducing carbon footprint of the built environment. For example, the production of 1 ton of cement emits the same amount of greenhouse gases. Ceramic waste can be used a partial (up to 30%) replacement in cement product including concrete. This can also help to reduce share of construction waste in the MSW because the ceramic waste normally goes to landfills which create a number of environmental issues. Similarly, there is great scope to improve the planning and design elements of the built environment projects and make sure the new developments have the required public spaces which is the main element of goal 11. The built environment professionals also need to think how the reduce to current slum by contributing to availability of affordable housing to inhabitants of these slum. The government support and commitment will play a vital role in this.

The current statistics indicates that only Venezuela has challenges with goal 12 but its progress is on track and will be able to achieve the goal by 2030. The Nigeria Pakistan have already achieved the goal and their performance are maintaining the achievement of goal. At the outset this is a positive indication, but the situation will change when these countries progress in other goals which can possibly affect the performance of goal 12. A close monitoring will be required so that advancement in one goal do not derail the progress of other goals. The built environment sectors operations produce a lot of waste which mainly goes to landfills. The key aspects to focus here is the reduction in waste and promoting recycling and reusing. The use of technology such as 3D printing can contribute significantly to reduce the

construction waste. Built environment sectors therefore need to take the advantages of the technologies available. There is also a great scope to improve the energy efficiencies in existing as well as in new buildings. Rooftop solar panel to produce electricity is one of the best approaches to get advantages of available renewable resources. The built environment sectors need to work closer with the government agencies to develop strategies and policies so this and other initiative can be implemented. The built environment sectors also use a significant amount of energy in its operation, therefore, there is a need for the built environment sector as a whole to reduce the dependency on fossil fuel and reduce its carbon footprint.

Sustainable Development Goals are universal which need a great level of cooperation that is why it has goal 17 "partnership for the goals". Developing countries mainly has economic, manpower and technological challenges to deliver these goals. Developed countries need to find the ways to best support the countries that are struggling with the goals. Developing countries are not supposed to wait for the assistance. They need to come forward, learn from the countries experience which show better performance. A high degree of partnerships, not only among the countries but also between different institutions within a country, that are working towards any goals or supporting other institutions in the delivery of goals, is a must for improving progress on Sustainable Development Goals.

References

Adams, A.C (2017). The Sustainable Development Goals, Integrated Thinking and the Integrated Report. International Integrated Reporting Council (IIRC), London.

Ambrose, M., 2009. Energy-efficient planning and design. In Technology, Design and Process Innovation in the Built Environment (pp. 264-275). Spon Press.

Arnhof, M., 2016, July. Design of a human settlement on Mars using in-situ resources. 46th International Conference on Environmental Systems.

Baynes, T.M. and Musango, J.K., 2018. Estimating current and future global urban domestic material consumption. Environmental Research Letters, 13(6), p.065012.

BDC (Building, Design and Construction), 2018. Global construction waste to almost double by 2025. Building, Design and Construction, Palatine. See: https://www.bdcnetwork.com/global-construction-waste-almost-double-2025 (accessed 02/10/2022)

Big Rentz, 2021. 23 Construction Waste Statistics & Tips to Reduce Landfill Debris. Big Rentz. See: https://www.bigrentz.com/blog/construction-waste-statistics (accessed 03/10/2022).

BOI (Board of Investment), 2022. Housing and Construction. Board of Investment, Islamabad, Pakistan. See: https://invest.gov.pk/housing-and-construction (accessed 28/09/2022).

Brundtland Commission, 1987. Our Common Future. Oxford University Press: Oxford, London, United Kingdom. See: https://sswm.info/sites/default/files/reference_attachments/UN%20WCED%201987%20Brundtland%20Report.pdf (accessed 23/08/2022).

CDB (Construction Development Board) Bhutan, 2022. Construction Development Board, Bhutan, Thonsel Lam. See: http://www.cdb.gov.bt/web/index (accessed 29/09/2022).

Clarke, J.A., Johnstone, C.M., Kelly, N.J., Strachan, P.A. and Tuohy, P., 2008. The role of built environment energy efficiency in a sustainable UK energy economy. Energy policy, 36(12), pp.4605-4609.

Cohen, C. B., 2018. Industry 4.0: Are You Ready for the Fourth Industrial Revolution?. See: https://medium.com/@carmitberdugocohen/industry-4-0-are-you-ready-for-the-fourth-industrial-revolution-464de2dea3b1 (accessed 24/09/2022).

CPA (Construction Production Association), 2015. Water Efficiency the contribution of construction products. Construction Production Association, London, United Kingdom. See: https://www.constructionproducts.org.uk/media/87904/water_efficiency_report.pdf (accessed 28/09/2022)

Deloitte, 2017. Deloitte GCC Powers of Construction 2017, If it's fundable it's feasible. Deloitte, Dubai, United Arab Emirates. See: https://www2.deloitte.com/content/dam/Deloitte/xe/Documents/realestate/construction/gccpowersofconstruction/me_construction_gccpoc2017.pdf. (accessed 27/09/2022).

DESA (Department of Economic and Social Affairs), 2022. Goal 7: Affordable and Clean Energy. Department of Economic and Social Affairs, Statistic Division, United Nations, New York, United States. See: https://unstats.un.org/sdgs/report/2022/goal-07/ (accessed 28/09/2022)

Du Plessis, C., 2002. Agenda 21 for sustainable construction in developing countries. CSIR Report BOU E, 204, pp.2-5.

Ebekozien, A., Aigbavboa, C. and Aigbedion, M., 2021. Construction industry post-COVID-19 recovery: Stakeholders perspective on achieving sustainable development goals. International Journal of Construction Management, pp.1-11. https://doi.org/10.1080/15623599.2021.1973184.

Fei, W., Opoku, A., Agyekum, K., Oppon, J.A., Ahmed, V., Chen, C. and Lok, K.L., 2021. The critical role of the construction industry in achieving the sustainable development goals (SDGs): delivering projects for the common good. Sustainability, 13(16), p.9112. https://doi.org/10.3390/su13169112.

Ganji, S. K. (2016). Leveraging the World Cup: Mega sporting events, human rights risk, and worker welfare reform in Qatar. Journal on Migration and Human Security, 4(4), 221–259. https://doi.org/10.1177/233150241600400403.

Global Footprint Network (2022). How many Earths? How many countries? Global Footprint Network. See: https://www.overshootday.org/how-many-earths-or-countries-do-we-need/#:~:text=Humanity%20is%20using%20nature%201.8,the%20resources%20of%201.8%20Earths. (accessed 03/10/2022).

Griggs, D., Stafford-Smith, M., Gaffney, O., Rockström, J., Öhman, M.C., Shyamsundar, P., Steffen, W., Glaser, G., Kanie, N. and Noble, I., 2013. Sustainable development goals for people and planet. Nature, 495(7441), pp.305-307.

Guo, H., 2010. Understanding global natural disasters and the role of earth observation. International Journal of Digital Earth, 3(3), pp.221-230.

Guppy, L. and Anderson, K. (2017). Water Crisis Report. United Nations University Institute for Water, Environment and Health, Hamilton, Canada. See: https://inweh.unu.edu/global-water-crisis-the-facts/ (accessed 13/07/2022).

Hopwood, B., Mellor, M. and O'Brien, G. (2005). Sustainable development: mapping different approaches. Sustainable Development, 13(1), 38–52.

ICED (Infrastructure and Cities for Economic Development), 2014. Construction Sector Employment in Low-Income Countries: Size of the Sector. ICED. See: http://icedfacility.org/resource/construction-sector-employment-low-income-countries-size-sector/ (accessed 25/09/2022).

IGBP (International Geosphere-Biosphere Programme), 1999. "Global Analysis, Integration and Modelling, "(IGBP, International Council of Scientific Unions, (ICSU), Durham, NH, 2000) http://gaim.unh.edu/; H. J. Schellnhuber, Nature 402, C19 (1999); National Research Council, Committee on Global Change Research, Global Environmental Change: Research Pathways for the Next Decade (National Academy Press, Washington, DC, 1999), p. 531, http://www.nap.edu/catalog/5992.html. (accessed 23/08/2022).

ILO (International Labour Organization), 2022. ILO Conventions on child labour. International Labour Organization, Genève 22, Switzerland. See: https://www.ilo.org/ipec/facts/ILOconventionsonchildlabour/lang--en/index.htm (accessed 28/09/2022).

ITUC (International Trade Union Confederation). (2014). The Case Against Qatar, Host of the FIFA 2022 World Cup, ITUC Special Report, March 2014. International Trade Union Confederation. https://www.ituc-csi.org/IMG/pdf/the_case_against_qatar_en_web170314.pdf (accessed 25/09/2022).

Jørgensen, R., 1989. Criteria for dating prehistoric graves: Stone Age, Bronze Age or Iron Age?. Acta Borealia, 6(2), pp.28-41.

Marsh, (2022). Five Ways COVID-19 Has Impacted Construction Companies. See: https://www.marsh.com/uk/industries/construction/insights/five-ways-covid-19-has-impacted-construction-companies.html (accessed 29/09/2022).

MDGs (Millennium Development Goals), 2000. The eight Millennium Development Goals (MDGs). United Nations, New York, United States. See: https://www.un.org/millenniumgoals/bkgd.shtml (accessed 24/09/2022).

Mensah, J. (2019). Sustainable development: meaning, history, principles, pillars, and implications for human action: literature review. Cogent Social Sciences, 5(1), 1653531, https://doi.org/10.1080/23311886.2019.1653531.

MNRE (Ministry of New and Renewable Energy), 2022. Solar Schemes. Ministry of New and Renewable Energy, India. See: https://mnre.gov.in/solar/schemes#:~:text=Grid%20Connected%20Solar%20Rooftop%20Programme&text=For%20achieving%20cumulative%20capacity%20of,Projects%20by%20the%20year%202022.&text=Progressive%20incentive%20for%20Discoms%20for,end%20of%20previous%20financial%20year). (accessed 03/10/2022).

MPDSI (Ministry of Planning Development and Special Initiatives), 2022. Construction Industry Development Board (CIDB) Bill. Ministry of Planning Development and Special Initiatives, Islamabad, Pakistan. See: https://www.pc.gov.pk/web/draftlegis (accessed 29/09/2022).

NASA (National Aeronautics and Space Administration), 2022. Global Temperature, NASA, Washington, D.C. United States. See: https://climate.nasa.gov/vital-signs/global-temperature/ (accessed 29/09/2022).

NASA (National Aeronautics and Space Administration), 2022. The Mars Exploration Program. National Aeronautics and Space Administration, Washington, United States. See: https://mars.nasa.gov/programmissions/overview/ (accessed 03/10/2022).

Nässén, J., Holmberg, J., Wadeskog, A. and Nyman, M., 2007. Direct and indirect energy use and carbon emissions in the production phase of buildings: an input–output analysis. Energy, 32(9), pp.1593-1602.

Nilsson, M., Griggs, D. and Visbeck, M., 2016. Policy: map the interactions between Sustainable Development Goals. Nature, 534(7607), pp.320-322.

OECD (Organisation for Economic Co-operation and Development), 2012. Environmental Outlook to 2050: the Consequences of Inaction Organization for Economic and Co-operative Development (2012). OECD Headquarters, Paris, France. See: https://www.oecd.org/g20/topics/energy-environment-green-growth/oecdenvironmentaloutlookto2050theconsequencesofinaction.htm (accessed 13/07/2022).

Ofori, G., 2016, May. Construction in Developing Countries: Current imperatives and potential. In Proceedings of the CIB World Building Congress (Vol. 1, pp. 39-52).

Olanipekun, A.O. and Saka, N. 2019. Response of the Nigerian construction sector to economic shocks . Construction Economics and Building, 19:2, 160-180. https://doi.org/10.5130/AJCEB.v19i2.6667.

ONS, 2022 (Office for National Statistics), 2022. Dataset - EMP13: Employment by industry. ONS, United Kingdom. See: https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/datasets/employmentbyindustryemp13 (accessed 25/09/2022).

Opoku, A., 2022. Construction industry and the Sustainable Development Goals (SDGs). In Research Companion to Construction Economics. Edward Elgar Publishing.

Opoku. A (2919). Biodiversity and the built environment: implications for the Sustainable Development Goals (SDGs). Resour. Conserv. Recycl., 141 (2019), pp. 1-7. https://doi.org/10.1016/j.resconrec.2018.10.011.

Paris Agreement, 2015. Paris Agreement. United Nations, New York, United States. See: http://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf (accessed 24/09/2022).

RICS (Royal Institution of Chartered Surveyor), 2021. Q4 2021: Global Construction Monitor. RICS, London, United Kingdom. See: https://www.rics.org/globalassets/rics-website/media/knowledge/research/market-surveys/construction-monitor/q4-2021-global-construction-monitor---headline-report.pdf (accessed 25/09/2022).

Robinson, G., 2015. Global Construction 2030. See: https://www.databasedanalysis.com/global-construction-perspectives/ (accessed 25/09/2022).

Rose, M. (2021). Data Review: How many people die from air pollution? Our World in Data. See: https://ourworldindata.org/data-review-air-pollution-deaths (accessed 02/10/2022).

Roy, A. and Pramanick, K., 2019. Analysing progress of sustainable development goal 6 in India: Past, present, and future. Journal of environmental management, 232, pp.1049-1065.

Sachs, J., Lafortune, G., Kroll, C., Fuller, G. and Woelm, F., 2022. From Crisis to Sustainable Development: the SDGs as Roadmap to 2030 and Beyond. Sustainable Development Report 2022. Cambridge: Cambridge University Press. See: https://dashboards.sdgindex.org/ (accessed 27/09/2022).

Sachs, J., Schmidt-Traub, G., Mazzucato, M., Messner, D., Nakicenovic, N. and Rockström, J. (2019). Six transformations to achieve the Sustainable Development Goals. Nature Sustainability, 2(9), 805–814. https://doi.org/10.1038/s41893-019-0352.

Sachs, J.D., 2015. The age of sustainable development. Columbia University Press, New York, United States.

SDGR (Sustainable Development Goals Report), 2022. Sustainable Development Goals Report, 2022, United Nations, New York, United States. See: https://unstats.un.org/sdgs/report/2022/ (accessed 25/09/2022).

Statista, 2021. Total employed persons in the United States in 2021, by industry. Statista, New York, United States. See: https://www.statista.com/statistics/200143/employment-in-selected-us-industries/ (accessed 25/09/2022).

The Global Economy, 2019. Roads quality - Country rankings. The Global Economy, online. See: https://www.theglobaleconomy.com/rankings/roads_quality/ (accessed 12/01/2022).

The Guardian, 2018. Experts call for construction industry development board. The Guardian, Nigeria. See: https://guardian.ng/property/experts-call-for-construction-industry-development-board/ (accessed 29/09/2022).

Transparency Market Research, 2017. Construction Waste Market Construction Waste Market - Global Industry Analysis, Size, Share, Growth, Trends, and Forecast 2017 – 2025. Transparency Market Research, New York, United States. See: https://www.transparencymarketresearch.com/construction-waste-market.html (accessed 25/09/2022).

Tronchin, L., Manfren, M. and Nastasi, B., 2018. Energy efficiency, demand side management and energy storage technologies–A critical analysis of possible paths of integration in the built environment. Renewable and Sustainable Energy Reviews, 95, pp.341-353.

Umar, T. and Umeokafor, N., 2022. Exploring the GCC Progress Towards United Nations Sustainable Development Goals. International Journal of Social Ecology and Sustainable Development (IJSESD), 13(1), pp.1-32. https://doi.org/10.4018/IJSESD.2022010105.

Umar, T., 2021. Estimating greenhouse gas (GHG) emissions from municipal solid waste (MSW) in Oman using different frameworks. The Journal of Solid Waste Technology and Management, 47(2), pp.332-348. https://doi.org/10.5276/JSWTM/2021.332.

Umar, T., 2022. The impact of COVID-19 on the GCC construction industry. International Journal of Service Science, Management, Engineering, and Technology (IJSSMET), 13(2), pp.1-17. https://doi.org/10.4018/IJSSMET.20220301.oa1.

Umar, T., Egbu, C., Ofori, G., Honnurvali, M.S., Saidani, M. and Opoku, A., 2020. Challenges towards renewable energy: an exploratory study from the Arabian Gulf region. Proceedings of the institution of civil engineers-energy, 173(2), pp.68-80. https://doi.org/10.1680/jener.19.00034.

Umar, T., Egbu, C., Ofori, G., Honnurvali, M.S., Saidani, M., Shibani, A., Opoku, A., Gupta, N. and Goh, K., 2020, March. UAE's commitment towards UN Sustainable Development Goals. Proceedings of the Institution of Civil Engineers-Engineering Sustainability (Vol. 173, No. 7, pp. 325-343). https://doi.org/10.1680/jensu.19.00036.

Umar, T., Egbu, C., Wamuziri, S. and Honnurvali, M.S., 2018. Briefing: Occupational safety and health regulations in Oman. Proceedings of the Institution of Civil Engineers-Management, Procurement and Law, 171(3), pp.93-99. https://doi.org/10.1680/jmapl.18.00007.

UN (united Nations), 2018. Around 2.5 billion more people will be living in cities by 2050, projects new UN report. Department of Economic and Social Affairs, United Nations, New York, United States. See: https://www.un.org/development/desa/en/news/population/2018-world-urbanization-prospects.html (accessed 02/10/2022).

UN SDGs (United Nations Sustainable Development Goals), 2015. About the Sustainable Development Goals. United Nations, New York, United States. See: https://www.un.org/sustainabledevelopment/sustainable-development-goals/ (accessed 23/08/2022).

UNDP (United Nations Development Programme), 2022-a. Human Development Index (HDI), United Nations Development Programme, New York, United States. See: https://hdr.undp.org/data-center/human-development-index?source=searchad&gclid=CjwKCAjwvsqZBhAlEiwAqAHElfv9w--rmVb1jt9YGMYhermAIOhTc2HXYiVFH7OUXRki8xPI6-7a-RoCSEQQAvD_BwE#/indicies/HDI (accessed 27/09/2022).

UNDP (United Nations Development Programme). 2022-b. Human Development Report 2021-22: Uncertain Times, Unsettled Lives: Shaping our Future in a Transforming World. New York, United States. See: https://hdr.undp.org/content/human-development-report-2021-22 (accessed 27/09/2022).

UNEP (United Nations Environment Programme), 2021. 2021 Global Status Report for Buildings and Construction: Towards a Zero-emission, Efficient and Resilient Buildings and Construction Sector. Nairobi. See: https://globalabc.org/resources/publications/2021-global-status-report-buildings-and-construction (accessed 25/09/2022).

UNICEF (United Nations International Children's Emergency Fund), 2022. Devastating floods in Pakistan. UNICEF, New York, Untied States. See: https://www.unicef.org/emergencies/devastating-floods-pakistan-2022 (accessed 29/09/2022).

United Nations (2019). World Population Prospects (2019). United Nations, New York, United States. See: https://population.un.org/wpp/Download/Standard/Population/ (accessed 13/07/2022).

UNSC (United Nations Statistical Commission), 2019. Interlinkages of the 2030 Agenda for Sustainable Development, prepared by the Interlinkages Working Group of the Inter-Agency and Expert Group on Sustainable Development Goal Indicators (IAEG-SDGs) United Nations Statistical Commission (UNSC). 2019. See: https://unstats.un.org/unsd/statcom/50th-session/documents/BG-Item3a-Interlinkages-2030-Agenda-for-Sustainable-Development-E.pdf (accessed 27/09/2022).

Weart, S.R., 2003. *The discovery of global warming*. Harvard University Press.

WEF (World Economic Forum), 2016. These are the world's five biggest slums. World Economic Forum, Geneva, Switzerland. See: https://www.weforum.org/agenda/2016/10/these-are-the-worlds-five-biggest-slums/ (accessed 02/01/2022).

WEF (World Economic Forum), 2018. This is how to sustainably feed 10 billion people by 2050. World Economic Forum, Cologny, Switzerland. See: https://www.weforum.org/agenda/2018/12/how-to-sustainably-feed-10-billion-people-by-2050-in-21-charts/ (accessed 23/08/2022).

WEF (World Economic Forum), 2019. These eco-friendly, affordable housing settlements around the world are under threat. World Economic Forum, Geneva, Switzerland. See: https://www.weforum.org/agenda/2019/08/billion-slum-dwellers-at-risk/ (accessed 02/10/2022).

WEF (World Economic Forum), 2021. Global Warming Chart - Here's How Temperatures Have Risen Since 1950. World Economic Forum, Cologny, Switzerland. See: https://www.weforum.org/agenda/2021/01/global-warming-chart-average-temperatures-rising (accessed 25/09/2022).

WHO (World Health Organization), 2021. WHO Global Air Quality Guidelines. World Health Organization, Geneva, Switzerland. See: https://www.who.int/news-room/questions-and-answers/item/who-global-air-quality-guidelines (accessed 02/10/2022).

World Bank (2022). Trends in Solid Waste Management. World Bank, Washington, United States. See: https://datatopics.worldbank.org/what-a-waste/trends_in_solid_waste_management.html (accessed 02/10/2022).