Book Chapter

Adoption of Green Building Technologies in Ghana

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1.1 Introduction

The construction industry has gained growing attention in international policies for sustainable development (Berardi, 2013; Lai et al., 2017). Much of this attention could be accredited to the industry's energy consumption and greenhouse gas (GHG) emissions, which on a global level characterize over 40% each of the total energy consumption and GHG emissions (IEA, 2013a, b). Through this large consumption of energy and emission of GHGs, the construction industry generates significant negative impacts upon the environment, economy, and society. The GHG emissions provoke climate change, which has been one of the world's most pressing issues for years (IPCC, 2007, 2014, 2018). The United Nations Environment Programme (UNEP) (2009) argued that reducing the GHG emissions from the construction industry, which can be done by reducing the industry's energy consumption, would bring multiple sustainability benefits to the environment, economy, and society. It is urgent for the world's governments, policy makers, and decision makers to find ways to tackle the construction industry's energy consumption and GHG emissions. This is because it has been predicted that, if nothing is done, the construction industry's energy use and GHG emissions would rise by more than 50% by 2050 (IEA, 2014; Berardi, 2017). The construction industry has also been said to be a resource-intensive industry (Shi et al., 2017) that consumes 40% of the global raw materials (sand, gravel, and stone), 25% of the global timber resources, and 12-16% of the global water available (Arena and De Rosa, 2003; Son et al., 2011). As well, the activities and operations of the construction industry lead to the generation of huge amounts of solid waste, dust, smoke, noise, and wastewater (Tam and Tam, 2008; Shen et al., 2017), which can be detrimental to the environment and human health.

The aforesaid issues emphasize the need for transition towards sustainability in the construction industry. As established by Berardi (2013), the need to move towards sustainability within the construction industry is further justified by the contribution that the industry makes toward the general economy. The construction industry accounts for 10-40% of countries' gross domestic product (GDP) and, on average, provides 10% of world employment, according to the UNEP (2009). Inside developing countries, the increasing importance of the construction industry also underscores the necessity for greater attention towards sustainability (Berardi, 2013). Likewise, owing to the fact that developing countries face numerous problems, such as rapid urbanization, environmental degradation, social inequity, and deep poverty, Du Plessis (2002, 2007) argued for embracing sustainability in the construction industry of developing countries. Accordingly, she designed an "Agenda 21" and a "Strategic Framework" for sustainable construction within developing countries. Moreover, as developing countries cause approximately 60% of the total GHG emissions of the global construction industry (Huang et al., 2018), it is highly important to implement sustainability inside the construction industry of these countries.

As much of the discussion in the present chapter refers to the Ghanaian construction industry, understanding the Ghanaian situation is valuable. The World Economic Situation and Prospects (2014) classifies developing countries as those countries with gross national income (GNI) per capita of US$12,615 or less. As a developing country, Ghana had a GNI per capita of US$1,380 in 2016 (World Bank, 2017). In addition, in 2016, the estimated GDP of Ghana was US$42.69 billion (Trading Economics, 2018), with the construction industry accounting for US$667.35 million. Also, Owusu-Manu and Badu (2011) indicated that in Ghana, the construction industry accounts for approximately 8.2% of GDP annually, and provides employment for 2.3% of the population of nearly 29.5 million (Worldometers, 2018). In spite of the construction industry's contribution to the Ghanaian economy, the industry also has harmful environmental, economic, and social effects upon the community, as a result of its poor and unsustainable use of resources such as energy, water, and construction materials (Twumasi-Ampofo et al., 2014). In Ghana, buildings are responsible for over 54% of the total electricity energy consumption (Asumadu-Sarkodie and Owusu, 2016). One of the key problems facing Ghana today is the energy crises. During the past four decades (1984, 1994, 1998, 2007, and 2012), Ghana has experienced many serious energy crises with the electricity sector faced with challenges concerning power quality and supply security (Agyarko, 2013). This condition has not only caused Ghana to suffer from load shedding from the start of 2013 till now (Gyamfi et al., 2018), but also costs the country an average of US$2.1 million in loss of productivity every day (Kumi, 2017). The high energy consumption inside the construction industry may be one of key driving factors for these energy crises, particularly as the Ghanaian electricity sector is characterized by high total energy losses and unreliable, inadequate supply to meet high demands (Gyamfi et al., 2018). This underlines the urgency of accepting and implementing sustainability in the construction industry of Ghana.

Green building has emerged as the new way of building to address sustainability issues in the construction industry. While there exist various definitions of green building out there, the US Green Building Council (USGBC) (2018) considered green building as a holistic and integrated concept that begins with the understanding that the construction industry could have significant impacts – both positive and negative – upon the natural environment, as well as the people who inhabit buildings each day. The council further declared that green building represents an effort to amplify the positive and mitigate the negative of these effects all through the whole lifecycle of a building. Through amplifying the positive environmental, economic, and social impacts of the construction industry, while mitigating the negative ones, green building greatly contributes towards sustainable development. The WorldGBC (2018a) has comprehensively demonstrated how green building is contributing to achieving the United Nation's Sustainable Development Goals (SDGs). However, it is worthy to note that green building is not achievable without the adoption/use of green building technologies (GBTs) (Chan et al., 2018). GBTs are defined as technologies, such as green roof technology, prefabrication technology, solar technology, and energy-efficient lighting systems, that are employed in building design and construction so as to hone overall sustainability and environmental performance (Ahmad et al., 2016).

Given that different countries and regions have various characteristics, such as unique cultures and traditions, distinctive climatic conditions, diverse building types and ages, or wide-ranging environmental, economic and social priorities, all of which shape their green building approach (WorldGBC, 2018b), it is necessary to understand how to promote GBTs adoption in specific countries and regions. Whereas many developed countries have made considerable progress in GBTs adoption and development (Lau et al., 2011; Gou et al., 2013), developing countries such as Ghana are nowadays still struggling to emulate the developed countries' GBTs adoption and development progress. One reason may be that green building is fairly new to the construction market of developing countries (Nguyen et al., 2017) and accordingly the green building policy of these countries is still underdeveloped. Mao et al. (2015) and Darko and Chan (2018) showed that GBTs adoption has been slower within developing countries than in developed countries. Stronger efforts are therefore needed in order to promote and accelerate the GBTs adoption in developing countries. As Zhang et al. (2018) highlighted, the adoption of GBTs in buildings is an important step towards global sustainable development. Kumi et al. (2017) also claimed that dealing with Ghana's energy crises requires a variety of actions, such as diversifying the energy generation mix through developing and using renewable energy sources and promoting energy efficiency programs. This supports that adopting GBTs, such as renewable energy technologies (e.g., solar panels) and energy-efficient technologies (e.g., energy-efficient lighting systems), has an enormous potential of helping Ghana to deal with the energy crises by improving energy efficiency (Karunathilake et al., 2018). In 2009, the government of Ghana introduced Ghana's Sustainable Development Action Plan (Alfris, 2013). However, it might be difficult to realize the sustainable development of Ghana in the face of the energy crises. The encouragement of the widespread GBTs adoption in Ghana is therefore critical.

The GBTs adoption in Ghana is slow and still in its infancy (Darko et al., 2017). Consequently, GBTs adoption, and thus green buildings development, is still uncommon in Ghana. While the Ghana Green Building Council (GHGBC) was established in 2009 to lead the green building movement in Ghana (GHGBC, 2010), the government has yet to devise a roadmap to facilitate this movement. Also, only a handful of buildings in Ghana, e.g., the first LEED-certified green hospital within Africa, the Ridge Hospital (Bubbs, 2017); and the first green commercial office building within West Africa, the One Airport Square (ArchDaily, 2015), have received green certification. This indicates that GBTs adoption is not widespread in Ghana, justifying the value of taking initiatives to promote the widespread adoption of GBTs to realize sustainability goals. This chapter attempts to contribute towards these initiatives through understanding three issues that are momentous to the successful adoption and promotion of GBTs in Ghana – drivers for the GBTs adoption; barriers to GBTs adoption; and strategies to promote GBTs adoption. This chapter is based upon empirical evidence and was born from a larger research project aimed at promoting GBTs adoption in Ghana (Darko, 2018). Because of the word/space restriction, this chapter has purposefully not entered into presenting the comprehensive reviews of the relevant literatures, and detailed descriptions of the study methodology and data analysis, which can be found in Darko (2018). It is hoped that this study will assist the Ghanaian government and other policy makers, industry practitioners and stakeholders, as well as green building advocates to formulate and apply proper and effective policies and strategies to promote the GBTs adoption.

1.2 Drivers for GBTs Adoption in Ghana

GBTs adoption provides numerous sustainability benefits that act as drivers for GBTs adoption. Due to different economic conditions and regulations within different countries, the drivers for adopting GBTs differ from country to country. A strong understanding of the drivers for GBTs adoption is useful for helping practitioners and companies (such as developer, consultant, and contractor companies) to understand the significant benefits the GBTs adoption can offer, and thereafter help them to make more informed decisions regarding whether or not to adopt GBTs (Darko et al., 2017). Such an understanding can also help policy makers and advocates in their GBTs adoption promotion efforts; they may identify and widely promote the key drivers in the society to impact the interest people have in GBTs. The key drivers of GBTs adoption in Ghana are – setting a standard for future design and construction, greater energy efficiency, improved occupants' health and well-being, non-renewable resources conservation, and reduced whole lifecycle costs (Darko et al., 2017).

1.2.1 Setting a Standard for Future Design and Construction

Incorporating GBTs into construction projects today can serve as an empirical/practical benchmarking sustainability-focused practice for motivating the meeting of high, green standards in future construction projects via adopting GBTs. This has been a noteworthy driver for the GBTs adoption within Ghana at the moment. It is generally accepted that applying GBTs and practices in the construction industry can affect the industry standards via setting a standard for future design and construction (Mondor, et al., 2013). This is particularly a unique GBTs adoption driver for those developing countries that are now trying to move their built environments in sustainability ways in order to emulate most developed countries. The Ghana Green Building Council has set its mission to "transform the built environment in Ghana towards sustainability through the way Ghanaian communities are planned, designed, constructed, operated, and maintained." So as to successfully carry out this mission, it is imperative for the council to encourage the widespread adoption of GBTs in the current construction industry of Ghana. Doing so to consequently achieve some green buildings may provide confidence for the implementation of GBTs in future construction projects, which may aid the green building movement in Ghana. Moreover, the adoption and diffusion of GBTs today is core to the future of GBTs adoption because the more diffused a particular technology inside the construction industry, the less risky it may be to implement it (Ozorhon and Karahan, 2016). That is, existing green building projects might essentially offer concrete evidence about the practicality and feasibility of using GBTs in construction projects in Ghana, and thus help to inspire the widespread adoption of GBTs. Similarly, it is worthy to note that those companies and practitioners in the current construction industry of Ghana implementing GBTs to achieve green buildings are not only setting a pace for GBTs adoption and development, but might also be enjoying the competitive advantage associated with such action (Zhang et al., 2011). This competitive advantage may play an essential role in encouraging others to also go "green" by using GBTs as part of their portfolio and marketing strategies. A typical example of adopting GBTs in Ghana to set a standard for future design and construction was established in the One Airport Square project. The consultants of the project stated that the project was developed to "set new standards for sustainable developments in West Africa" (Mace Group, 2018), whereas the architects asserted that the project was designed with green technologies and measures "to become a point of reference and example for the new generation of commercial office buildings in West Africa" (ArchDaily, 2015).

1.2.2 Greater Energy Efficiency

Being in line with and closely tied to the energy problems in Ghana, as explained before, greater energy efficiency represents another major driver behind the GBTs adoption inside Ghana. Energy efficiency is of high importance for sustainable development in both developed and developing countries (Pacheco et al., 2012). It has been globally recognized as a low-cost, readily available resource that has great potential for ameliorating the electricity supply security and thus energy efficiency situation in a country (Gyamfi et al., 2018). As such, energy efficiency has emerged as a priority issue in Ghana and recently received considerable attention from the regulating agencies in charge of energy issues, e.g., the Energy Commission of Ghana, and Ghana Energy Foundation. One of the well-documented benefits associated with green buildings around the world is energy efficiency, which is associated with GHG emissions reduction. The WorldGBC (2018c) highlighted the benefits of green buildings in an attempt to facilitate a growing evidence base for verifying them. It indicated that, at a global level, through green building, the construction industry has the potential of making energy savings of 50% or more, together with emissions savings of as much as 84 gigatons of CO_2 ($GtCO_2$), by 2050. At a building level, green buildings inside India are shown to save 40-50% of energy compared to non-green Indian buildings (WorldGBC, 2018c). GBTs adoption has a key role in securing this energy saving potential of the construction industry and buildings. For the Ridge Hospital in Ghana, the main reason for applying GBTs such as solar water heater was to limit the reliance upon electricity energy (Bubbs, 2017). This implies that the desire for greater energy efficiency greatly influenced the decision-making process of adopting GBTs in this project. Ghana should take actions to promote and encourage the widespread use of GBTs in the construction industry to reduce energy consumption and so realize greater energy efficiency throughout the country. Achieving greater energy efficiency through GBTs adoption might have power in transforming the sustainability and sustainable development of Ghana, because it would significantly benefit the environment and climate.

1.2.3 Improved Occupants' Health and Well-being

While the average person spends approximately 90% of his or her time indoors, the levels of pollutants indoors are usually higher than the levels outdoor (USEPA, 2017). Thus, ensuring that the indoor environment of buildings possesses a good quality is indispensable to the health and well-being of people who occupy buildings for various purposes, such as working and entertainment. In addition to setting a standard for future design and construction and causing greater energy efficiency, GBTs adoption can also help to ensure that buildings run in a way that improves and protects the health and well-being of their occupants. The improved occupants' health and well-being that GBTs adoption brings shapes and drives GBTs adoption within Ghana (Darko et al., 2017). According to the World Health Organization (2015), in Ghana, safe and healthy environment has weighty implications for the health and well-being of people, making the GBTs adoption to create a healthy and sustainable built environment necessary. Many studies have discussed the GBTs adoption benefits that are around the health and well-being of building occupants. The WorldGBC (2018c) indicated that compared to workers in non-green offices, workers in green, well-ventilated offices experience much better brain function. The American Academy of Sleep Medicine (2013) studied the link among workplace daylight exposure and the sleep, physical activity, and quality of life of office workers. The study yielded some interesting findings. It was found that office workers who are exposed to workplace daylight slept an average of 46 minutes more per night, have much more physical activity and much better quality of life, compared to those without workplace daylight exposure. This finding seems to confirm Kats's (2003) claim that applying natural lighting and ventilation as well as air quality enhancement technologies in buildings typically contribute to optimizing the health and well-being of occupants. In view of these occupants' health and well-being-related benefits GBTs adoption can afford, it may be justifiable and reasonable to support and promote the widespread GBTs adoption in Ghana. The One Airport Square adopted GBTs such as glass façade composed of a fixed and a movable bottom, central atrium, and spaces of circulation so as to promote natural lighting and ventilation in indoor environments (Alchimag, 2016). This action might substantially benefit the health of the occupants, as deliberated above, and therefore may be rational for other Ghanaian building projects to replicate it.

1.2.4 Non-renewable Resources Conservation

This is another principal driver for GBTs adoption in Ghana. Taking non-renewable energy resources for example, Ghana supports their protection, for a sustainable socioeconomic development, by the development and deployment of naturally gifted renewable energy sources (such as solar, biomass, and wind) for electricity generation. Accordingly, the country enacted the "Renewable Energy Act" – Act 832 – in 2011 to provide for the management, development, and sufficient supply and application of renewable energy for generating power and heat and for other related issues (Parliament of the Republic of Ghana, 2011; Togobo, 2016). Several studies confirm a positive correlation between renewable energy and sustainable development, including those that agree that making electricity from renewable energy resources can have a crucial part in electricity generation in Africa (Bugaje, 2006; Aliyu et al., 2018). Ghana is among the leading African countries with substantial renewable energy policies (Sakah et al., 2017), suggesting that Ghana has all the potential for resolving its energy glitches if these renewable energy policies are properly optimized and used appropriately. One recommendation is to enforce the incorporation of renewable energy (green) technologies, such as solar water heating and electricity, in construction projects. Such a strategy would result in solar-powered, energy-efficient buildings that can help to combat climate change and its effects via the mitigation of the use of non-renewable energy resources (e.g., fossil fuel) that produce huge quantities of GHG emissions, the leading cause of climate change. Aside from helping to conserve non-renewable energy resources, adopting renewable energy technologies also makes a remarkable contribution to achieving the greater energy efficiency that is also driving GBTs adoption in Ghana. The WorldGBC (2018a) claimed that "energy efficiency coupled with local renewable sources improves energy security", an unavoidable factor for Ghana's sustainable development.

1.2.5 Reduced Whole Lifecycle Costs

GBTs adoption delivers economic/financial benefits too, which are also driving the GBTs adoption within Ghana in a notable way because they are relevant to a broad range of stakeholders (WorldGBC, 2018c). In essence, adopting GBTs helps to deliver green buildings that, throughout their entire lifecycle, could be cheaper to operate and maintain than non-green ones. Green buildings that use renewable energy technologies, for instance, can be cheaper to run since they make use of free, renewable resources. Unquestionably, renewable energy could be cheaper than fossil fuel alternatives, for example. The International Renewable Energy Agency (IRENA) suggested that residential photovoltaic or solar technologies in Africa can offer households with electricity for as low as US$56 per year, which is much cheaper than energy from kerosene or diesel (WorldGBC, 2018a). This may provide enough justification for Ghana to promote the widespread adoption of solar technologies and other GBTs that can result in additional long-term cost savings upon utility bills – via, for example, water efficiency (e.g., rainwater harvesting technology) – in the construction industry.

1.3 Barriers to GBTs Adoption in Ghana

Despite its many benefits, the GBTs adoption still encounters various barriers. Advantageous to the successful adoption and promotion of GBTs is a clear understanding of these barriers – it can help to find ways to address the barriers and thus promote the widespread GBTs adoption. Like several other countries, Ghana encounters barriers in GBTs adoption. These barriers are due to various reasons ranging from economic and local market conditions to human attitudes. The chief barriers to the GBTs adoption in Ghana, however, are: higher costs of GBTs; lack of government incentives; lack of financing schemes (e.g., bank loans); unavailability of GBTs suppliers; and lack of local institutes and facilities for GBTs research and development (R&D) (Chan et al., 2018). As Berardi (2013) substantiated, the most recognized barriers to the GBTs and practices adoption are economic ones. This is reflected in the Ghanaian setting.

1.3.1 Higher Costs of GBTs

As an economic issue, cost has been a longstanding major barrier to the widespread adoption of GBTs and practices (Yudelson, 2008). Of course, even though the extra cost of adopting GBTs can be compensated for in a lifecycle perspective, the higher initial cost of GBTs could be a barrier to the GBTs adoption. GBTs typically cost significantly more than non-green building technologies. For example, Hwang and Tan (2012) reported that, as a green substitute for conventional plywood, compressed wheat board costs around 10 times more than conventional plywood. Additionally, energy-efficient technologies may be more expensive. In essence, the higher costs of GBTs add to project cost, and could be a major problem for project stakeholders as long as they remain sensitive to financial issues. Research has established that green building projects cost about 9.37% more than non-green building projects (Vyas and Jha, 2018). A remarkable part of this phenomenon could be attributed to the higher costs of GBTs. Some also trust that the use of GBTs can increase project cost by 10-20% (WorldGBC, 2013). In the light of these issues, the higher costs of GBTs may represent a main impediment to GBTs adoption in construction projects within especially developing countries such as Ghana wherein poverty is prevalent and entrenched (Cooke et al., 2016).

1.3.2 Lack of Government Incentives

In fact, government leadership and role is vital for the adoption and promotion of GBTs, and this is particularly true in developing countries wherein the GBTs adoption practice is still in its early stages. Within such countries, the government needs to take a more proactive role in promoting the GBTs adoption by taking a variety of relevant actions, one of which is providing incentives – both financial and nonfinancial incentives – to stimulate the GBTs adoption. An incentive may be described as something that impacts people to act in some ways (Ozdemir, 2000). Essentially, in the green building context, government incentives impact people to accept and embrace GBTs in their construction projects because they help in many ways, including offering compensation for the extra cost and time that the GBTs adoption might require. However, unfortunately, Ghana presently has no government incentive schemes directed toward the use of GBTs in construction projects, a situation that is largely contributing to the slow pace of GBTs adoption in the country. While the lack of government incentives for the GBTs adoption does not help lowering the barrier of cost, this chapter will later discuss the strategies that can be used to address these barriers for the successful and widespread adoption of GBTs in Ghana.

1.3.3 Lack of Financing Schemes (e.g., Bank Loans)

For all stakeholders, raising money for projects always represents a challenge (Yudelson, 2008). This challenge is more critical for those who need to raise money for green building projects which involve GBTs with higher costs. Thus, over the past decade, there has been an increasing number of third-party financing sources for investing in green projects and hence GBTs. While this holds true in developed countries such as the US, UK, Australia, Singapore, and Hong Kong (Shan et al., 2017), the opposite situation exists in Ghana. So, Ghanaian practitioners have a difficult time trying to find financing sources for green projects that can defray the high costs of GBTs. Again, the lack of financing schemes also makes it hard to deal with the cost barrier in the GBTs adoption in Ghana. Bank loans, for example, are one of the most common financing schemes for green projects around the world (Shan et al, 2017). Yet, within Ghana, it is arduous to find banks and other financial institutions that grant loans for green projects.

1.3.4 Unavailability of GBTs Suppliers

Suppliers have an important part in the successful adoption of GBTs. They are not only the vendors who serve the industry with the needed GBTs, but also the main source of information concerning the GBTs. But, the unavailability of GBTs suppliers that result in unavailability of GBTs in the local market has been a key barrier to GBTs adoption in Ghana. This barrier was encountered in some existing green building projects in the country. For instance, it was encountered in the Ridge Hospital project where the architect revealed that most of the infrastructure and technologies that support green building in developed countries such as the US and Canada do not exist in Ghana (Bubbs, 2017). This is mainly because most GBTs are not manufactured and sold locally in Ghana. A similar situation can be found in other developing countries, e.g., Turkey (Aktas and Ozorhon, 2015), implying that the current GBTs supply chain within developing countries remains immature with a shortage of suppliers. Often, Ghana imports the GBTs from other countries like the US and Canada where the GBTs markets are more developed. While the global suppliers may offer innovative solutions, this move may come with "higher costs", which also greatly hinders the GBTs adoption in Ghana.

1.3.5 Lack of Local Institutes and Facilities for GBTs R&D

This is another important barrier to the GBTs adoption in Ghana. R&D is critical to the adoption and implementation of GBTs because it is helpful for developing innovating GBTs as well as for studying the benefits of these GBTs. Nevertheless, the GBTs adoption and development in developing countries lags behind that in developed countries, owing to that it is usually faced with a lack of R&D funds, institutes, and facilities (Zhang, 2015). The GBTs R&D requires a great deal of financial support for founding green technology research institutes/centers, educating/training, and recruiting qualified GBTs R&D experts, and this may be a large amount of money for developing countries such as Ghana to handle. As a result, Ghana has yet to establish accredited GBTs R&D institutes, resulting in a serious lack of GBTs R&D capacity in the country. Additionally, the GBTs education is still not better developed, leading to a lack of GBTs R&D experts in Ghana. In essence, the current GBTs R&D situation in Ghana proves to be a major barrier for Ghana in the adoption of GBTs.

1.4 Strategies to Promote GBTs Adoption in Ghana

After discussing barriers, it is reasonable and useful for this chapter to consider some strategies that can be rested upon in overcoming the barriers in order to promote the GBTs adoption. The key strategies to promote the GBTs adoption in Ghana are: more publicity through media (e.g., print media, radio, television, and internet); GBTs-related educational and training programs for developers, contractors, and policy makers; availability of institutional framework for effective GBTs implementation; a strengthened GBTs R&D; and financial and further market-based incentives for GBTs adoption (Darko and Chan, 2018). To promote the GBTs adoption, policy makers, practitioners, and advocates should pay special attention to and implement these strategies.

1.4.1 More Publicity Through Media

The media offers one of the most effective and efficient means to easily and swiftly communicate with the general public, whereas publicity, also called public relations, is a promotion strategy that can help create a positive image for a product, encourage people to use the product through conveying the benefits of the product, raise awareness, and boost demand for the product (Belch and Belch, 2007). Thus, publicity through media can help in promoting GBTs in the public domain. Publicity through the electronic media of the internet and television, for example, capitalizes on innovative technologies to easily communicate with the public about GBTs. In order to promote the GBTs adoption in Ghana, the media should be used as a communication and marketing channel for advertising GBTs alongside their benefits. The government could sponsor media campaigns that draw attention and exposure to GBTs, as awareness of the public regarding GBTs and their benefits can help to breakdown the key GBTs adoption barrier of cost. With understanding and awareness of the full range of GBTs adoption benefits, people might be motivated to find the funds to adopt GBTs.

1.4.2 GBTs-related Educational and Training Programs for Developers, Contractors, and Policy Makers

Developers, contractors, and policy makers are key players in adopting and promoting GBTs within the construction industry. The role of developers, for instance, has been generally acknowledged. Mao et al. (2015) showed that developers are not only the chief decision makers in GBTs adoption, but their use of GBTs also impacts scholars' R&D activities, manufacturers' investment plans, and contractors' construction technique. Moreover, Hu et al. (2017) indicated that developers are chief decision makers in GBTs and practices adoption because they are the investors. The research on the main drivers for innovation in construction (Blayse and Manley, 2004) established that developers have massive capacity to influence companies and individual practitioners in the industry in a way that fosters innovation (such as GBTs) adoption. In Ghana, the Ghana Real Estate Developers Association (GREDA) is one of the most active construction industry associations that make recommendations to the government vis-à-vis ways to promote real estate development (GREDA, 2014). It is also active in seeking solutions to the problems, including sustainability problems, inside the Ghanaian property market (GREDA, 2014). These issues indicate that educating and training developers on GBTs would greatly help in promoting GBTs adoption in Ghana. Thus, Ghana needs to develop and implement effective GBTs-related education and training programs for enhancing developers' knowledge and awareness of and expertise in GBTs, so as to promote the widespread GBTs adoption. The GBTs education and training must also consider contractors and policy makers, who are also major stakeholders in GBTs adoption and promotion.

1.4.3 Availability of Institutional Framework for Effective GBTs Implementation

To promote the successful and effective implementation of GBTs inside Ghana, an institutional framework that clearly delineates the roles and responsibilities of all stakeholders is required. As indicated by the Global Water Partnership (GWP) (2008), frameworks represent an important prerequisite for implementing sustainable practices, as they create the basis for successful implementation. Frameworks typically have two key components: legal framework and institutional framework. Whereas the legal framework is determined by local, provincial, and national policies, which constitutes the "rules of the game", the institutional framework consists the organizations and institutions with mechanisms and forums, data and capacity building, instituted to establish the "rules of the game", and to ease stakeholder involvement (GWP, 2008). Hence, an institutional framework could be simply described as a set of formal organizational structures, rules, and informal norms for doing an activity (IEES, 2006). In GBTs adoption, institutional framework may offer an aiding environment for adoption (Lloyd-Williams, 2012) by guiding stakeholders' behavior. To advance GBTs implementation, Ghana should establish an efficient institutional framework, which should comprise various bodies that could actively promote GBTs adoption at various societal levels. Governmental and nongovernmental bodies, industry associations, and community-based organizations are some bodies that may be considered in developing the institutional framework for GBTs implementation; the framework must clearly outline the roles and responsibilities of each body.

1.4.4 A Strengthened GBTs R&D

This GBTs adoption promotion strategy fundamentally assists in overcoming the "lack of local institutes and facilities for GBTs R&D" barrier. Having strong R&D base in GBT can be critical to promoting GBTs adoption. To promote GBTs adoption in Ghana, it is essential to strengthen GBTs research and communication. The R&D efforts could focus on studying the locally available GBTs, their application, applicability, and performance. They should also conduct proper analyses to show the lifecycle costs and benefits of the GBTs in real time. To support this agenda, the government can establish GBTs research institutes and centers and/or support academic institutions, e.g., universities, to undertake GBTs R&D. Once the research about GBTs and their costs and benefits has been done, good communication and marketing strategies, such as "more publicity through media", workshops, seminars, academic and industrial publications, and development tours, must be adopted to share the outcomes with the industrial practitioners and the public. This is necessary because having proper information on costs, benefits, and return on investment is important to keeping GBTs under consideration, rather than losing them to strictly financial considerations (Yudelson, 2008), thus overcoming the "higher costs of GBTs" barrier.

1.4.5 Financial and Further Market-based Incentives for GBTs adoption

In the context of Ghana, this promotion strategy may help to overcome three key barriers to the GBTs adoption: lack of government incentives, higher costs of GBTs, and lack of financing schemes. Giving incentives represents a very crucial strategy to promote GBTs adoption. To promote widespread adoption of GBTs in Ghana, the Ghanaian government should launch effective green building incentive schemes. It could provide financial and nonfinancial incentives for encouraging people to adopt GBTs within their construction projects. For the financial incentives, the government can adopt green building incentives such as free or subsidized development application fees, direct grants, tax reliefs, special loans, and density bonus, while for the nonfinancial incentives, it can adopt the gross floor area concession scheme, expedited permitting, etc. (Gou et al., 2013). In order to ensure the promotion of GBTs adoption, these incentives should be offered to organizations and companies that support GBTs adoption; this can encourage and incentivize them and others to pursue GBTs.

1.5 Conclusions

Green building represents a construction approach that aims at contributing towards achieving the world's key sustainable development goal: decoupling economic development from climate change, inequality, and poverty. The adoption of GBTs is a necessity for successfully executing green building, and hence every nation needs to promote the GBTs adoption in its construction industry to foster sustainable development worldwide. This chapter aimed at fostering a crystal-clear understanding of how to promote GBTs adoption in Ghana, a developing country in West Africa. To this end, the primary drivers for GBTs adoption have been discussed, with particular focus on Ghana. Similarly, this chapter has analyzed the key barriers hampering the widespread adoption of GBTs in Ghana. Finally, strategies that can be used to overcome the current barriers in the industry and promote the GBTs adoption are presented. The value of this research lies in the fact that this research can aid policy makers, practitioners, and advocates promote the GBTs adoption. The key strategies they could adopt for promoting the GBTs adoption include – more publicity through media; GBTs-related educational and training programs for key stakeholders; availability of institutional framework for effective GBTs implementation; a strengthened GBTs R&D; and financial and further market-based incentives.

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