TOWARDS A GREEN MATERIALS PROCUREMENT: INVESTIGATING THE EGYPTIAN GREEN PYRAMID RATING SYSTEM

Daoud, Ahmed Osama[1,2]
Othman, Ayman[3]
Robinson, Herbert[4]
Bayyati, Ali[5]
[1]Assistant Lecturer, Civil Engineering Dept., Faculty of Engineering, the British Univ. in Egypt, Room 104 Building A, Cairo-Suez Desert Road, Al-Shorouk, 11837, Cairo, Egypt.
[2]PhD Researcher, School of Built Environment and Architecture, London South Bank Univ., 103 Borough Road, London SE1 0AA, Room 315.
[3]Professor of Construction and Project Management, Head of Architectural Engineering Dept., Faculty of Engineering, the British Univ. in Egypt, Room 208 Building A, Cairo-Suez Desert Road, Al-Shorouk, 11837, Cairo, Egypt.
[4]Professor of Project Management and Strategy, School of Built Environment and Architecture, London South Bank Univ., 103 Borough Road, London SE1 0AA, Room 510.
[5]Senior Lecturer, School of Built Environment and Architecture, London South Bank Univ., 103 Borough Road, London SE1 0AA, Room 520.
Email: ahmed.daoud@bue.edu.eg

Abstract

The construction industry plays a crucial role in the social and economic development of countries. Recently, the Egyptian government is exerting tremendous efforts in implementing major construction projects as one of the main goals of Egypt's sustainable development strategy (SDS) 2030. However, construction projects are associated with materials waste generated at different stages. Several studies showed that materials procurement, a critical interface between design and construction stages, contributes up to 50% of total project cost and 11.2% of materials waste. In addition, materials waste has significant negative impacts on the environment. As a result, different organizations worldwide have developed green building rating systems (GBRS) to reduce both materials waste and total project cost necessary to achieve sustainability. The aim of this paper is to explore the following: (1) current problems facing the Egyptian construction industry; (2) construction materials waste in the Egyptian construction industry; and (3) the role of the GBRS in minimizing materials waste and its financial impact on the total project cost. Particularly, the "Materials and Resources" category of Egypt's Green Pyramid Rating System (GPRS) is investigated and analysed to assess its effectiveness and robustness as an approach to reduce materials waste during the procurement process. Limitations of "Materials and Resources" category are indicated and recommendations for its improvement are stated.

Key words

Materials Procurement, Egyptian Green Pyramid Rating System, Green Building Rating Systems, Materials Waste Reduction, Sustainable Development Strategy.

1. Introduction

On the 14th of March 2015, the Egyptian government introduced the "Sustainable Development Strategy (SDS) – Egypt's Vision 2030" during the International Economic Conference in Sharm El Sheikh (State Information Service (SIS), 2015). Egypt's SDS 2030 is a strategy which aims to improve the current economic, environmental, and social dimensions in the Egyptian society without depriving the next generations from enjoying their rights for a better life. Accordingly, Egypt's SDS 2030 clearly stated its vision as follows "*By 2030, Egypt will be a country with a competitive, balanced, and diversified economy, depending on knowledge and creativity, and based on justice, social integration, and participation, with a balanced and varied ecosystem, a country that uses the genius of the place and the citizens in order to achieve sustainable development and improve the quality of the life for all. Moreover, the government looks forward to lifting Egypt, through this strategy, to a position among the top 30 countries in the world, in terms of economic development indicators, fighting corruption, human development, market competitiveness, and the quality of life.*" (Ministry of Planning, Monitoring and Administrative Reform (MPMAR), 2016).

One of the main pillars of Egypt's SDS 2030 is the "urban development" which is categorized under the environmental dimension of Egypt's SDS 2030. The non-existence of new areas, which can accommodate the continuous population growth in Egypt, has led to degradation of urban environment quality due to environmental pollution, traffic congestion, reduction in green spaces, and expansion of random construction on agricultural lands (MPMAR, 2016). Based on that, the government is exerting great efforts towards decentralization by planning and constructing new communities and infrastructure projects all over Egypt such as National Project for the Development of Sinai, National Projects for Roads, National Project for the Development of Upper Egypt, Establishment of New Cities (e.g., New Administrative Capital, East Port Said City, The New Ismailia City, The New Alamein City, and an Integrated City at Al-Galala), The Golden Triangle Project, The National Project for Social Housing, etc. (Invest-gate, 2016). The urban development pillar of Egypt's SDS 2030 is consistent with United Nations sustainable development goals (SDGs) in general, and with Goal no. (11) specifically which is related to sustainable cities and communities through balanced development management of land and resources.

Unfortunately, construction projects are suffering from materials waste generated at different stages in which at least 10% of project's materials cost is wasted (Hussin *et al.*, 2013). The construction industry has its own negative impact on the environment in which 40% of generated waste worldwide is caused by the construction industry (Yılmaz and Bakış, 2015). This means that materials waste leads to financial loss of construction firms and negative impacts on the environment. Materials procurement, a critical interface between design and construction stages, plays an important role in materials waste generation. Materials procurement is defined by Zeb *et al.* (2015) as *"purchasing of materials needed for execution of a project. Procurement is organizing the purchasing and scheduling delivery of materials to the suppliers"*. Materials procurement is responsible for obtaining construction materials in terms of right quantity, quality, time, cost, and place (Kamalaeaswari and Vedhajanani, 2015). Daoud *et al.* (2018) explored the relationship between materials procurement and materials waste minimization, and it was indicated that inefficient materials procurement management would lead to cost and time overrun, and materials waste generation in construction projects. Ajayi *et al.* (2017) indicated that materials procurement affects 50% of total project cost. Additionally, Fadiya *et al.* (2014) stated that materials procurement contributes up to 11.2% of total materials waste generated in the UK. Therefore, a green materials procurement approach has to be applied in the construction industry to alleviate the aforementioned problems.

The main reason of the previous problems is that the unsustainable practices in the construction industry are unable to handle the different challenges regarding waste generation and pollution of the environment. These challenges encouraged many countries to develop and improve their construction practices by taking effective steps towards "sustainable construction" which can help in reducing the use of energy, minimize waste, conserve water resources and materials, minimize water and air pollution, and enhance quality of life (Hussin *et al.*, 2013). Different countries started to develop guidelines and strict standards, named "green building rating systems (GBRS)", to achieve sustainable and green construction industry. One of the main aims of the GBRS is to optimize the usage of materials to reduce both materials waste and total project cost by setting several requirements for sustainable procurement of construction materials. Two examples of the most well-known GBRS are: (1) Building Research Establishment Environmental Assessment Methodology (BREEAM) which is developed in 1990 in the UK to review and develop the performance of buildings related to the environment; and (2) Leadership in Energy and Environment Design (LEED) certification which is developed in the US in 1993 to evaluate the performance of the whole building process starting from water savings, energy efficiency, selection of materials during construction, and ending by the quality of indoor environment during the actual usage of the building (Hussin *et al.*, 2013).

In January 2009, the Egyptian Green Building Council (GBC-Egypt) was established to improve the Egyptian society and act towards cleaner environment through the adoption of green building (GB) practices (Housing and Building National Research Center (HBRC), 2011). In April 2011, the GBC-Egypt has introduced the first version of the Green Pyramid Rating System (GPRS) which included certain guidelines and best practices for sustainable GBs. In 2017, the second version of the GPRS has been published introducing developments and changes to the first published version (HBRC, 2017). Despite the fact that GPRS was developed based on the US LEED, the GPRS still needs more development and improvement (Ammar, 2012). This paper focuses mainly on the "Materials and Resources" category in a trial to better improve the GPRS to help in minimizing the negative impacts of materials waste on the environment and total project cost. This paper starts with a literature review to investigate the current challenges of the construction industry in Egypt, sources of construction materials waste in the Egyptian construction industry and its impact on the environment and economy, and the environmental dimension of Egypt's SDS 2030. Moreover, it explains the GBRS, their aims, and the obstacles towards the implementation of GB practices. Additionally, this paper explores the GPRS and it focuses on the "Materials and Resources" category to indicate the current shortcomings of this category in the GPRS. Finally, conclusion and recommendations for future research are presented.

2. Literature Review

2.1. The Current Challenges of the Egyptian Construction Industry

The construction industry plays a main role in the growth of the Egyptian economy. It contributes 5% of total GDP and employs about 11% of the total population in Egypt (Esam and Ehab, 2015). Despite the unstable economic situations in Egypt through the past seven years, the Egyptian economy has experienced a development in the construction industry in which the real growth rate of "Construction and Building" sector has increased from 9.7% in the fiscal year (FY) 2014/2015 (Central Bank of Egypt (CBE), 2015) to 11.2% in the FY 2015/2016 (CBE, 2016). The amount of investments in the "Construction and Building" sector has been tripled in the FY 2015/2016, in which the value of investments rose by 198.6% to reach LE 11.7 billion in the FY 2015/2016 compared to a rise of 43.2% reaching LE 3.7 billion in the FY 2014/2015 (Barakat *et al.*, 2016; Barakat *et al.*, 2017). This proves that the Egyptian government is exerting great efforts in executing a lot of construction megaprojects, as indicated in the previous section, towards the implementation of Egypt's SDS 2030 goals. However, Barakat *et al.* (2017) stated that the progress of the Egyptian construction industry could slow down in 2017, compared to the past two fiscal years, due to reduction in energy subsidies and devaluation of the Egyptian pound. Consequently, this may lead to a lot of obstacles in the Egyptian construction industry in the form of higher construction materials costs. In spite of that, the Egyptian construction sector would remain on its progress way due to strong structural demand and the increase of investments in this sector (Barakat *et al.*, 2017).

The construction industry is a wasteful sector known by its waste generation and polluting effect on the environment (Azis *et al.*, 2012). In Egypt, construction materials waste represents a great problem to the construction industry (Garas *et al.*, 2001). For instance, the Egyptian construction industry generated 4 million tons of construction and demolition (C&D) waste in 2012 (Zaki and Khial, 2014). This constitutes about 4.5% of the total solid waste generated in Egypt by 2012. Unfortunately, “dumping” is the dominating practice of dealing with C&D waste in Egypt as shown below in Fig. (1) (Azmy and El Gohary, 2017; Abdelhamid, 2014). C&D waste is dumped in facilities which do not have any effective management. Most of the dumping sites are unsafe and there are no effective precautions followed at these sites to prevent the self-ignition of waste which lead to more environmental pollution. Although the Egyptian Environmental Law regulates C&D waste’s disposal; however, it does not include any clause which promotes waste reduction (Azmy and El Gohary, 2017). Unfortunately, the Egyptian construction industry’s attitude towards C&D waste has not improved for a long time leading to a rapid and continuous increase of C&D waste generation (Hany and Dulaimi, 2014; Azmy and El Gohary, 2017). It has been proven that the increasing demand of executing megaprojects will demand the use of more materials and resources which consequently will lead to generation of more C&D waste (Azis *et al.*, 2012; Nagapan *et al.*, 2012; Foo *et al.*, 2013; Ahmad *et al.*, 2014). Accordingly, in order to minimize the environmental pollution and waste of financial resources, the usage of materials should be rationalized through guidelines and standards indicating how to procure materials in a sustainable and green manner (Hany and Dulaimi, 2014; Abdelhamid, 2014).

Fig. (1): 300 Tons of C&D Waste Dumped on Main Roads of Mansoura City

Source: (Dot Msr, 2017)

2.2. Sources of Construction Materials Waste in Egypt and its Impact on the Environment and Economy

The literature of C&D waste has identified various factors which lead to generation of construction materials waste. In a study carried out by Hany and Dulaimi (2014) to explore the C&D waste problem in Egypt specifically in Greater Cairo (GC), four main sources of C&D waste generation were identified as follows: human source, technology source, industry source, and process and governmental source. First, **the human source** is related to the poor planning and design which neglect the environmental best practices and standards such as BREEAM, LEED, GPRS or any other environmental measures. Also, it is related to the higher management's wrong perception regarding waste minimization in which they consider the efforts exerted to minimize C&D waste as a time and profit loss. Moreover, it is related to the client's lack of awareness and responsibility for not advising the designers and the supply chain of the project to follow the GB concepts and practices. Second, **the technology source** is related to the poor technology adopted by the Egyptian construction industry in executing most of its project. It worth mentioning that the generation of massive C&D waste is associated with the poor technology. Third, **the industry source** is related to the unwillingness of the Egyptian construction companies to follow and implement new construction technologies, process management, procurement methodologies, etc. in their projects. Fourth, the **process and governmental source** is related to the lack of the Egyptian government's role in promoting the adoption of green principles through incentives and issuance of legislations.

C&D waste has serious negative impacts on the environment and economy. Construction activities lead to many environmental problems such as dust, noise, vibration, and pollution of soil and groundwater. In Egypt, the current problem of C&D waste management is represented in the accumulation of waste in landfills of limited spaces leading to less strict environmental protection regulations which control waste disposal operations. The biodegradation of C&D waste in landfills leads to serious health and environmental problems (Azmy and El Gohary, 2017). Moreover, C&D waste leads to reduction in the efficiency, effectiveness, value, and profitability of construction companies. C&D waste negatively impact the overall economy of countries (Memon *et al.*, 2015). It has been proven that construction materials and equipment constitutes 50-60% of total project cost and affect 80% of its schedule (Caldas *et al.*, 2014). Accordingly, it is obvious that any loss in materials would impact the construction companies negatively. Therefore, construction companies carrying out megaprojects should pay attention to the sustainable procurement of materials to reduce the negative impact of C&D waste on the environment and avoid huge financial losses.

2.3. The Environmental Dimension of Egypt's SDS 2030

The concept of the environment has been tremendously changed over the past decades to be more comprehensive and not limited only to environmental systems pollution (MPMAR, 2016). The "green economy" concept has emerged and different approaches have been suggested to integrate it into different strategies, policies, plans, and programs. Accordingly, the Egyptian government is trying to imitate different countries which have embedded the green economy concept in different sectors including sustainable societies, eco-friendly cities, GBs, rationalization of resources consumption, etc. The strategic vision for environment to Egypt 2030 clearly states that "*environment is integrated in all economic sectors to preserve natural resources and support their efficient use and investment, while ensuring the next generations' rights. A clean, safe and healthy environment leading to diversified production, resources, and economic activities, supporting competitiveness, providing new jobs, eliminating poverty, and achieving social justice.*" (MPMAR, 2016). This gives insights about the role of the Egyptian government in facing the environmental issues at the international levels knowing its leading role regionally and internationally.

3. Green Building Rating Systems

3.1. History of Green Building Rating Systems

The US Environmental Protection Agency (EPA) defines GBs as "*the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction. This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort. Green building is also known as a sustainable or high performance building.*" (EPA, 2016). The main focus of GB is to eliminate and reduce the negative impacts of buildings on the environment and human health. A GB addresses several aspects such as building's site and surrounding land, energy efficiency, water efficiency, materials and resources, indoor air quality, and building envelope design and elements (Karmany, 2016). All these aspects should be considered and implemented by the project team in any building since early stages to be labelled as a "GB".

Many countries have developed their local GBRS to provide standards and design guidelines to construct GBs. These rating systems were developed to reduce the negative effect of a building on the surrounding environment by quantifying and assessing the impact of buildings on the environment (Karmany, 2016). The development of GBRS has started since early 1990's when the British Research Establishment (BRE) firstly introduced the pioneering Building Research Establishment Assessment Method (BREEAM) to help in reviewing, evaluating, and improving the environmental performance of buildings (Hussin *et al.*, 2013; Karmany, 2016). The initiative of UK's BREEAM has led to the development of many other rating systems worldwide such as US's LEED, US's Green Globes, Japan's CASBEE, France's HQE™, Germany's DGNB, Australia's Green Star, Egypt's GPRS, United Arab Emirates' Estidama Pearl, India's GKHA, China's GBAS, Hong Kong's BEAM, Hong Kong's CEPAS, Malaysia's GBI, Sweden's EcoEffect, Canada's R-2000, etc. (Hussin *et al.*, 2013; Naguib, 2016; Bernardi *et al.*, 2017). Most of these rating systems cover wide range of buildings such as commercial, residential, and retail buildings. Despite the fact that the majority of these rating systems were developed to be optional for projects; however, they became obligatory for the issuance of buildings' permits in some countries. For instance, regulatory bodies in Japan will not certify buildings unless they pass CASBEE assessment with a minimum Built Environment Efficiency (BEE) score of one (Lee, 2013). Moreover, all the governmental buildings in the UK must be certified by BREEAM. Similarly, all public building developments in Hong Kong must receive BEAM Plus certification. Also, regulatory bodies in United Arab Emirates will not issue a residential building's construction initiation approval until it receives a minimum certification of "1 pearl" according to Estidama rating system (Karmany, 2016).

3.2. Main Aims of Green Building Rating Systems

Besides being an assessment tool for evaluating the environmental performance of buildings, GBRS act as a management tool and provide specific guidelines to tackle environmental issues during design, construction, and operation stages. They provide communication channels between project's stakeholders to investigate the environmental concerns to better construct a GB (Li *et al.*, 2017). Moreover, GBRS offer economic benefits by helping in waste and energy costs reduction and offering chances for tax incentives and long-term operating cost savings (Naguib, 2016). The adoption of the GBRS leads to more durability, efficiency, and resiliency of the final project outcome. GBRS encourage project teams to analyse the project from different perspectives in order to minimize costs, increase project life, attract investors, and improve community well-being. They provide milestones which assist in tracking project progress and monitor the performance of the project team (Naguib, 2016). Additionally, GBRS help policy makers in increasing public awareness, encouraging attainment of standards above the minimum requirements of regulations, and maintaining communication channels with the private sector (Lee, 2013). In a few words, GBRS boost the sustainability practices during project execution and have great impacts on achieving a sustainable and green construction industry as shown in Fig. (2).

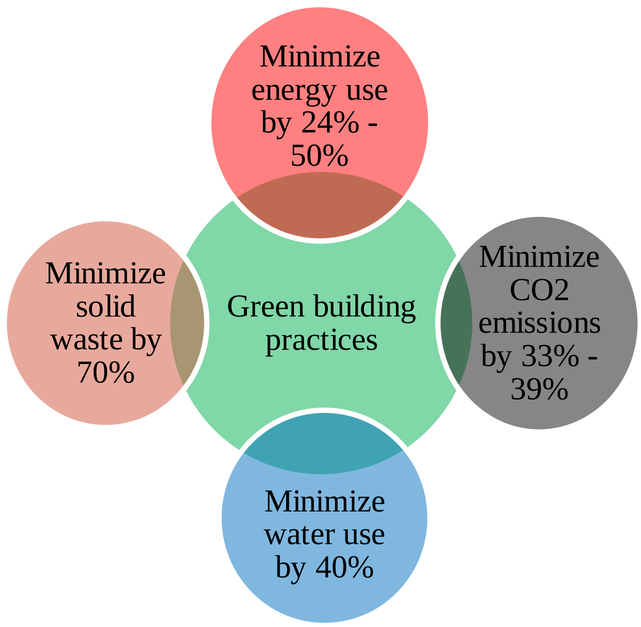

Fig. (2): The Effect of GB Practices on Achieving Sustainable Construction Industry

Source: (Hussin *et al.*, 2013)

3.3. Structure of Green Building Rating Systems

Bernardi *et al.* (2017) claimed that GBRS are made up of four main components as follows: (1) categories; (2) scoring system; (3) weighting system; and (4) output. First, the **categories** refer to a certain set of items which are considered during the assessment of the building's environmental performance. Second, the **scoring system** refers to a performance measurement system which adds the number of possible credits or points that can be gained by fulfilling a certain level of performance in different aspects. Third, the **weighting system** refers to the degree of relevance and importance allocated to each category within the overall scoring system and among the other categories. Fourth, the **output** refers to the overall score and result obtained after carrying out the environmental performance assessment. It is worth mentioning that this general structure and organization is adopted by all GBRS with differences in the weighting system and assessment criteria.

3.4. Obstacles Towards the Implementation of Green Buildings Practices

There are several barriers which hinder the application of the GBs practices within a project. Despite the fact that Egypt has a comprehensive set of design codes and regulations for construction, they are not efficiently implemented due to several reasons as follows: (1) the misplaced incentives; (2) low prices of energy and electricity; and (3) lack of awareness about the importance of using resources efficiently (Karmany, 2016). Chan *et al.* (2017) carried out a survey which examined the barriers affecting the adoption of the GBs practices and technologies in 20 countries including Egypt in which the five main clusters of barriers were identified as follows: (1) economic issues; (2) attitude and market; (3) information, knowledge, and awareness; (4) management and government; and (5) technology and training. Each cluster of barriers consists of series of identified barriers as shown below in Table 1.

Table 1: Main Barriers of Adopting GB Practices and Technologies

Main Cluster of Barriers	**List of Individual Barriers**
Economic issues	- Higher cost of green technologies - Implementation of GB technologies is time consuming and causes project delays - High market prices, rental charges, and long pay-back periods of GBs - Lack of financing schemes (e.g., bank loans)
Attitude and market	- Resistance to change from the use of traditional technologies - Lack of interest and market demand - High degree of distrust about GB technologies - Conflicts of interests among various stakeholders in adopting green technologies - Lack of available and reliable green technologies suppliers - Lack of availability of demonstration projects - Lack of tested and reliable GB technologies
Information, knowledge, and awareness	- Lack of GB technologies databases and information - Lack of knowledge and awareness of GB technologies and their benefits - Lack of reliable GB technologies research and education - Unfamiliarity with GB technologies - Limited experience with the use of untraditional procurement Methods

Management and government	- Lack of government incentives/supports for implementing GB technologies - Fewer GB codes and regulations/legislations available - Insufficient GBRS and labelling programs available - Lack of promotion (i.e., no GB promoters and promotion strategies) - Lack of importance attached to GB technologies by leaders
Technology and training	- Risks and uncertainties involved in implementing new technologies - Difficulties in providing GB technological training for project staff - Lack of technical standard procedures for green construction - Lack of GB expertise/skilled labour - Complexity and rigid requirements involved in adopting GB technologies

Source: (Chan *et al.*, 2017)

4. The Egyptian Green Pyramid Rating System (GPRS)

4.1.1. Main Categories of the GPRS

The GPRS consists of seven main categories considered during the assessment of the building's environmental performance as follows: (1) Sustainable Sites; (2) Energy Efficiency; (3) Water Efficiency; (4) Materials and Resources; (5) Indoor Environmental Quality; (6) Management Protocols; and (7) Innovation and Value Added (HBRC, 2011; HBRC, 2017). Each category contributes by a certain weight towards the certification of the assessed building. These weights have been modified in the second version of the GPRS compared to its first version to consider different weights for certain categories based on their importance and impact on the environment as shown in Table 2 below. Each category consists of a series of defined criteria by which a project can earn credit points by meeting them. A project must satisfy all the minimum mandatory requirements listed in the different categories to be certified by the GPRS. The type of GPRS certification mainly depends on the total accumulated credit points gained after the assessment of the building performance through the different listed categories as shown in Table 3 below. It is worth mentioning that projects which gain credit points less than 40 will be uncertified by the GPRS.

Table 2: The weights of Different Categories Listed in the GPRS

Main Category	**Category weight in GPRS V1**	**Category weight in GPRS V2**

Sustainable Sites	15%	10%
Energy Efficiency	25%	32%
Water Efficiency	30%	20%
Materials and Resources	10%	12%
Indoor Environmental Quality	10%	16%
Management Protocols	10%	10%
Innovation and Value Added	Bonus	Bonus

Source: (HBRC, 2011, HBRC, 2017)

Table 3: The Different Certification Levels of the GPRS

GPRS Certification Levels	Accumulated Credit Points
GPRS Certified	40 – 49 credits
Silver Pyramid	50 – 59 credits
Gold Pyramid	60 – 79 credits
Green Pyramid	80 credits and above

Source: (HBRC, 2011)

4.1.2. Materials and Resources Category of the GPRS

The “Materials and Resources” category aims to reduce the negative environmental impact of using construction materials by considering the following aspects during materials procurement: (1) avoid using toxic or hazardous materials; (2) using materials of high renewable content; and (3) using locally processed materials to reduce transportation needs. This category is made up of five main criteria related to materials extraction, processing, manufacturing and distribution (HBRC, 2017). The five main criteria with their credit points, weights, and options and requirements are summarized as shown below in Table 4. Documents and proofs have to be submitted during the assessment to demonstrate that the different assessment criteria requirements have been fulfilled as indicated.

Table 4: Different Criteria of the Materials and Resources Category Listed in the GPRS

Main Criteria	Maximum Credit Points	Weight in Percentage	Requirements and Options
Renewable Materials and Materials Manufactured Using Renewable Energy	4	2	- Option 1: using at least one construction material which is obtained from renewable resources such as natural stones, earth, etc. - Option 2: using at least one construction material which is manufactured using renewable energy sources such as solar energy, wind energy to reduce CO_2 emission
Regionally Procured Materials and Products	6	3	Credit points are gained when construction materials and products value have been extracted or manufactured within a distance of 500 km of the project site with no less than 50% of the total materials value based on cost
Reduction of Overall Material Use	6	3	- Option 1: using standard assemblies and reducing customized spaces - Option 2: using materials that does not need finishing - Option 3: using materials that possess high durability and require low maintenance
Alternative Building Prefabricated Elements	4	2	Credit points are gained for utilizing totally or partially prefabricated elements. The quantity of prefabricated elements should not be less than 10% of the total element quantity. These prefabricated elements are used to reduce the need for construction skills and reduce materials waste
Environment – Friendly, Sound and Thermal Insulation Materials.	4	2	Credit points are obtained for using materials which satisfy specific requirements as follows: 1) free from chlorofluorocarbons, 2) does not release toxic fumes when burned, 3) the percentage of volatile organic compound is less than 0.1, 4) thermal insulation materials should have an ozone depleting materials of zero and a low global warming potential which does not exceed 5

Source: (HBRC, 2017)

4.1.3. Limitations and Shortcomings in Materials and Resources Category of the GPRS

After investigating the “Materials and Resources” category in the previous section, some limitations have been discovered which need to be further examined and improved. **First**, the weight of the “Materials and Resources” category is observed to be low compared to the weights of other categories listed in the GPRS. Despite the fact that the weight of the “Materials and Resources” has been increased in the second version of the GPRS by 2% compared to its weight in the first version of the GPRS, its weight is still low compared to the weights of most of the GPRS categories. This indicates that a low importance is given to this category regarding its negative environmental impact compared to most of the different categories listed in the GPRS. As aforementioned in this paper, materials waste highly affects the environment and the total project cost. Accordingly, this category should be prioritized in terms of its weight and credit points to be considered with a great attention and concern by developers and construction companies during project execution for materials waste reduction. **Second**, there is no indication or examples of the different types of sustainable materials which are available within the Egyptian context. There should be a list of sustainable materials which are GPRS certified and follow the specifications set by national standards (e.g., Egyptian Organisation for Standards and Quality (EOS)) or international standards (e.g., International Organisation for Standardization (ISO)) to be used as a benchmark during the assessment and a guide by developers and construction companies. It is worth mentioning that these shortcomings could be not the only ones existing in the “Materials and Resources” category, but other shortcomings and limitations could be found if the GPRS is compared with other well-established international rating systems. Accordingly, it is recommended to compare the “Materials and Resources” category in GPRS with its peers in BREEAM and LEED for the sake of improvement and development. The BREEAM and LEED are considered for this comparison as they are the oldest, most implemented and explored, and most well-known rating systems worldwide (Bernardi *et al.*, 2017; Yoon and Park, 2015; Say, 2008).

On the 21st of November 2017, the first author has attended a public workshop at the HBRC where the GPRS in its second version was officially introduced to the public and researchers who are interested in GBs. The GPRS technical committee investigated in depth the different GPRS categories which they shared in their development. The first author has directed two questions to the technical committee regarding his concerns about the weight of the “Materials and Resources” category and the non-existence of a list of certified sustainable materials in the GPRS. Regarding the first question, the technical committee agreed that the weight of the materials and resources category could be considered to be increased in the future versions of the GPRS. Regarding the second question, the technical committee claimed that they left the “Renewable Materials and Materials Manufactured Using Renewable Energy” and “Environment – Friendly, Sound and Thermal Insulation Materials” criteria unspecified in order not to restrict the user of the GPRS by a list of certain materials, but they suggested that this issue can be considered in future versions of the GPRS by introducing a list of certified materials.

5. Conclusion and Recommendations

The construction industry is one of the main pillars of a nation’s development. It contributes greatly to the economic and social development of countries. Nowadays, the Egyptian government is executing a lot of construction megaproject to fulfil the targets of Egypt’s SDS 2030. The execution of these mega projects will be accompanied by the usage of more materials and resource which will consequently result in the generation of more C&D waste. As presented in this paper, the current challenges in the Egyptian construction industry is represented in the higher costs of construction materials and the unsustainable practices of dealing with C&D waste by dumping it in landfills. It has been investigated in this paper that the C&D problem in Egypt is related to four main obstacles as follows: (1) human source; (2) technology source; (3) industry source; and (4) process and governmental source. Accordingly, green solutions have to be promoted and implemented in the Egyptian construction sector to rationalise the materials procurement in order to reduce C&D waste which consequently will lead to mitigation of C&D negative impacts on the environment and economy.

Many countries worldwide developed their own GBRS to rationalise the use of materials and resources and reduce the negative environmental impacts of the construction industry. These GBRS act as guidelines and standards for practitioners and industry professionals to follow the principles of green construction starting from the design phase till operation and maintenance. Following the US's LEED, Egypt has developed its own rating system named "Green Pyramid Rating System (GPRS)". The GPRS has the same general structure and organization which is adopted by most of the GBRS with differences in the weighting system and assessment criteria. This paper investigated thoroughly the "Materials and Resources" category of the GPRS and it was found that this category has two main limitations. The **first limitation** is related to the weight of this category compared to other categories listed in the GPRS. The **second limitation** is related to the non-existence of a list of GPRS certified materials which can be used as a benchmark for assessment and a guide for users. Further shortcomings could be discovered in this category if it is compared in details to its peers in other well-established GBRS such as BREEAM and LEED.

This review, as a part of a current PhD research project, contributes to the existing body of knowledge by investigating the current limitations in the "Materials and Resources" category of the GPRS. Future research in this PhD project will focus on comparing the "Materials and Resources" category in GPRS with its peers in BREEAM and LEED in order to introduce suggestions for better improving and developing this category of the GPRS which highly impact the environment and economy. In order to better achieve the goals of Egypt's SDS 2030 and reduce C&D waste, the governmental bodies in Egypt has to exert more effort in promoting GB principles within the Egyptian society to reduce materials waste which affect both the environment and the economy. GB principles have to be implemented extensively in construction education at universities across Egypt to boost their application and increase the awareness of the negative impact C&D waste on the environment, economy, and society. A minimum score of GPRS certification has to become obligatory for issuance of building's permits like what has been done by several countries such as UK, Japan, and United Arab Emirates. The Egyptian government should introduce incentives for those companies which apply GB principles. Finally, construction companies have to implement green construction technologies and green procurement methodologies within its projects and encourage their clients and employees to follow and implement them.

References

Abdelhamid, M. S., (2014), "Assessment of Different Construction and Demolition Waste Management Approaches", ***HBRC Journal***, 10 (3), pp. 317–326. DOI:10.1016/j.hbrcj.2014.01.003.

Ahmad, A. C., Husin, N. I., Zainol, H., Tharim, A. H. A., Ismail, N. A. and Wahid, A. M. A., (2014), "**The Construction Solid Waste Minimization Practices among Malaysian Contractors**", in: Mydin, M. and Salim, N. (eds.) *Building Surveying, Facilities Management and Engineering Conference (BSFMEC 2014)*. Perak: EDP Sciences, pp. 249–257.

Ajayi, S. O., Oyedele, L. O., Akinade, O. O., Bilal, M., Alaka, H. A. and Owolabi, H. A., (2017), "Optimising Material Procurement for Construction Waste Minimization: An Exploration of Success Factors", ***Sustainable Materials and Technologies***, 11, pp. 38–46. DOI:10.1016/j.susmat.2017.01.001.

Ammar, M. G., (2012), "Evaluation of the Green Egyptian Pyramid", ***Alexandria Engineering Journal***, 51 (4), pp. 293–304. DOI:10.1016/j.aej.2012.09.002.

Azis, A. A. A., Memon, A. H., Rahman, I. A., Nagapan, S. and Latif, Q. B. A. I., (2012), "**Challenges Faced by Construction Industry in Accomplishing Sustainablity Goals**", in: *2012 IEEE Symposium on Business, Engineering and Industrial Applications Challenges - ISBEIA 2012*. Bandung: IEEE Xplore, pp. 630–634.

Azmy, A. M. and El Gohary, R., (2017), "**Environmental and Sustainable Guidelines for Integrated Municipal Solid Waste Management in Egypt**", in: *International Conference on Advanced Technology in Waste Water and Waste Management for Extractive Industries*. Bali.

Barakat, M. S., Naayem, J. H., Baba, S. S., Kanso, F. A., Arabian, G. H., Nahlawi, F. N. and Badr, A., (2017), "*Egypt Economic Report: Amid the Spillover Effects of Wide Macroeconomic Pressures and the Prospects of an Ambitious Adjustment Program*". Bab Idriss. Available from: http://www.bankaudigroup.com

Barakat, M. S., Naayem, J. H., Baba, S. S., Kanso, F. A., Borgi, S. F., Arabian, G. H. and Nahlawi, F. N., (2016), "*Egypt Economic Report: Between the Recovery of the Domestic Economy and the Burden of External Sector Challenges*". Bab Idriss. Available from: http://www.bankaudigroup.com

Bernardi, E., Carlucci, S., Cornaro, C. and Bohne, R. A., (2017), "An Analysis of the Most Adopted Rating Systems for Assessing the Environmental Impact of Buildings", ***Sustainability***, 9 (7), pp. 1–27. DOI:10.3390/su9071226.

Caldas, C. H., Menches, C. L., Reyes, P. M., Navarro, L. and Vargas, D. M., (2014), "Materials Management Practices in the Construction Industry", ***Practice Periodical on Structural Design and Construction***, 20 (3), pp. 1–8. DOI:10.1061/(ASCE)SC.1943-5576.0000238.

Housing and Building National Research Center (HBRC), (2011), "*The Green Pyramid Rating System - First Version*". Ad Doqi, Giza.

Housing and Building National Research Center (HBRC), (2017), "*The Green Pyramid Rating System - Second Version*". Ad Doqi, Giza.

Central Bank of Egypt (CBE), (2015), "*Annual Report 2014/2015*". Cairo. Available from: http://www.cbe.org.eg/en/EconomicResearch/Publications/Pages/AnnualReport.aspx

Central Bank of Egypt (CBE), (2016), "*Annual Report 2015/2016*". Cairo. Available from: http://www.cbe.org.eg/en/EconomicResearch/Publications/Pages/AnnualReport.aspx

Chan, A. P. C., Darko, A., Ameyaw, E. E. and Owusu-Manu, D.-G., (2017), "Barriers Affecting the Adoption of Green Building Technologies", ***Journal of Management in Engineering***, 33 (3), pp. 4016057. DOI:10.1061/(ASCE)ME.1943-5479.0000507.

Daoud, A. O., Othman, A. A., Robinson, H. and Bayyati, A., (2018), “**Exploring The Relationship Between Materials Procurement and Waste Minimization in The Construction Industry: The Case of Egypt**”, in: *The 4th NZAAR International Event Series on Natural and Built Environment, Cities, Sustainability and Advanced Engineering*. Kuala Lumpur: New Zealand Academy of Applied Research Ltd, pp. 76–85.

Dot Msr, (2017), Removing 300 Tons of Construction Waste from Mansoura Streets. Available from: http://www.dotmsr.com/details/850191/صور-رفع-٣٠٠-طن-مخلفات-بناء-من-شوارع-المنصورة [Accessed 9 December 2017].

Esam, M. and Ehab, M., (2015), “*Construction Supply Chain, Inter-sectoral Linkages and Contribution to Economic Growth: The Case of Egypt*”. Cairo. Available from: http://www.eces.org.eg/MediaFiles/Uploaded_Files/5c2eab3f.pdf

Fadiya, O. O., Georgakis, P. and Chinyio, E., (2014), “Quantitative Analysis of the Sources of Construction Waste”, ***Journal of Construction Engineering***, 2014, pp. 9.

Foo, L. C., Abdul Rahman, I., Asmi, A., Nagapan, S. and Khalid, K. I., (2013), “Classification and Quantification of Construction Waste at Housing Project Site”, ***International Journal of Zero Waste Generation***, 1 (1), pp. 1–4. Available from: http://www.zwgm.org/index.php/zerowastejournal/article/view/4 [Accessed

Garas, G. L., Anis, A. R. and El Gammal, A., (2001), “**Materials Waste in the Egyptian Construction Industry**”, in: Chua, D. and Ballard, G. (eds.) *9th International Group for Lean Construction Conference*. Kent Ridge Crescent: National University of Singapore, pp. 1–8.

Hany, O. and Dulaimi, M., (2014), “**Creating a sustainable future : Solutions for the construction waste in the Greater Cairo**”, in: *The First International Conference of the CIB Middle East & North Africa Research Network (CIB-MENA 2014)*. Abu Dhabi, pp. 281–305.

Hussin, J., Rahman, I. A. and Memon, A. H., (2013), “The Way Forward in Sustainable Construction : Issues and Challenges”, ***International Journal of Advances in Applied Sciences (IJAAS)***, 2 (1), pp. 31–42. DOI:dx.doi.org/10.11591/ijaas.v2i1.1321.

Invest-gate, (2016), “*Egyptian Government’s Mega Projects 2016*”. Cairo. Available from: http://invest-gate.me/wp-content/uploads/2016/10/Egyptian-Government’s-Mega-Projects-2016-.pdf

Kamalaeaswari, A. S. and Vedhajanani, A. B., (2015), “Process Analysis of Material Procurement in Commercial Buildings and Recommendation”, ***International Journal of Engineering Research & Technology***, 4 (3), pp. 1006–1010.

Karmany, H. M., (2016), “Evaluation of Green Building Rating Systems for Egypt.” MSc dissertation. Center for Sustainable Development, The American University in Cairo. Available from : http://dar.aucegypt.edu/handle/10526/4628

Lee, W. L., (2013), “A Comprehensive Review of Metrics of Building Environmental Assessment Schemes”, ***Energy and Buildings***, 62, pp. 403–413. DOI:10.1016/j.enbuild.2013.03.014.

Li, Y., Chen, X., Wang, X., Xu, Y. and Chen, P. H., (2017), “A Review of Studies on Green Building Assessment Methods by Comparative Analysis”, ***Energy and Buildings***, 146, pp. 152–159. DOI:10.1016/j.enbuild.2017.04.076.

Memon, N. A., Akram, M., Khahro, S. H. and Nicolae, P., (2015), “**Reduction of Construction Waste At Site**”, in: *3rd International Conference on Energy and Environment: Innovation, Research & Sustainability 2015 (ICEE’15)*. Nawabshah: Quaid-e-Awam University of Engineering, Science and Technology (QUEST),.

Ministry of Planning, Monitoring, and Administrative Reform (MPMAR), (2016), “*Sustainable Development Strategy: Egypt’s Vision 2030*”. Cairo. Available from: http://www.mfa.gov.eg/SiteCollectionDocuments/SDS2030_English.pdf

Nagapan, S., Rahman, I. A. and Asmi, A., (2012), “Factors Contributing to Physical and Non-Physical Waste Generation in Construction Industry”, ***International Journal of Advances in Applied Sciences (IJAAS)***, 1 (1), pp. 1–10. DOI:10.11591/ijaas.v1i1.476.

Naguib, I., (2016), “**International Rating Systems And Their Applicability On Historic Buildings**”, in: Bulucea, A. (ed.) *Proceedings of the 5th International Conference on Energy Systems, Environment, Entrepreneurship and Innovation (ICESEEI ’16)*. Barcelona: WSEAS Press, pp. 192–198.

Say, C., (2008), “Sustainable Rating Systems Around the World”, ***Council on Tall Buildings and Urban Habitat Journal***, (II), pp. 18–29.

State Information Service (SIS), (2015), Egypt launches 2030 development strategy. Available from: http://www.sis.gov.eg/section/7281/4111?lang=en-us [Accessed 27 November 2017].

US Environmental Protection Agency (EPA), (2016), Basic Information | Green Building |US EPA. Available from: https://archive.epa.gov/greenbuilding/web/html/about.html [Accessed 21 December 2017].

Yılmaz, M. and Bakış, A., (2015), “Sustainability in Construction Sector”, ***Procedia - Social and Behavioral Sciences***, 195, pp. 2253–2262. DOI:10.1016/j.sbspro.2015.06.312.

Yoon, J. and Park, J., (2015), “Comparative Analysis of Material Criteria in Neighborhood Sustainability Assessment Tools and Urban Design Guidelines: Cases of the UK, the US, Japan, and Korea”, ***Sustainability***, 7 (11), pp. 14450–14487. DOI:10.3390/su71114450.

Zaki, T. and Khial, A., (2014), “*Country Report on the Solid Waste Management in Egypt*”. Available from: http://www.sweep-net.org/sites/default/files/EGYPT RA ANG 14_1.pdf

Zeb, E. A., Malik, E. S., Nauman, S., Hanif, E. H., Muhammad, E. and Amin, O. S., (2015), “**Factors Affecting Material Procurement , Supply and Management in Building Projects of Pakistan : A Contractor ’ s Perspective**”, in: *Proceedings of 2015 International Conference on Innovations in Civil and Structural Engineering (ICICSE’15)*. Istanbul, pp. 170–175.