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Methodology for assessing GPRS Materials and Resources Credits- A Case Study

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يعد اختيار مواد البناء أحد العوامل التي تؤثر بشكل كبير على استدامة المبنى. يمكن أن يساعد استخدام المواد المستدامة والمحلية في تقليل الأحمال البيئية والمسافات الانتقالية، وتقليل تلوث الهواء الناتج عن المركبات. وبناءً على ذلك ،أجرت هذه الورقة مراجعة واسعة لأهمية اختيار مواد البناء المستدامة ، والعقبات التي تؤثر على اختيار المواد الخضراء. ولتغطية الجانب البيئي للاستدامة أثناء اختيار مواد البناء المحلية تم تطبيق نظام تقييم الهرم الأخضر في مصر. ومن ثم ، تم تنفيذ مقارنات بين GPRS وأنظمة التقييم الأخرى مع مراجعة شاملة للعقبات التي تعترض تنفيذ. GPRS اقترح البحث الحالي طريقة تستند إلى ترجيح اعتماد المواد المستدامة وفقًا لمعايير .GPRS تساعد الطريقة المقترحة في اختيار مواد البناء المستدامة إما بشكل منفرد أو مدمج مع أهداف أخرى مثل تكلفة دورة الحياة.

Abstract :

Building materials selection is one of the factors that considerably affect the building's sustainability. Employing long-lasting and local materials could assist reduce environmental loads and transition distances, lowering vehicle-generated air pollution. Accordingly, this paper conducted a wide review of the importance of selecting sustainable building materials, and the obstacles affecting the selection of green materials. To cover the environmental aspect of sustainability while selecting the local building materials Green Pyramid Rating System (GPRS) is applied. Thus, comparisons between GPRS and the other rating systems have been implemented with a comprehensive review of the obstacles of implementing the GPRS in Egypt. The current research has proposed a method based on weighting for crediting the sustainable materials according to GPRS criteria. the proposed method aids in selecting the sustainable building materials (SBM) either solely or combined with other objectives such that Life Cycle Cost (LCC).

1. Introduction

Green or sustainable construction strives to maximize resource efficiencies, such as water, energy, and materials. It aims on minimizing a building's environmental and human health impacts throughout its lifecycle. A common understanding is that buildings should be planned and operated in such a way that the overall impact of the built environment on human health and the environment is minimized [1]. The construction of sustainable buildings has proven to be more difficult, necessitating the use of novel construction methods. The importance of incorporating sustainability principles in a building is becoming more widely recognized. Some commercial firms have realized that incorporating sustainable concepts into their operations has financial benefits [2]. As illustrated in fig (1) there are numerous advantages to adopting sustainability and green growth in terms of the three primary aspects: social, economic, and environmental. The choice of building materials is one of the aspects that can influence the sustainability of a building. An appropriate material selection can help reduce a building's embodied energy and carbon dioxide emissions to the environment. [3].

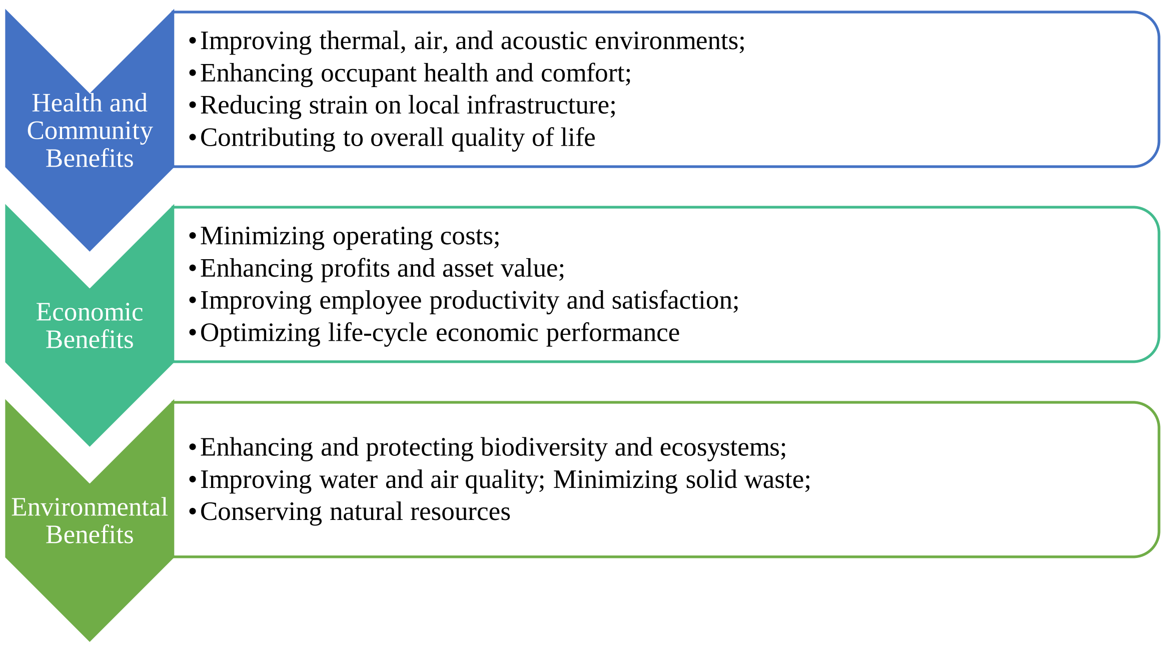


Figure (1) Advantages of adopting sustainability

In 2013, Laura et al. proposed some objectives to consider when selecting sustainable materials for buildings. Designers must consider a variety of elements to make the greatest and most effective decisions. Cost, mechanical qualities, energy impacts, physical properties, and safety are all factors that are frequently considered. Visual characteristics and metaphysical qualities of items, on the other hand, may influence assessments [3]. In 2015, Akadiri et al. analyzed the primary roadblocks that building construction professionals in Nigeria face when choosing sustainable building materials. Table (1) provides an overview of the findings, accordingly, the top obstacles to selecting sustainable materials are the perception of additional costs and a lack of sustainable material information. The report concludes with recommendations and actions that can be taken to help overcome these obstacles. Building contractors are reluctant to take risks to gain more sustainable results because of the lack of information on how much it costs to use sustainable materials, a study by the University of Bristol has found [4]. The lack of information barrier about achieving sustainability means that there is a skill and knowledge gap. Stakeholders in the construction industry want information on various types of building materials. It's critical to have a system that serves as a central archive for information on all aspects of local and sustainable building material [5]. There is a need to increase the demand for sustainable building materials among construction professionals. The government should promote and support the adoption of sustainable construction materials. Information should be disseminated through the media to build a greater knowledge of their potential benefits [4].

Table (1) Ranking of perceived barriers in sustainable material selection

Major Barriers	**Overall Rank**
Lack of sustainable material information	2
Uncertainty in liability of final work	8
Maintenance concern	5
Building code restriction	9
Lack of comprehensive tools and data to compare material alternatives	3
Perception of the extra cost being incurred	1
Perception of extra time being incurred	4
The perception that sustainable materials are low in quality	11
Esthetically less pleasing	12
Possible project delay due to sustainability requirement	10
Limited availability of supplier	6
Low flexibility of alternatives or substitutes	7
Unwilling to change the conventional way of specifying	11

2. Green Rating Systems

Green building rating systems have been quickly implemented in civilized countries such as Canada and the United Kingdom. The British Building Research Establishment Environmental Assessment Method (BREEAM) was first implemented in 1990. The American Leadership in Energy and Environmental Design (LEED) was established in 1998 [6]. It quickly became one of the most widely used green building rating systems on the planet. Green Globes for Existing Buildings was produced in 2000 by ECD Energy and Environmental in Canada, with backing from the Canadian Departments of National Defense and Public Works and Government Services. Green Globes for New Buildings Canada has developed shortly after. The concept was adapted for the United States in 2004. Since then, the assessments have been updated regularly. Green Globes is a science-based building rating system that helps property owners and operators choose sustainable features. Green Globes are awarded to projects that have received more than 35% of the 1,000 available points through third-party verification [7]. The Australian Green Stars (GS) were first issued in 2003. It employs a basic certification level of stars as a measure of a building's sustainability. Although it is a new rating system, it alters the way Australian construction markets think. It's not surprising that some countries, such as South Africa, rely on it due to its adaptability and usability [8].

There are two grading systems for green buildings in the Middle East region, specifically in the United Arab Emirates (UAE): UAE–LEED of Dubai and ESTIDAMA–PEARL Rating System of Abu-Dhabi. In 2010, the ESTIDAMA–PEARL Rating System was created and launched. It attempts to concentrate on the long-term viability of a structure from conception to completion [9]. It is determined by the addition of points when assigning a final rating from 1PEARL to 5PEARL (best) and primarily based on LEED, with an emphasis on their local water issues. Going east in the Middle East, GPRS was created by the Egyptian Green Building Council (EGBC) in 2011 to assess local green building standards and encourage the construction industry to adopt green architecture concepts.

2.1 Green Pyramid Rating System (GPRS)

In 2011, Egypt developed the "Green Pyramid Rating System - GPRS" Version (1) as a tool for developers, owners, architects, and engineers to plan and create green buildings. The buildings that are "GPRS certified" use less water and energy, emit fewer greenhouse gases, and conserve natural resources. Furthermore, these buildings are less expensive throughout their whole existence. The GPRS rating score for a building is a measure of the building's sustainability for the chosen site, architectural and engineering systems, construction processes, and operational standards [10]. In 2018, the second edition of the GPRS rating system was updated to encourage wider adoption by both public and private developers and owners in Egypt. The GPRS application aids in the attainment of strategic goals connected to three of the SDS's primary objectives: the environment, energy, and urban development. The certification system was created to strike a balance between environmental and economic benefits for society.

GPRS is made up of seven primary areas that are taken into account during the evaluation of a building's environmental performance; each category contributes a particular amount of weight to the certification of the examined building. As stated in Table (2), these weights have been updated in the second version of the GPRS in comparison to the first version to incorporate various weights for certain categories based on their importance and environmental impact. Each category has a set of stated requirements that a project must achieve to receive credit points. To be certified by the GPRS, a project must meet all of the minimum necessary parameters mentioned in each category. The kind of GPRS certification is primarily determined by the total accumulated credit points obtained following the evaluation of the building's performance using the many mentioned criteria in Table (3). It's important noting that projects with less than 30 credit points will be uncertified by the GPRS.

Table (2) Green Pyramids weighting aspects

Aspects	**Green Pyramid assessment Percentage in (V1)**	**Green Pyramid assessment Percentage in (V2)**
Sustainable Sites (SS)	15%	10%
Energy Efficiency (EE)	25%	28%
Water Efficiency (WE)	30%	30%
Materials and Resources (MR)	10%	12%
Indoor Environmental Quality	10%	12%
Management Protocols (MP)	10%	8%
Innovation and Value-added (Bonus)	5%	5%
TOTAL	**105%**	**105%**

A project is assigned one of the five GPRS rating levels based on the total amount of points earned in those seven areas, with "One Green Pyramid" being the lowest certification level (30-40%) and "Five Green Pyramids" being the highest certification level (80%), as stated in Table (3).

Table (3) Certification Levels

Certification Levels			Credit Weight
Denied			< 30%
One Green Pyramid	▲	Certified	≥ 30% – < 40%
Two Green Pyramid	▲▲	Bronze	≥ 40% – < 50%
Three Green Pyramid	▲▲▲	Silver	≥ 50% – < 65%
Four Green Pyramid	▲▲▲▲	Gold	≥ 65% - < 80%
Five Green Pyramid	▲▲▲▲▲	Platinum	≥80%

2.2International Rating Systems versus GPRS

This section contains comparisons between the GPRS and various international rating systems, including grades, certificates, and priority rankings. *The first is a comparison* of five credit weight grading systems, as indicated in Table (4): BREEAM (United Kingdom), LEED (United States), Green Globes (Canada), PEARL (United Arab Emirates), and Green Pyramids (Egypt). The selection of worldwide, national, and regional rating systems was made to reflect a wide range of scenarios. The five rating systems were developed in different contexts with distinct standards, but the materials are all in the same group [12].

The second comparison is established by Abd El-Hafez et al. between the weights and priorities assigned to each category by LEED, GPRS (Version 1) [10], and GPRS (Version 2) is added (Table 5). It shows that the most important category in the GPRS is water efficiency, whereas Regional Priority has been completely ignored, and Innovation in Design receives bonus grades in version 2. The most important category under LEED, on the other hand, is Energy and Atmosphere. There are four stages to the priority of categories:

- High priority (From 40%-30%).
- Medium priority (From 30%-20%).
- Low priority (From 20%-10%).
- No priority (Under 10%).

Table (4) Rating Systems Certificates

Green Building Rating Systems	Credit Weight	
BREEAM	Pass	(25–39%)
	Good	(40–54%)
	Very Good	(55–69%)
	Excellent	(70%andabove)
LEED	Certified	(40–49 points)
	Silver	(50–59 points)
	Gold	(60–79 points)
	platinum	(80 points and above)
Green Globes	4 Globes	85-100%
	3 Globes	70-84%
	2 Globes	55-69%
	1 Globe	35-54%
ESTIDAMA–PEARL	1 pearl	All Mandatory Credits
	2 pearls	All Mandatory Credits + 60 credit points
	3 pearls	All Mandatory Credits + 85 credit points
	4 pearls	All Mandatory Credits + 115 credit points
	5 pearls	All Mandatory Credits + 140 credit points
GPRS	1 Green Pyramid	≥ 30% – < 40%
	2 Green Pyramid	≥ 40% – < 50%
	3 Green Pyramid	≥ 50% – < 65%
	4 Green Pyramid	≥ 65% - < 80%
	5 Green Pyramid	≥80%

خطأ! لا يوجد نص من النمط المعين في المستند.) The Priority of every category in LEED vs. GPRS

Categories	**LEED**		**GPRS (V1)**		**GPRS (V2)**	
	%	**Priority**	**%**	**Priority**	**%**	**Priority**
Sustainable Sites	23%	Medium	15%	Medium	10%	Low
Water Efficiency	9%	Low	30%	High	30%	High
Energy and Atmosphere	32%	High	25%	Medium	28%	Medium
Materials and resources	13%	Low	10%	Low	12%	Low
Indoor Environmental Quality	14%	Low	10%	Low	12%	Low
Innovation in Design	5%	Low	+5%	No	+5%	No
Regional Priority	4%	Low	0%	No	0%	No
Management	0	No	10%	Low	8%	No

The third comparison was formed between different international & national building rating systems criteria, the chosen rating systems were divided into two categories; the first category was the international rating systems which includes five building rating systems (LEED, BREEAM, ESTIDAMA, CASBEE, and GSAS). While the second was the Egypt rating system which includes two building rating systems (GPRS, Tarsheed) figure (2). The comparison revealed that CASBEE is the weakest rating system among all other rating systems which measures only 10 aspects of sustainable buildings and it lack to cover most of the essential aspects of sustainable buildings. On the other hand, Tarsheed (Residential) measures 23 aspects out of 32 sustainable buildings aspects but it is not implemented in Egypt so far. Moreover, GPRS contains 21 measuring criteria for sustainable buildings but it is also not yet implemented in Egypt [13].

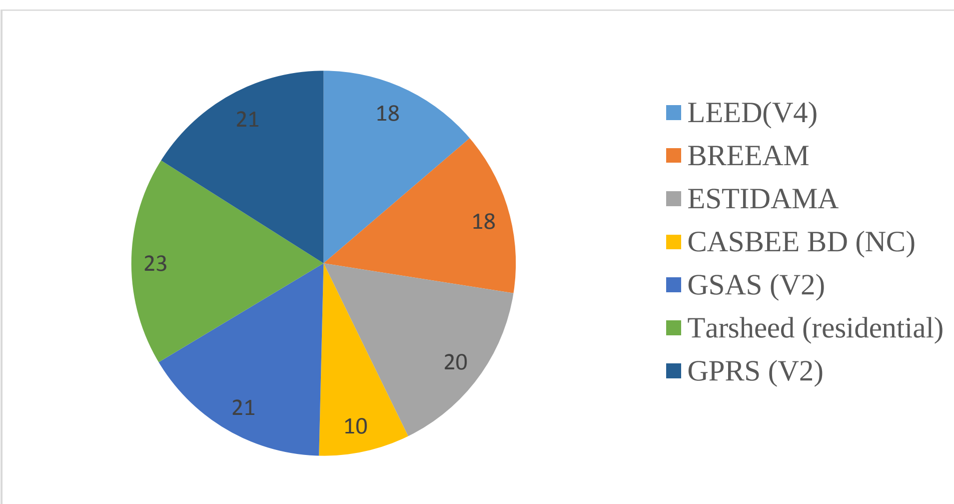


Figure (2) Rating Systems Criteria Comparison

2.3The GPRS implementation barriers in Egypt

The reasons behind the negligence of implementing GPRS into projects as a sustainable design approach are discussed by Rania in 2019. It is discovered that there are certain gaps regarding the coverage of GPRS criteria, the results of the relationship are shown in the following table (6) [13].

Table (6) Gaps in architectural modules in universities regarding the coverage of GPRS Criteria

Aspects	Main Criteria	Status of coverage
Sustainable Sites (SS)	**Preservation of Habitat**	Not Covered
	Accessibility and Site selection	Well Covered
Energy Efficiency (EE)	**Operation and maintenance**	Only one private educational system
	Energy efficiency appliances	Well covered
	Renewable energy devices	Well Covered
Water Efficiency (WE)	**Water leak prevention**	Not Covered
	Indoor water use	Covered by one module in private universities. Covered by four modules in public universities
Materials and Resources (MR)	**Materials fabricated on site**	Not Covered
	Material reuse	covered in modules related to environmental and managerial
	Regionally produced material	Covered in vernacular architecture and environmental-related modules.
Indoor Environmental Quality	**Smoke control"**	not covered in BUE modules while well covered in public universities
	Acoustic comfort	not covered in BUE modules while well covered in public universities
	Emission control	Covered in the design studio and environmental-related modules.
Management Protocols (MP)	**Access for lorries**	not covered
	Emission control	Covered as management and design approach.
	Separate storage	not covered in some private universities as the BUE nor AUC
Innovation and Value-added	**Culture heritage**	well covered in vernacular architecture-related modules
	Innovation	well covered in the design studio and architecture modules

In, 2018 Sarah et al. addresses the possibility of applying the principles of green architecture in Egypt through a review of selected Egyptian environmental-oriented projects and applying GPRS (Version1) on them to determine the obtained credits and the non-obtained credits and the reasons for not being achieved. Obstacles of fulfilling some credits of GPRS in the Egyptian context can be concluded as follows [15]:

At the first GPRS Aspect is Sustainable Sites; appears that there is an absence of governmental incentives for redeveloping informal areas and incentives for following the national development plan. Also, it has an issue with the high initial cost.

The second GPRS Aspect is Energy & Atmosphere; the high initial cost required for some credits is the main obstacle. Also, the lack of design team specialists and the unavailability of the required equipment and technology for some credits are stated to be difficulties.

The third GPRS Aspect "Water Efficiency"; the high initial cost required for some credits is the main obstacle. Also, the unavailability of the required equipment, technologies, and certified sanitary pipes in the Egyptian market, lack of design team and contractors' awareness of the importance of irrigation operation and maintenance plan, lack of specialists are stated to be difficulties.

The fourth GPRS Aspect "Materials & Resources"; the high initial cost required for some credits is the main obstacle. Also, the lack of qualified contractors and builders. And the unavailability of recycling companies for construction materials to provide the required materials, and the unavailability of data about the life cycle cost of the available materials are stated to be difficulties.

The fifth GPRS Aspect "Indoor Environmental Quality"; designers are not aware of the mentioned code (ASHRAE) its requirements and how to apply it, the high initial cost required for some credits is the main obstacle. Besides, the unavailability of low emitting materials in the Egyptian market, and the lack of design team specialists who are aware of appropriate daylighting strategies and simulation programs are required for this purpose.

The last GPRS Aspect "Management": the main issue is the lack of awareness of contractors and builders.

3. Materials and Resources Criteria

The focus of this study is on the criteria for assessing the materials and resources used in the buildings. The first section shows the GPRS criteria with their associated weights, while the second one is for the comparison of the materials and resources criteria of assessment in Gprs versus the other rating systems.

3.1 Material and Resources Criteria in 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. This category is made up of four main criteria related to materials extraction, processing, manufacturing, and distribution [11]. The four main criteria with their credit points, weights, options, and requirements are summarized as shown below in fig. (3).

MR-1

- Renewable Materials or Materials Manufactured Using Renewable Energy
- Maximum points (4)
- condition: Use at least one of the building materials

MR-2

- Regionally Procured Materials and Products
- Maximum points (6)
- condition: Using building materials that have been produced within 500 km of the project site for ≥ 50% of the total materials value.

MR-3

- Reduction of Overall Material Use
- Maximum points (8)
- Condition 1: more than 90% of the total assemblies' quantity should be standard assemblies products such as doors or windows.
- Condition 2: At least one of the building materials should have more than 20% of its quantity does not require finishing.

MR-4

- Environment – Friendly, Sound, and Thermal Insulation Materials.
- Maximum points (6)
- no condition has been specified

Figure (3) Main Criteria for the assessment of the materials and Resources

3.2Materials and resources criteria in the rating systems

The Criteria for materials that are frequently utilized in different rating systems are illustrated in table (7). Most rating systems, for example, are concerned with recycled materials and waste management; as a result, the selection of Sustainable Building Materials (SBM) should be based on the materials' negative environmental implications. The basic purpose of applying sustainable methods is to reuse and recycle building materials. Furthermore, adopting durable and local materials might help a building's sustainability. The use of local building materials can reduce environmental loads and transition distances, reducing vehicle-generated air pollution [14].

Table (7) The Materials and Recourses Criteria that are repeatedly used in different rating systems

Assessment Criteria for the Materials		LEED	BREEAM	Pearl	Green Globes	GPRS
1	Building Reuse	1				
2	Construction Waste Management / Operational Waste Management /Improve construction and operational waste management	1		1	1	
3	Resource Reuse / Use of salvaged materials	1				1
4	Recycled Content / Recycled materials	1		1		1
5	Local/Regional Materials	1		1		1
6	Rapidly/readily renewable materials	1				1
7	Certified Wood / treated Timber Elimination	1		1		
8	Deconstruction, Disassembly, and Reassembly				1	
9	Designing for durability and resilience / Use of high durability materials		1		1	1
10	Materials fabricated on site					1
11	Life cycle cost analysis (LCCA)					1
12	Hazardous Waste Management			1		
13	Use of lightweight material					1
14	Organic Waste Management			1		
15	Modular Pavement and Hardscape Cover			1		
16	Interior Fit-Outs (including Finishes and Furnishings)				1	
17	Minimize use of Interior Materials				1	
18	Material efficiency		1			
19	Insulation		1			
20	Responsible sourcing of construction products		1			
21	Life cycle impacts		1			
22	Hard landscaping and boundary protection		1			
23	Use of prefabricated elements					1
Percentage of criteria covered by the rating system		**30%**	**26%**	**30%**	**22%**	**40%**

The comparison showed that Green Globes is the weakest rating system among all other rating systems which measures only 20% of the criteria of SBM, and it lacks to cover most of the essential criteria. On the other hand, GPRS (version 2) measures 40% of the criteria of sustainable building materials but it is not implemented in Egypt so far.

4. Case Study

In this paper, three different types of housing buildings (distinct, middle income & social) are used as a source of data to obtain the Bill of quantities for ten construction work packages as shown in table (7) New administrative capital, Obour city, and New 6th of October city respectively.

It was noticed that all points of the GPRS are obtained by using a specific percentage of the total materials value (based on cost) or at least one material that applies the aspect. Thus, in this study, it is assumed that, if the material complies with any of the four aspects, the GPRS credits are summed up then multiplied by the work package's percentage (see Equation 1). Where the building materials are assumed to be divided into 10 Work packages. Each work package weight is calculated as a percentage of the total building cost as shown in table (8).

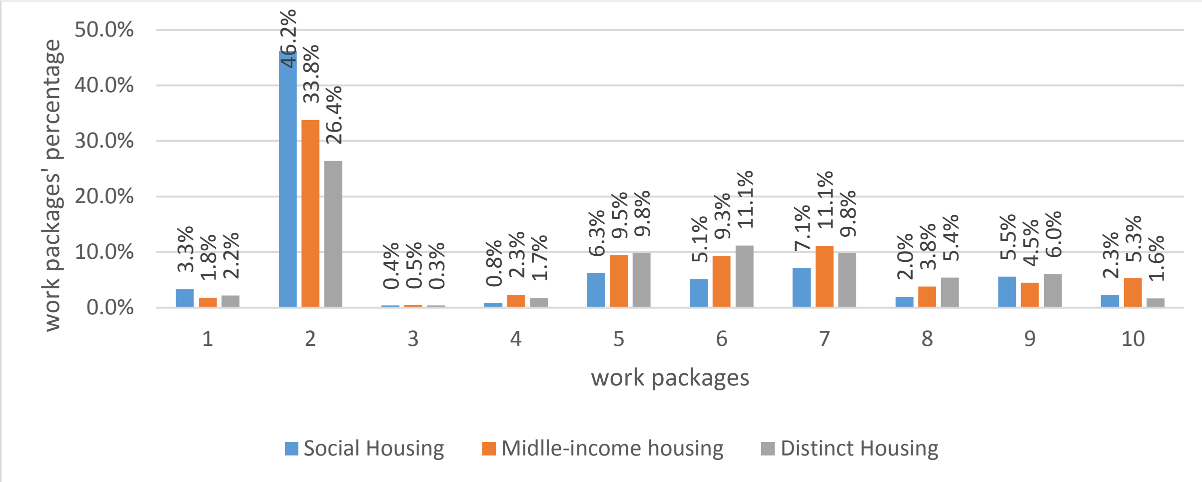
Table (8): Raw cost of construction work packages in housing projects.

Construction work packages	Distinct Housing	Middle-income Housing	Social Housing
	Cost (EGP.)	Cost (EGP.)	Cost (EGP.)
1. Plain concrete	300,625	84,779	182,300
2. Reinforced concrete	3,620,200	1,614,840	2,530,750
3. Thermal insulation	48,000	23,500	20,130
4. Water insulation	235,750	110,245	44,680
5. Building wall	1,342,350	452,400	343,050
6. Plastering	1,528,750	446,225	281,115
7. Flooring	1,338,600	584,600	391,030
8. Coating and paints	743,850	181,250	107,340
9. Doors	829,600	214,500	304,100
10. Windows	224,400	251,550	125,480

A noticeable diversity in the percentage of the work packages was detected. As the total percent of the work packages in distinct housing is lower than the middle-income and social housing, this can be attributed to the building's concrete. As can be seen, reinforced concrete acquires the highest proportion at the expense of the other materials. And it turns out that the share of reinforced concrete in social housing is higher than in other types. This is owing to a preference for the appearance and finish quality of other types of housing versus social housing. It is obvious that in distinct and middle-income housing, the percent of building walls, plastering, flooring, and paintings is greater than in social housing. Consequently, these portions are applied to compute the GPRS credits.

Table (9) construction work package weight as a percentage of the total building value

Construction work package	**Distinct Housing**	**Middle-income Housing**	**Social Housing**
1.Plain Concrete	2.2%	1.8%	3.3%
2.Reinforced Concrete	26.4%	33.8%	46.2%
3.Thermal Insulation	0.3%	0.5%	0.4%
4.Water Insulation	1.7%	2.3%	0.8%
5.Building Wall	9.8%	9.5%	6.3%
6.Plastering	11.1%	9.3%	5.1%
7.Flooring	9.8%	11.1%	7.1%
8. Coating & Paints	5.4%	3.8%	2.0%
9. Windows	6.0%	4.5%	5.5%
10.Doors	1.6%	5.3%	2.3%
Total	74.4%	81.8%	79%



$$\textbf{Mateial GPRS credit} = \left(\mathbf{1^{st}\ aspect + 2^{nd}\ aspect + 3^{rd}\ aspect + 4^{th}\ aspect}\right) \times \mathbf{materials'}\,\% \quad (1)$$

To compute the Material GPRS credit for the Windows work package for instance in the distinct housing with a percentage of 6% as per table (9), if the material complies with the first three aspects of the GPRS materials' aspects. Thus, by applying equation (1) the material credit would be 1.08 as follows;

$$\text{GPRS credit} = (4 + 6 + 8 + 0) \times 6\,\% = 1.08$$

Thus to compare the current method used in GPRS of assessing the resources and materials credits demonstrated in figure (3) with the conditions by the proposed method by this study. Distinct housing building has been studied at the New Administrative Capital's third residential district, "Capital Residence," where 30 buildings with 720 housing units have been constructed for 4,116,90,300 EGP. The single building consists of a ground floor and five floors, the area of the floor is 600 m2 costs 13,723,010 EGP as per the BOQ mentioned previously in table (8). Table (10) illustrates how far the used building materials complies with GPRS Materials and Resources criteria to gain credits. Thereupon this building would gain 18 points out of 24 points according to the following:

- MR-1: 4 credits for using wooden doors as a renewable material
- MR-2: 6 credits for using more than 50% of the total material cost of regionally produced materials
- MR-3: 8 credits for using standard assembled windows and doors.
- MR-4: 0 credit for not using environment-friendly sound or thermal insulation material

However, by applying the proposed method in this paper, the total gained points for the used building materials are 6.3 points. Which is more realistic compared with the 18 points gained when applying the current method of the GPRS because it depends on the weight of the material in the building according to its cost.

Table (10) the used building materials and GPRS credits gained

Work Package	Material	MR-1	MR-2	MR-3	MR-4	WP's weight	GPRS credit
1.Plain Concrete	200kg/cm^2concrete	0	6	0	0	2.2%	0.132
2.Reinforced Concrete	250kg/cm^2concrete	0	6	0	0	26.4%	1.584
3.Thermal Insulation	Polystyrene	0	6	0	0	0.3%	0.036
4.Water Insulation	Bitumen	0	6	0	0	1.7%	0.102
5.Building Wall	Perforated bricks	0	6	0	0	9.8%	1.372
6.Plastering	cement mortar	0	6	0	0	11.1%	0.666
7.Flooring	Ceramics	0	6	0	0	9.8%	0.98
8.Coating & Paints	plastic (oil- based)	0	6	0	0	5.4%	0.324
9.Windows	Aluminum Window	0	6	8	0	6.%	0.84
10.Doors	Wooden doors	4	6	8	0	1.6%	0.288
Total						**74.4%**	**6.324**

Summary and Conclusion

The choice of building materials is one of the aspects that can influence the building's sustainability. An appropriate material selection can help reduce a building's embodied energy, carbon dioxide emissions to the environment, energy use in the materials manufacturing process, environmental impact across the life cycle, energy consumption, and air quality discomfort, among other things. Although cost differences had not been properly studied in many cases it is considered as the most obstacle affecting the selection and usage of sustainable materials because of the lack of information. Besides, stakeholders think that anything other than "business as usual" would be more costly. The other major obstacle is the use of recycled products. Hence, Egyptian standards have been modified to allow the use of recycled materials as an acceptable alternative to natural materials for the manufacture of building products in 2021, and the solid waste recycling code that was issued in 2017 as the first steps to overcome that barrier for using SBM.

Various developments for sustaining a green and sustainable planet have been implemented, with a focus on green construction sectors. These advances include the integration of three main aims: social, environmental, and economic goals so green building rating systems have been implemented. In this regard, Egypt introduced GPRS Version (1) in 2011, and the second edition of the GPRS rating system was modified in 2018. The materials and resources category in GPRS, which is the focus of this study, is comprised of four basic criteria relating to the extraction, processing, manufacture, and distribution of resources. By comparing GPRS and other international and regional rating systems including grades, certificates, and priority rankings to show how far GPRS is covering the sustainability aspects. It shows that GPRS covers 70% of the measuring criteria for sustainable buildings, and 40% of the SBM criteria, which is the highest percentage when compared with the other rating systems. GPRS implementation in Egyptian projects face several barriers; the lack of awareness of contractors and builders, the high initial cost required for some credits, the lack of design team specialists, and the unavailability of the required equipment and technology for some credits are stated to be difficulties.

Moreover, it was found that all points of the GPRS are obtained by using a specific percentage of the total materials value (based on cost) or at least one material that applies the aspect. Thus, this study proposes a method for assessing the materials' credits which is if a material complies with any of the four aspects, the credits are summed up then multiplied by the work package's percentage. This proposed approach could be used to evaluate the environmental dimension of sustainability in different housing projects' building materials. It also aids in the selection of the SBM, either alone or in combination with other objectives such as LCC.

6. **References :**

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