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Assessing the Sustainability of Construction Projects in Egypt.

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Abstract:

Construction industry became the most significant. Therefore, great efforts have been carried out in the field of sustainable development. In addition, new researches and codes of design and construction have been conducted. This paper presents a green rating model to assess the sustainability of administration buildings in Egypt. Twenty-four factors have been gathered from literature. The factors are divided into five groups: The project aspects group, the site aspects group, Material aspects group, resources aspects group, and Management and innovation aspects group. The project aspects group includes: Controlling emission from building materials, protecting water sources from pollution, Acoustic comfort, Project waste management plan, Minimizing pollution during construction. The site aspects group includes: Site selection, Development density and community connectivity, Public transportation access, Low emitting and fuel efficient vehicles, and Maximize open space. Materials aspect group includes: Regionally procured materials, Materials fabricated on site, Use of renewable materials, Use of recycled materials, and Life cycle cost analysis of materials in the project. Resources aspects group includes: Use of higher durability materials, efficient water use during construction, Energy efficiency improvement, and Renewable energy sources. Management and innovation aspects group includes: Providing building user guide, providing a periodic maintenance schedule, Respect for sites of historic or cultural interest, Cultural heritage, and innovation and flexibility in design. Sustainable rating model has been proposed to assess the sustainability of administration buildings in Egypt. The proposed rating model can be used in case of residential buildings.

Key words: Sustainable development; Residential projects; Administration projects; Rating

1 INTRODUCTION

The main objective of this paper is to provide a green rating model for the administration buildings in Egypt. Therefore, past researches have been reviewed such as, the sustainability standards of the green rating buildings. For example, the green building rating system which provided by LEED includes the following categories: 1) sustainable sites with fourteen credit with total fourteen possible points, water efficiency category with five credit with total five possible points, Energy and atmosphere category with eight credits with total seventeen possible points, Materials and resources category with thirteen credit with total thirteen possible points, Indoor environmental quality category with fifteen credit with total fifteen possible points, and innovation and design process category with five credit with total five points. The project may get on one of four certificate: certified (26-32 points), silver (33-38 points), gold (39-51 points), and platinum (52-69 points) [1].

Furthermore, the green pyramid rating system (GPRS) consists of seven categories: 1) sustainable site accessibility and ecology, 2) energy efficiency, 3) water efficiency, 4) materials and resources, 5) indoor environmental quality, 6) management, 7) innovation and added value. In addition, the green pyramid rating is in accordance with the following rating system: GPRS certified: 40-49 credits, Silver pyramid: 50-59 credits, Gold pyramid: 60-79 credits, Green pyramid: 80 credits and above [2].

In addition, the approaches of sustainable building analysis during the project life cycle have been presented based on the environmental impact of the projects. Furthermore, some researches have been made to create checklist of factors belong to the sustainability performance of the project during the project life cycle. The checklist includes factors that assesse the project performance in the project inception stage, factors that assists the project performance in the design stage, factors that assesse the project performance in the construction stage, factors the assesse the project performance in the operational stage, and factors the assesse the project performance in the demolition stage [3-5].

Finally, methodologies have been presented for the project design phase, residential building, and the infrastructure projects. Groups of weighted indicators have been collected to evaluate the residential buildings based on the environmental, social, and economic. Moreover, methodologies presented to evaluate the sustainable structural design. Simulation model based on system dynamics has been created to evaluate the infrastructure projects in the construction and operational phases. Also, key assessment indicators have been introduced for assessing the sustainability performance of infrastructure projects [6-12].

2 Research Methodology

To develop the green rating model for the administration projects in Egypt, the following research methodology has been followed:

- Literature reviewed to gather factors belong to the sustainability of the administration projects in Egypt. Past researches and references in the field of sustainable development have been reviewed.
- Unstructured interviews with ten senior engineers work in design and construction of the administration projects have been conducted to review the gathered factors and to identify the final list of sustainable factors.
- Structured interviews with sixteen senior engineers work in design and construction of the administration projects have been conducted. The main purpose of the structured interviews was to collect data belong to the relative impact of the factors on the sustainability of the administration projects in Egypt. A lerkit scale model consists of five lekirt scales, scale one for the very low impact, scale two for the low impact, scale three for the medium impact, scale four for the higher impact, and scale five for the very high impact. The experts were asked to give each factor a lekirt scale according to its impact of the project sustainability. The weight of the factor has been calculated by applying the following equation: The weight equals the sum of multiplying each scale by the number of experts' respond. The relative impact index for each factor has been calculated. The factors were ranked according to their relative impact index.
- A green rating model for the administration buildings has been developed.
- The proposed rating model has been applied on a case study. Figure 1 shows the research methodology.

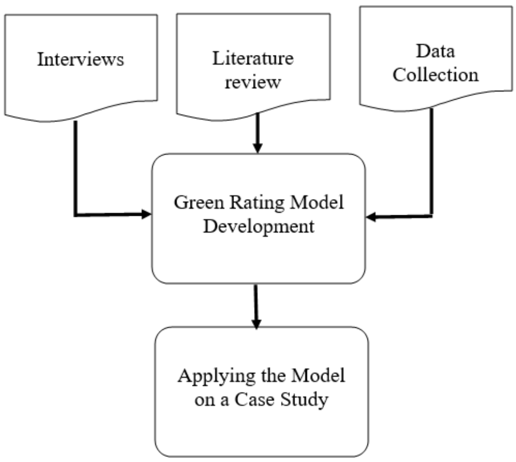

Fig. 1. Research Methodology

3 Gathering the Sustainable Factors

Firstly, preliminary list of factors that can be used to assess the sustainability of administration buildings have been gathered from literature [1-12]. Secondly, unstructured interviews with ten senior engineers have been conducted. The main purpose of these interviews was to review the list of factors. Twenty-four factors have been chosen from the gathered factors. Thirdly, the factors are divided into five groups: The project aspects group, the site aspects group, Material aspects group, resources aspects group, and Management and innovation aspects group. Project aspects group includes: controlling emission from building materials, protecting water sources from pollution, acoustic comfort, project waste management plan, and minimizing pollution during construction. Site aspect group includes: site selection, development density and community connectivity, public transportation access, low emitting and fuel efficient vehicles, maximize open space. The materials aspects include: Regionally procured materials, Materials fabricated on site, Use of renewable materials, Use of recycled materials, and Life cycle cost analysis of materials in the project. Resources aspects include: Use of higher durability materials, efficient water use during construction, Energy efficiency improvement, and Renewable energy sources. Management and innovation aspects include: Providing building user guide, providing a periodic maintenance schedule, Respect for sites of historic or cultural interest, Cultural heritage, and innovation and flexibility in design. Finally, unstructured interviews have been conducted with the ten senior engineers to review final list of the gathered factors and their descriptions. Table 1 and Table 2 contain the sustainable factors and their descriptions respectively. Figure 2 shows the steps of the rating model development.

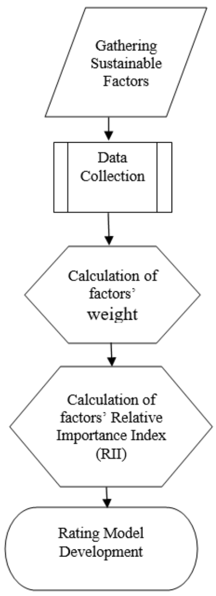

Fig. 2. Steps of Rating Model Development

Table 1: Sustainable performance key factors

Group	Factors
Project Aspects	1- Controlling emission from building materials.
	2- Protecting water sources from pollution.
	3- Acoustic comfort.
	4- Project waste management plan.
	5-Minimising pollution during construction.
Sites aspects	1- Site selection.
	2- Development density and community connectivity
	3-. Public transportation access
	4-. Low emitting and fuel efficient vehicles
	5- Maximize open space
Materials aspects	1- Regionally procured materials
	2- Materials fabricated on site.
	3- Use of renewable materials.
	4- Use of recycled materials.
	5- Life cycle cost analysis of materials in the project.
Resources aspects	1-Use of higher durability materials
	2- Efficient water use during construction.
	3- Energy efficiency improvement
	4-Renewable energy sources.
Management and innovation aspects	1-Providing building user guide
	2- Providing a periodic maintenance schedule.
	3- Respect for sites of historic or cultural interest..
	4- Cultural heritage.
	5- innovation and flexibility in design

Table 2: sustainable factors' descriptions

Factors	Discretion
1- Controlling emission from building materials.	Demonstrating the use of low emission adhesives, sealants, and paints, coatings, flooring and ceiling models, and certification that building materials and products containing formaldehyde have not been used.
2- Protecting water sources from pollution.	Safeguarding water sources from pollution arising from site operations.
3- Acoustic comfort.	All spaces within the building have been modeled to determine suitable acoustic conditions and noise control strategies, all in accordance with national and local codes.

4- Project waste management plan.	Presenting a project waste management plan that includes strategies from reducing, and , where possible, re-using and recycling the waste arising from site operations.
5-Minimising pollution during construction.	Demonstrating a strategy to minimize pollution from construction operations (including generation of dust and pollution
6- Site selection.	Site selection in desert areas to encourage development in the desert outside the Nile valley.
7- Development density and community connectivity	LEED site vicinity plan showing project site and surrounding development show density boundary or note drawing scale.
8-. Public transportation access	Statement indicating which option for compliance applies. State whether public transportation is existing or proposed and, if proposed, cite source of this information.
9-. Low emitting and fuel efficient vehicles	Statement indicating which option for compliance applies.
10- Maximize open space	Statement indicating which option for compliance applies. State whether public transportation is existing or proposed and, if proposed, cite source of this information. Option1: LEED site vicinity plan showing project site, mass transit stops and pedestrian path to them with path distance noted. Option 2: LEED site vicinity plan showing project site, bus stops and pedestrian path to them with path distance noted.
11- Regionally procured materials (to reduce the environmental impact of transportation).	Demonstrating that building materials are extracted and manufactured in Egypt. Points awarded as follows: 1) value of regional materials is not less than 25% of total materials value; 2) value of regional materials is not less than 50% of total materials value; and 3) value of regional materials is not less than 75% of total materials value.
12- Materials fabricated on site.	Demonstrating the use of building materials (such as bricks) that are fabricated on site.
13- Use of readily renewable materials.	Demonstrating that the building materials are readily renewable, such materials include earth materials, natural stone, palm tree products, bamboo, wool, cotton for insulation, agrifiber, linoleum and products made from crop fibers, such as rice and barley straw. Points awarded as follows:1) value of regional materials is not less than 5% of total materials value; 2) Value of regional materials is not less than 105 of total materials value, and 3) value of regional materials is not less than 20% of total materials value.
14- Use of recycled materials.	Use of recycled materials as follow: a) steel: at least 50% of all structural steel (by weight) has a minimum of 25% post-consumer recycled content or reused (for structural steel buildings) or at least 75% of all reinforcing or stressing steel (by weight) has a minimum of 90% post-consumer recycled content (for concrete framed buildings); b) concrete: demonstrate the overall amount of Portland cement used has been reduced by the use of supplementary

	cementations materials such as fly ash, ground granulated blast furnace slag; c) Aggregates: demonstrate that at least 20% of all aggregates used on site (by volume), in structural and non-structural applications are recycled; and d) Other materials: demonstrate that materials of at least 10% of the total material costs are contributed of at least: 30% post – consumer recycled content, 80% post-industrial content, and 50% agricultural waste by products.
15- Life cycle cost (LCC) analysis of materials in the project.	Presenting a life cycle cost (LCC) analysis of all significant building materials to be used on the project.
16-Use of higher durability materials	At least 25% (by value) of total materials are lightweight (e. g. hollow or compound) materials or elements (e. g. frames) in comparison with similar conventional materials.
17- Efficient water use during construction.	Demonstrating the use materials such as pre-mixed concrete for preventing loss during mixing.
18- Energy efficiency improvement	Demonstrate a minimum energy performance level 10% above an appropriate simulated base case model. The base case model is to be produced in accordance with Egyptian energy efficiency code and using method of standard.
19-Renewable energy sources.	Demonstrating that, an onsite and / or off-site renewable energy feasibility study has been undertaken.
20-Providing a building user guide	Providing a building user guide containing the necessary technical and non-technical information for the building users/ occupant to enable the efficient and responsible operation of the building.
21-Providing a periodic maintenance schedule.	Provision of a periodic maintenance schedule, which should be comprehensive and regularly updated.
22- Respect for sites of historic or cultural interest..	Demonstrating a strategy for conserving and protecting remains of historic or cultural interest that is part of or nearby the site.
23- Cultural heritage.	Incorporating architectural, construction and technical solutions which excel in reflecting national and regional cultural heritage while contributing to the environmental performance of the building.
24- Innovation and flexibility in design, construction and operation.	The design should be constructability and the designer should be awareness with BIM technology. Drawings flexibility and complexity should be taken in consideration. Sustainable operation and maintenance plan should be designed and documented.

4 Data Collections

Data belong to the factors' degree of importance has been collected. During the following sections steps of collecting data will be explained. To collect the required data, structured interviews with sixteen senior engineers have been conducted. These senior engineers work in the field of construction and design of construction projects. The senior engineers were asked to give alekirt scale from one to five (1-5) for each factor. The value of the scale and its meaning will be as follow, scale one for the very low impact of the factor on sustainability, scale tow for the low impact, scale three for the medium impact, scale four for the high impact, and scale five for the very high impact respectively. Table 3 shows the result of the structured interviews, and in the later sections these results will be explained. For example, the responds of the experts on the Controlling emission from building materials factor were: two responds were for scale five, seven responds were for scale four, four responds were for scale three, three responds were for scale two, and there is no respond for scale one. Protecting water sources from pollution factor has seven responds for scale five, four respond for scale four, four responds for scale three, one respond for scale two, and has no respond for scale one. Acoustic comfort factor has five responds for five scale, five responds for four scales, one respond for two scales, and has no respond for one scale. Project waste management plan factor has six responds for scale five, six responds for scale four, three responds for scale three, one respond for scale two, and has no respond for scale one. Minimizing pollution during construction factor has five respond for the scale five, six responds for scale four, three responds for scale three, two responds for scale tow, and zero respond for scale one. The site selection factor has nine responds for scale five, three responds for scale four, two responds for scale three, one respond for scale two, and one respond for scale one. Development density and community connectivity factor has three responds for scale 5, five responds for scale four, seven responds for scale three, one respond for scale two, and zero respond for scale one. Public transportation access factor has nine responds for scale five, four responds for scale four, two responds for scale three, one respond for scale two, and one respond for scale one. Low emitting and fuel efficient vehicles factor has three responds for scale five, six responds for scale four, three responds for scale three, three responds for scale two, and one respond for scale one. Maximize open space factor has five responds for scale five, two responds for scale four, three responds for scale three, six responds for scale two, and zero respond for scale one. Regionally procured materials factor has nine responds for scale five, three responds for scale four, three responds for scale three, zero respond for scale two, and one respond for scale one. Materials fabricated on site factor has two responds for scale five, six responds for scale four, three responds for scale three, two responds for scale two, and three responds for scale one. Use of renewable materials factor has four responds for scale five, eight responds for scale four, two responds for scale three, two responds for scale two, zero respond for scale one. Use of recycled materials factor has five responds for scale five, three responds for scale four, six responds for scale three, two responds for scale two, and zero for scale one. Life cycle cost analysis of materials in the project factor has five responds for scale five, three responds for scale four, six responds for scale three, two responds for scale two, and three responds for scale one. Use of higher durability materials factor has eight responds for scale five, seven responds for scale four, zero respond for scale three, and zero respond for scale two, and one respond for scale one. Efficient water use during construction factor has five responds for scale five, seven responds for scale four, two responds for scale three, one respond for scale two, and one respond for scale one. Energy efficiency improvement factor has three responds for scale five, ten responds for scale four, one responds for scale three, one respond for scale two, and one respond for scale one. Renewable energy sources factor has eight responds for scale five, three responds for scale four, four responds for three scale, one respond for scale two, and zero respond for scale one. Providing building user guide factor has two responds for scale five, four responds for scale four, three responds for scale three, four responds for scale two, and three responds for scale one. Providing a periodic maintenance schedule factor has seven responds for scale five, five responds for scale four, three responds for scale three, one respond for scale two, and zero respond for scale one. Respect for sites of historic or cultural interest factor has ten responds for scale five, two responds for scale four, four responds for scale three, zero respond for scale two, zero respond for scale one. Cultural heritage factor has six responds for scale five, six responds for scale four, one responds for scale three, three responds for scale two, and zero respond for scale one. innovation and flexibility in design factor has six responds for scale five, five responds for scale four, two responds for scale three, two responds for scale two, and one respond for scale one.

Table 3 Data collections

Factors	Degree of impact					Total responds
	5	4	3	2	1	
1- Controlling emission from building materials.	2	7	4	3	0	16
2- Protecting water sources from pollution.	7	4	4	1	0	16
3- Acoustic comfort.	5	5	1	2	3	16
4- Project waste management plan.	6	6	3	1	0	16
5-Minimising pollution during construction.	5	6	3	2	0	16
6- Site selection.	9	3	2	1	1	16
7- Development density and community connectivity	3	5	7	1	0	16
8-. Public transportation access	9	4	2	1	0	16
9-. Low emitting and fuel efficient vehicles	3	6	3	3	1	16
10- Maximize open space	5	2	3	6	0	16
11- Regionally procured materials	9	3	3	0	1	16
12- Materials fabricated on site.	2	6	3	2	3	16
13- Use of renewable materials.	4	8	2	2	0	16
14- Use of recycled materials.	5	3	6	2	0	16
15- Life cycle cost analysis of materials in the project.	5	6	3	1	1	16
16-Use of higher durability materials	8	7	0	0	1	16
17- Efficient water use during construction.	5	7	2	1	1	16

18- Energy efficiency improvement	3	10	1	1	1	16
19-Renewable energy sources.	8	3	4	1	0	16
20-Providing building user guide	2	4	3	4	3	16
21- Providing a periodic maintenance schedule.	7	5	3	1	0	16
22- Respect for sites of historic or cultural interest..	10	2	4	0	0	16
23- Cultural heritage.	6	6	1	3	0	16
24- innovation and flexibility in design	6	5	2	2	1	16

5 Factors' weight Calculations:

Table 4 and figure 3 illustrate the results of calculating the total weight of each factor. The following equation, has been used for this calculation as follow, the weight of each factor = the sum of multiplying each factor's scale by the number of its respond. For example: the weight of controlling emission from building materials factor = scale 5*2 respond +7 responds * scale 4+4 responds *scale 3+3 responds *scale 2+0*scale 1= 56. The sample size is 16 senior engineers. The weight of the rest factors in Table 4 has been calculated by the same method.

Table 4 Factors' Weight

Factors	Degree of impact					Total responds	Weight
	5	4	3	2	1		
1- Controlling emission from building materials.	2	7	4	3	0	16	56
2- Protecting water sources from pollution.	7	4	4	1	0	16	64
3- Acoustic comfort.	5	5	1	2	3	16	55
4- Project waste management plan.	6	6	3	1	0	16	65
5-Minimising pollution during construction.	5	6	3	2	0	16	62
6- Site selection.	9	3	2	1	1	16	66
7- Development density and community connectivity	3	5	7	1	0	16	58
8-. Public transportation access	9	4	2	1	0	16	69
9-. Low emitting and fuel efficient vehicles	3	6	3	3	1	16	55
10- Maximize open space	5	2	3	6	0	16	54
11- Regionally procured materials	9	3	3	0	1	16	67
12- Materials fabricated on site.	2	6	3	2	3	16	50
13- Use of renewable materials.	4	8	2	2	0	16	62
14- Use of recycled materials.	5	3	6	2	0	16	59
15- Life cycle cost analysis of materials in the project.	5	6	3	1	1	16	61
16-Use of higher durability materials	8	7	0	0	1	16	69
17- Efficient water use during construction.	5	7	2	1	1	16	62
18- Energy efficiency improvement	3	10	1	1	1	16	61
19-Renewable energy sources.	8	3	4	1	0	16	66

20-Providing building user guide	2	4	3	4	3	16	46
21- Providing a periodic maintenance schedule.	7	5	3	1	0	16	66
22- Respect for sites of historic or cultural interest..	10	2	4	0	0	16	70
23- Cultural heritage.	6	6	1	3	0	16	63
24- innovation and flexibility in design	6	5	2	2	1	16	61

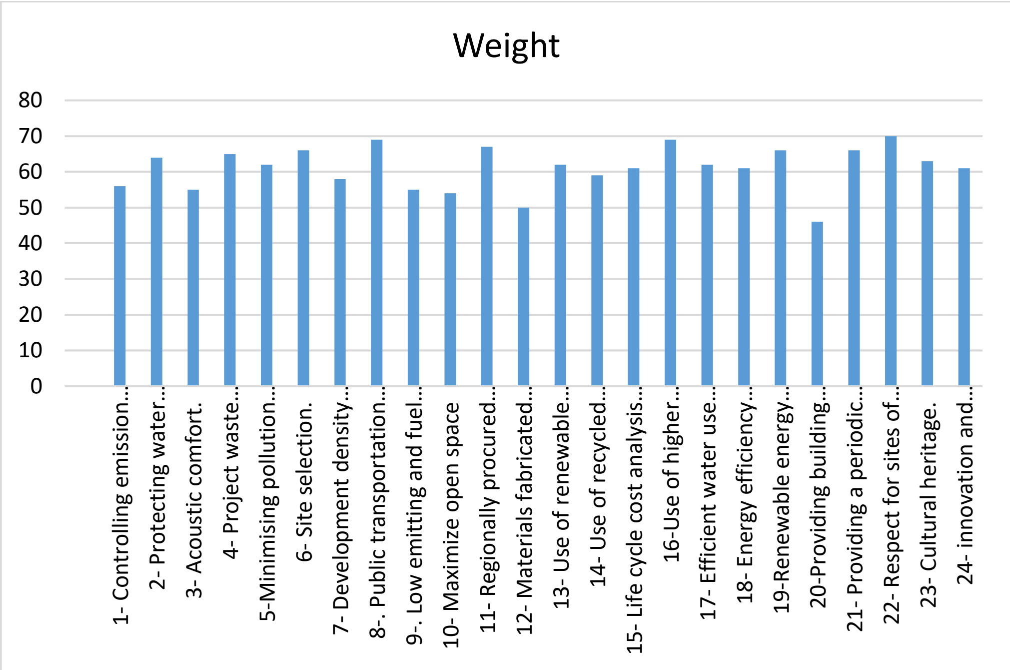

Fig. 3. Factor's Weight

6 Relative Importance Index (RII)

The relative importance index (RII) has been calculated according to the following equation, RII= Weight/ (A*N), where the weight is calculated in Table 4, A is the highest weight, in this study equals 5, and n is the total number of responds, in this study equals 16. The term A*N = 5*16 = 80. The RII will be a variable ranging from zero to one. Factors that have RII (≥0.00<60), have low impact on the project sustainability, factors that have RII (≥60<70), have medium impact, factors have RII (≥70<80), have high impact, and factors have (≥0.8<1), have very high impact. For example, the public transportation factor, and the use of higher durability materials factor have the same equal weight 69, and relative importance index RII = 69/80 = 0.863. So, the two factors ranked 2 in Table 5. Another example, regionally procure materials factor has weight equals 67 and RII equals 0.838, so, ranked 3. The RII and the ranking of the rest factors in Table 5 have been calculated by the same way. Figure 4, and figure 5 illustrate the RII and Ranking of the proposed factors.

Table 5 Factors' Relative Importance Index

Factors	Degree of impact					Total responds	Weight	RII	Rank
	5	4	3	2	1				
1-Controlling emission from building materials.	2	7	4	3	0	16	56	0.70	12.00
2- Protecting water sources from pollution.	7	4	4	1	0	16	64	0.80	6.00
3- Acoustic comfort.	5	5	1	2	3	16	55	0.688	13.00
4-Project waste management plan.	6	6	3	1	0	16	65	0.813	5.00
5-Minimising pollution during construction.	5	6	3	2	0	16	62	0.775	8.00
6- Site selection.	9	3	2	1	1	16	66	0.825	4.00
7-Development density and community connectivity	3	5	7	1	0	16	58	0.725	11.00
8-.Public transportation access	9	4	2	1	0	16	69	0.863	2.00
9-. Low emitting and fuel efficient vehicles	3	6	3	3	1	16	55	0.688	13.00
10- Maximize open space	5	2	3	6	0	16	54	0.675	14.00
11- Regionally procured materials	9	3	3	0	1	16	67	0.838	3.00
12- Materials fabricated on site.	2	6	3	2	3	16	50	0.625	15.00
13- Use of renewable materials.	4	8	2	2	0	16	62	0.775	8.00
14- Use of recycled materials.	5	3	6	2	0	16	59	0.738	10.00
15- Life cycle cost analysis of materials in the project.	5	6	3	1	1	16	61	0.763	9.00
16-Use of higher durability materials	8	7	0	0	1	16	69	0.863	2.00
17- Efficient water use during construction.	5	7	2	1	1	16	62	0.775	8.00

18- Energy efficiency improvement	3	10	1	1	1	16	61	0.763	9.00
19-Renewable energy sources.	8	3	4	1	0	16	66	0.825	4.00
20-Providing building user guide	2	4	3	4	3	16	46	0.575	16.00
21- Providing a periodic maintenance schedule.	7	5	3	1	0	16	66	0.825	4.00
22- Respect for sites of historic or cultural interest..	10	2	4	0	0	16	70	0.875	1.00
23- Cultural heritage.	6	6	1	3	0	16	63	0.788	7.00
24- innovation and flexibility in design	6	5	2	2	1	16	61	0.763	9.00

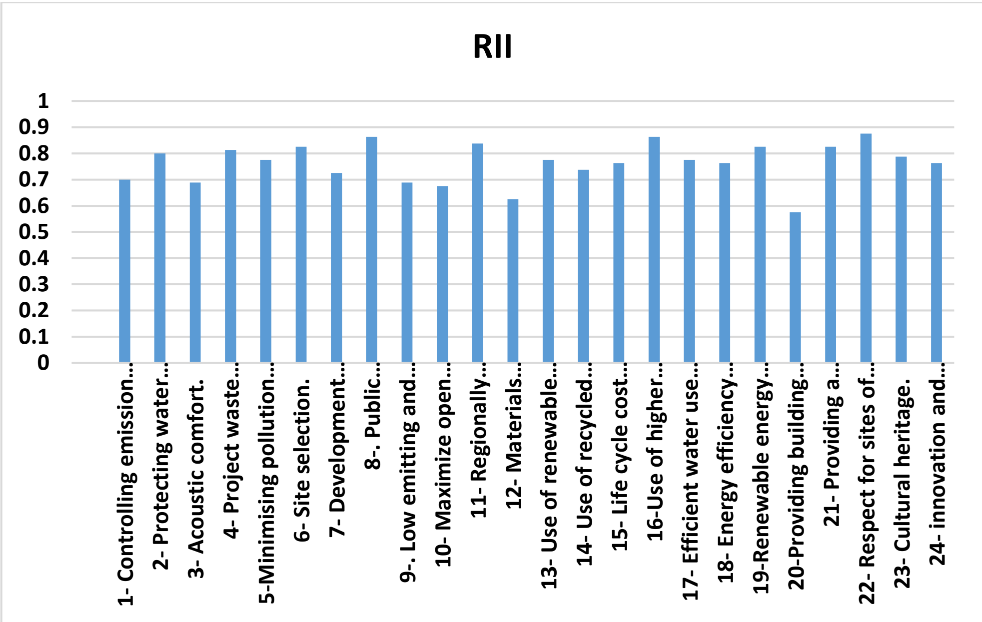

Fig. 4. Relative Factor’s Weight

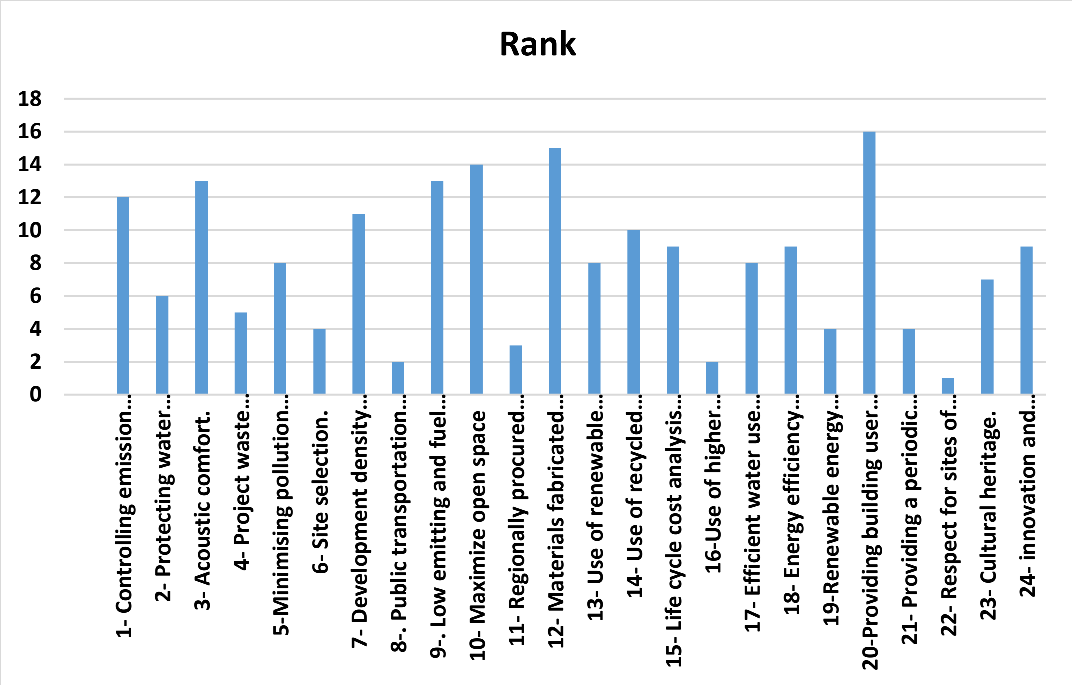

Fig. 5. Factors' Rank

7 Proposed Green Rating Model

Table 6 shows the project's credit and the corresponding certificate according to the proposed model. Figure 6 shows the final green rating factors. Figure 7 shows the total credit for each aspects, project aspects have 21% of the total credit, site aspects 22%, materials aspects 17%, resource aspects 20%, and the management and innovation aspects have 20%. The credit for each factor for the proposed green rating model has been given in Table 7. The steps of applying the proposed green rating model have been explained clearly in the section of the case study. To verify the results of the proposed green rating model, the LEED green rating system has been used to check the certificate of the project. The results of the proposed model were closer to the results of the LEED green system. Figure 8 illustrates The Credits of the proposed Green Rating Model.

Table 6: Project Certificate According to the Proposed Green Rating model

N	Project's credit	Certificate
1	Less than 40	Uncertified building
2	40-49	Certified building
3	50-59	Silver building
4	60-79	Gold building
5	≥80	Green building

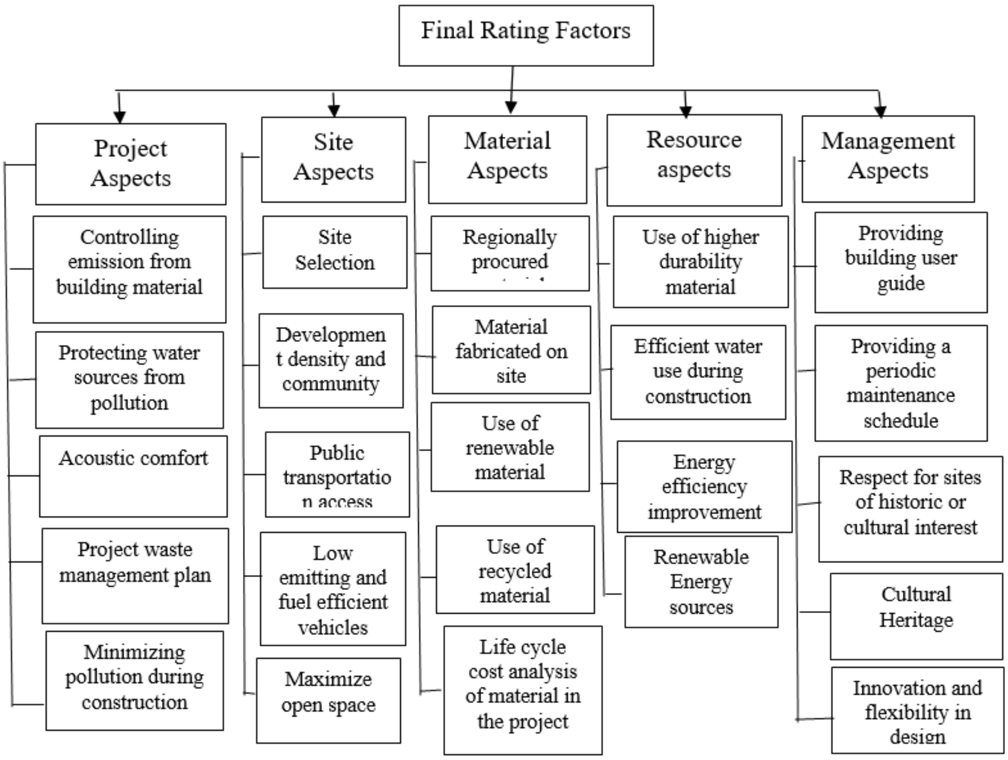

Fig. 6. Final Green Rating Factors

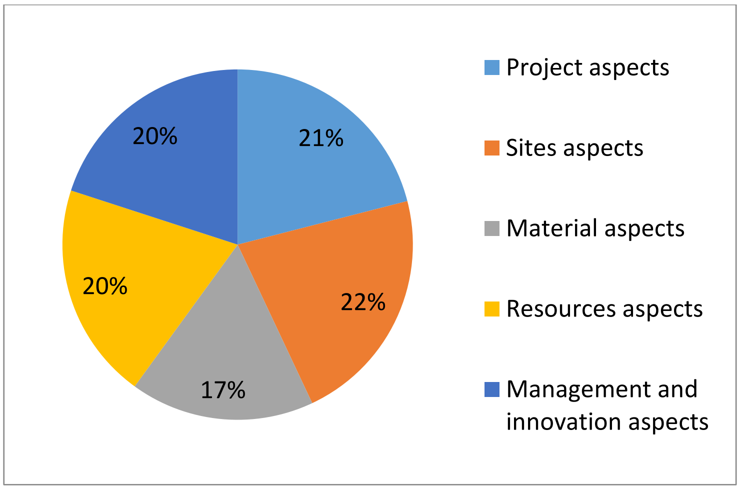

Fig. 7. The proposed Green rating model

Table 7 The Proposed Credit for the Green Rating Model

Group	Factors	Proposed Credit
Project Aspects	1- Controlling emission from building materials.	4
	2- Protecting water sources from pollution.	5
	3- Acoustic comfort.	3
	4- Project waste management plan.	5
	5-Minimising pollution during construction.	4
Sites aspects	1- Site selection.	5

	2- Development density and community connectivity	4
	3-. Public transportation access	7
	4-. Low emitting and fuel efficient vehicles	3
	5- Maximize open space	3
Materials aspects	1- Regionally procured materials	5
	2- Materials fabricated on site.	2
	3- Use of renewable materials.	4
	4- Use of recycled materials.	3
	5- Life cycle cost analysis of materials in the project.	3
Resources aspects	1-Use of higher durability materials	7
	2- Efficient water use during construction.	4
	3- Energy efficiency improvement	4
	4-Renewable energy sources.	5
Management and innovation aspects	1-Providing building user guide	1
	2- Providing a periodic maintenance schedule.	5
	3- Respect for sites of historic or cultural interest..	6
	4- Cultural heritage.	4
	5- innovation and flexibility in design	4

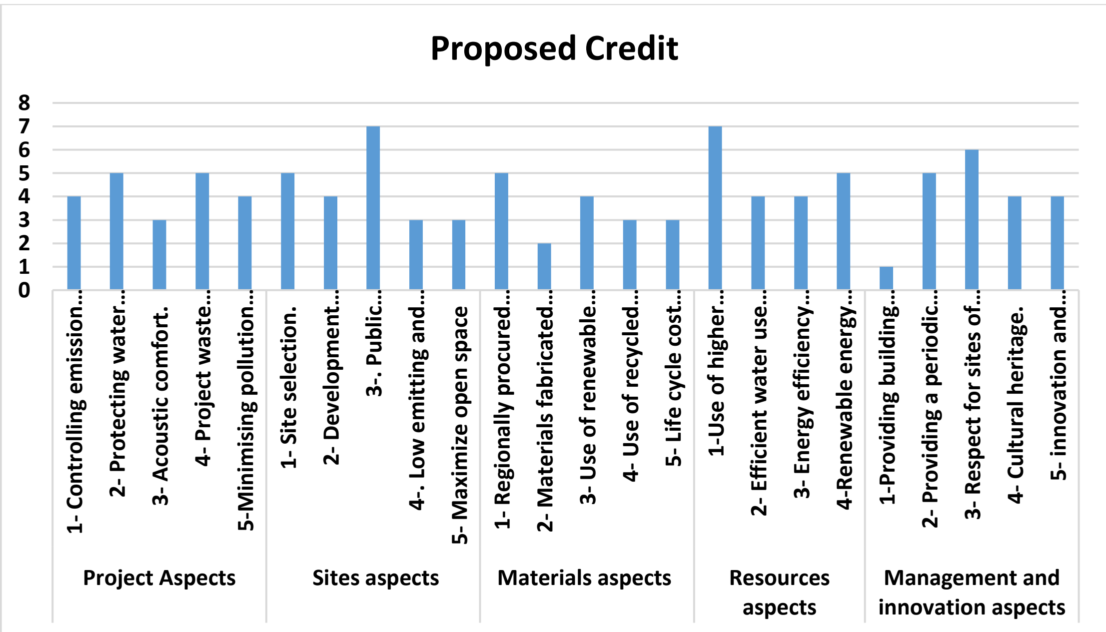

Fig. 8. The Credits of the proposed Green Rating Model

8 Case Study

The proposed green rating model has been applied to assess sustainability of an administration building named Credit Agricola Headquarters Complex. Table 8 contains the project credit points that achieved by the project according to the LEED system during the design stage. The total credit points according to The LEED certificate equals 57[1]. Table 9 contains the project credit points according to the proposed green rating model. The total credit points according to the proposed green rating model equals 55. The results of the green rating model are closer to the results of the LEED system.

Table 8 the project achieved points due to the LEED certificate

Aspects	The project points	The possible points
Sustainable sites	17	26
Water efficiency	07	10
Energy and atmosphere	21	35
Materials and resources	Zero	14
Indoor environmental quality	08	15
Innovation and design process	03	06
Regional priority credits	01	04
Total	57	110

Table 9 the project achieved points due to the proposed rating model certificate

Aspects	The project points	The possible points
Sustainable sites	14	22
Water efficiency, Energy and atmosphere	20	20
Materials and resources	Zero	17
Indoor environmental quality	11	21
Innovation and design process	10	20
Total	55	100

Table 10 contains the project credit points that achieved by the project according to the LEED system during the construction stage. The total credit points according to The LEED certificate equals 82[1]. Table 11 contains the project credit points according to the proposed green rating model during the construction stage. The total credit points according to the proposed green rating model equals 79. The results of the green rating model are closer to the results of the LEED system.

Table 10 the project achieved points due to LEED certificate during the construction

Aspects	The project points	The possible points
Sustainable sites	19	26
Water efficiency	06	10
Energy and atmosphere	26	35
Materials and resources	07	14
Indoor environmental quality	14	15
Innovation and design process	06	06
Regional priority credits	04	04
Total	82	110

Table 11 the project achieved points due to the proposed rating model certificate

Aspects	The project points	The possible points
Sustainable sites	16	22
Resources	14	20
Materials and resources	9	17
Indoor environmental quality	20	21
Innovation and design process	20	20
Total	79	100

9 Discussion of the Results

The achieved credit points by the project in the design phase were 57 according to the LEED requirement. According to the LEED requirement, the project gets on silver certificate [1]. According to the proposed green rating model the project achieved 55 credit points in the design phase, so, the project will get on silver certificate. In the construction phase the achieved points according to the LEED were 82 which mains the project got on platinum certificate [1]. In the other hand, according to the proposed green rating model, the project achieved 79 credit points, the project will get on Gold certificate. From the previous section, the results of the proposed green rating model are closer to the results of the LEED system. The proposed green rating method can be used in cases of the residential buildings and the infrastructures projects.

10 Conclusions

This paper presented a sustainable green rating model for administration buildings in Egypt. The proposed rating model classifies the projects into four categories, uncertified buildings, certified buildings, silver buildings, gold buildings and green buildings. The proposed rating model has been applied on a case study. The results that have been achieved by the proposed Green Rating model were closer to the results that have been achieved by the LEED green system. The proposed model can be applied in case of residential building.

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