EAI Endorsed Transactions
on Smart Cities

Research Article EAI.EU

Critical Success Factors of Green Project Management for Sustainable Housing

Dina Khater[1,*], A. Samer Ezeldin[2] and Medhat Elshazly[3]

[1]Lecturer, Arab Academy for Science and Technology, Faculty of Engineering, Architecture Department, Egypt
[2]American University in Cairo, School of Sciences Engineering, Department of Construction Engineering, Professor and Chair, Egypt
[3]Faculty of Engineering, Cairo University, Architecture Department, Professor of Architectural Design and Building Technology, Egypt

Abstract

The growing demand for green construction, which is associated with increased perceptions of the risks associated with going green, highlights the need for a standard or benchmark that should be identified for project management practices to ensure successful sustainable urban development, assess its progress and report the results. The article argues that this would require a rephrasing of the project management processes as the execution of green building projects requires changes to the traditional project management aspects. Therefore, the article will address the significant changes needed for project management practices that are appropriate to provide procedural parameters to a green building project. Based on this perspective, the article explores the integration of concepts of sustainability into knowledge areas and processes of project management and how it can be used as a tool to sustainably implement the construction projects. The article results to reach the critical success factors of a work plan which is introduced as a Guide Model. The introduced Guide Model was validated to ensure the integration of sustainability into the management of sustainable development and fast track mega projects, called Green Project Management (GPM) with Egyptian sustainable development in the housing sector as the case study.

Keywords: green project management, sustainable, housing, critical success factors.

Received on 25 November 2019, accepted on 20 May 2020, published on 03 June 2020

doi: 10.4108/eai.13-7-2018.164857

1. Introduction

Green Buildings has been presented through design and construction activities in several Egyptian research related to the field of building projects. Nonetheless, green building in the Egyptian building industry is still in the early stages of making a systematic change on the practical level. Regulations and laws in Egypt have not achieved a systemic structure or implementation mechanism to introduce an integrated green cycle in planning, design, pre-construction, construction and post-construction to sustainably deliver construction projects. Adopting this pattern and taking responsibility for the full change in the view of the authors would be successfully carried out by the project managers (PMs), being the key people in all organizations who should assume the following role: "To deliver the temporary organization, The Project, to a permanent organization, The Globe". The perception of green buildings projects is based upon considering the project life cycle stages (PLC) as an integrated process and an interconnected system from inception to operation and so project management processes

*Corresponding author. Email: dinah.khater@gmail.com

are assumed by the authors. However, for the housing projects that involve the end user (the owner or the tenant), the project management activities would be required to go further to ensure full integration of PLC phases and to be green and so project management processes to ensure sustainability objectives achievement. This will be established through the introduction of the end user as one of the stakeholders [7].

The case gets more difficult in housing projects than other projects, as the owners of other projects (hotels, commercial, industrial … etc) are paid back the high initial cost they endured during the project initiation stage during the project operation stage. The contribution of green project management (GPM) in enhancing the performance of communities' sustainable development process is revealed through the triple constraints pf project management (scope – cost – time) which will tend to keep constant with the same rigidity as the Iron Triangle and will align with sustainability triple bottom line (people – environment – profit) instead of contradicting them as it seems from an overall perspective, Table 1 [13].

Table 1. A comparison between sustainability and project management visions [13]

Sustainability Vision	⟷	Project Management Vision
Long term + short term oriented	⟷	Short term oriented
In the interest of this generation and future generations	⟷	In the interest of Sponsor / Stakeholders
Life-cycle oriented	⟷	Deliverable/result oriented
People, Planet, Profit	⟷	Scope, Time, Budget
Increasing complexity	⟷	Reduced complexity

2. Project Management Aspects and Sustainability Fundamentals

The sustainable housing projects criterions and the success models in project management in several researches highlight the lack of a structured project management framework that considers incorporating sustainability principles through PLC stages. Wu et al. (2010) emphasized that it is not sufficient to build a green building with new materials and technologies that are environmentally friendly. Additionally, the previous literature about sustainability in the project management context has focused on the project content and outcome not the way of management. In fact, the importance of an integrated approach in the whole project lifecycle, from planning till operating is not only for sustainable projects but as well to manage this process. It is necessary to propose a management work plan through the life cycle stage of green building.

The Project Management Body of Knowledge [9] describes project cycle as a series of sequential process groups with determined names that are related to one of the PLC stages, i.e. inception, design and tendering stages or construction stage or construction and operation … etc. Knowledge areas are performed through these process groups project management which has been mapped in PMBOK matrix, Table 2 [9].

The authors are looking to formulate the integration concept between project management processes and PLC stages in accordance with the sustainability long-term vision which mandates introducing new knowledge areas and viewing the traditional ones differently.

2.1. Project Management Processes

The project management has five processes (initiation, planning, execution, controlling and closing). These five process groups perform many relationships such as: overlapping, end to start … etc [9]. The process groups are linked by their results or outcomes, the result or outcome of one can often become an input to another. Among the central process groups, the links are iterated. For such, the planning process provides the project execution process with a documented project plan followed by documented progress updates throughout the project development. In addition, the project management process group are not discrete, they are overlapping activities that occur at varying levels of intensity throughout each phase of the project, Figure. 1. The process group interactions can also perform cross phases such that closing one phase provides an input to initiating the next. For example, closing a design phase requires customer acceptance of the design document. Simultaneously, the design document defines the product description for the implementation phase, Figure. 2. The non-discrete character of process groups will be utilized by the authors in relation with sustainability vision for PLC stages for the proposed management work plan.

2.2. Project Management Knowledge Areas

In the Project Management Body of Knowledge (PMBOK) [9] the process groups are the chronological phases that the project goes through in each of its stages, and the knowledge areas occur throughout any time during the process groups. The process groups are horizontal, and the knowledge areas are vertical, Table 2 [9]. These knowledge areas are the core technical subject matter of the project management profession, and they bring the project to life. This article will introduce another concept which will have the project management processes goes chronologically in linear relationship with PLC stages. A new version for mapping the project management process groups, project management knowledge areas and project life cycle stages will be illustrated from sustainability perspective by the researcher which contradicts with that one in PMBOK.

2.3. Project Management Success Factors for Sustainable Housing

For the sustainable housing various definitions exist; the European Union (EU) defined sustainable social housing in

terms relative to: the quality of construction; social and economic factors with regard to affordability and psychological impacts; and eco-efficiency such as efficient use of renewable resources in the built environment [4]. The following Figure. 3 proposes a sustainability framework to evaluate the performance of housing projects sector [10]. It shows a schematic framework for understanding and evaluating the key components of and strategies for achieving sustainable housing. Examination of Figure. 3 would reveal that the framework is made up of the four facets of sustainable development; namely, social; economic; cultural and environmentally sustainable housing policies and programs. Additionally, it indicates that the development of sustainable housing policies and programs do not necessarily translates to suitable housing without the engagement of sound implementation strategies by housing developers and project managers. This underscores the vital role of robust management and managers capacity in the successful implementation of sustainable housing policies and programs.

The PLC management is sustainable when the entire break down of work activities are directed in such a way that enhances the reduction of the environmental impacts and preserves the sustainability parameters. While, project management best practices may be described as an optimized solution to perform the scope of work in order to achieve high performance [10], it can be argued that it is fundamental to provide a problem-free housing projects management process which permits the housing to become sustainable. The common variables which act as the success factors for traditional project management are scope of work and its understanding, communication management, client involvement, project team, decision making authority, realistic cost and time estimate, project control, problem solving abilities, risk management, adequate resources, performance monitoring …etc [2]. Additionally, the main problems in traditional project management are basically with projects planning and implementation, cost and time overruns and quality non-achievement [3], while in GPM, sustainable project planning (SPP), Sustainability Principles Activation are introduced by the researcher to maintain sustainability practices continued through the PLC stages and orchestrated comprehensively by an integrated planning process.

3. Surveying the current status of Egyptian housing projects in government sector

A definition was derived for sustainable project management from combining the triple-P element of sustainability and the life cycle views [5], which was elaborated to: Sustainability in projects and project management is the development, delivery and management of project organized change in policies, processes, resources, assets or organizations with consideration of the (six) principles of sustainability in the project, its result and its effect [1]. However, the alignment between sustainability and project management is still very rare [4] and the link to defining a sustainable process and methodology for project management is still absent [5]. Hence, an integrated approach is vital in green building process which would require an effective role of project managers during the PLC of green building.

Sustainable performance (SP) of a construction project during its life cycle (LC) is a main objective to achieve sustainable development (SD). The factors affecting SP of construction project can be examined in three main categories: economic sustainability factors (ESF), social sustainability factors (SSF), and environmental sustainability factors (EnSF). These factors are classified in relation to the PLC stages; inception phase, design phase, construction phase and operation phase [1]. Based on this line of reasoning, studies that promote the integration of the sustainability concept into project management were deployed [8,14]. The authors have elaborated these studies to address the sustainability dimensions through PLC stages and relate them with the basic tools of project management which are project management processes and knowledge areas.

The authors proposed a work plan that is designed to discuss factors of sustainability in project life cycle and sustainability in project management knowledge areas. The designed work plan was developed through a structured questionnaire to survey the current status of project management practices. The questionnaire aimed to accomplish the work plan development that maintains the linkage between the temporary character of project management and the long term of sustainability through (2) sections, Table 3, 4, 5 and 6:

- Section (1): Factors affecting SP of construction projects throughout PLC stages from project management perspective have been investigated on Likert scale rating. The key variables were coded and clustered into three sets aligned with the sustainability triple bottom line and the basic project management process aspects [13,8].
- Section (2): Check listing the level of application of project management practices in housing projects on a Likert scale rating.

The government recent national housing developments were surveyed in 4 different cities and for 4 different levels of income. The questionnaire was discussed in interviews, site visits and correspondences to monitor and report the current status of project management practices from sustainability perspective with a total of (115 engineers) working as design project managers, construction managers, construction supervision engineers, architects, owner representatives and PMO Managers in addition to contractors in order to monitor and report the current status of project management practices from sustainability perspective. A total of (106 engineers) has responded to this questionnaire, Table 7. Additionally, in the operation stage a total of (168 end users) who have moved to live in their units and those who are waiting to move gave their responses through a questionnaire that was available on google documents, its link was announced on social media where end users were informed and easily responded.

The results of the questionnaire revealed the gaps in the existing project management processes to perform sustainably. The authors then identified the places to intervene in the existing processes. Therefore, the potentials

of project management to ensure green housing projects delivery were concluded as will be illustrated hereafter.

Table 2. Project Management Process Group and Knowledge Area Mapping [9]

Knowledge Areas	Project Management Process Groups				
	Initiating Process Group	Planning Process Group	Executing Process Group	Monitoring and Controlling Process Group	Closing Process Group
4. Project Integration Management	4.1 Develop Project Charter	4.2 Develop Project Management Plan	4.3 Direct and Manage Project Work	4.4 Monitor and Control Project Work 4.5 Perform Integrated Change Control	4.6 Close Project or Phase
5. Project Scope Management		5.1 Plan Scope Management 5.2 Collect Requirements 5.3 Define Scope 5.4 Create WBS		5.5 Validate Scope 5.6 Control Scope	
6. Project Time Management		6.1 Plan Schedule Management 6.2 Define Activities 6.3 Sequence Activities 6.4 Estimate Activity Resources 6.5 Estimate Activity Durations 6.6 Develop Schedule		6.7 Control Schedule	
7. Project Cost Management		7.1 Plan Cost Management 7.2 Estimate Costs 7.3 Determine Budget		7.4 Control Costs	
8. Project Quality Management		8.1 Plan Quality Management	8.2 Perform Quality Assurance	8.3 Control Quality	
9. Project Human Resource Management		9.1 Plan Human Resource Management	9.2 Acquire Project Team 9.3 Develop Project Team 9.4 Manage Project Team		
10. Project Communications Management		10.1 Plan Communications Management	10.2 Manage Communications	10.3 Control Communications	
11. Project Risk Management		11.1 Plan Risk Management 11.2 Identify Risks 11.3 Perform Qualitative Risk Analysis 11.4 Perform Quantitative Risk Analysis 11.5 Plan Risk Responses		11.6 Control Risks	
12. Project Procurement Management		12.1 Plan Procurement Management	12.2 Conduct Procurements	12.3 Control Procurements	12.4 Close Procurements
13. Project Stakeholder Management	13.1 Identify Stakeholders	13.2 Plan Stakeholder Management	13.3 Manage Stakeholder Engagement	13.4 Control Stakeholder Engagement	

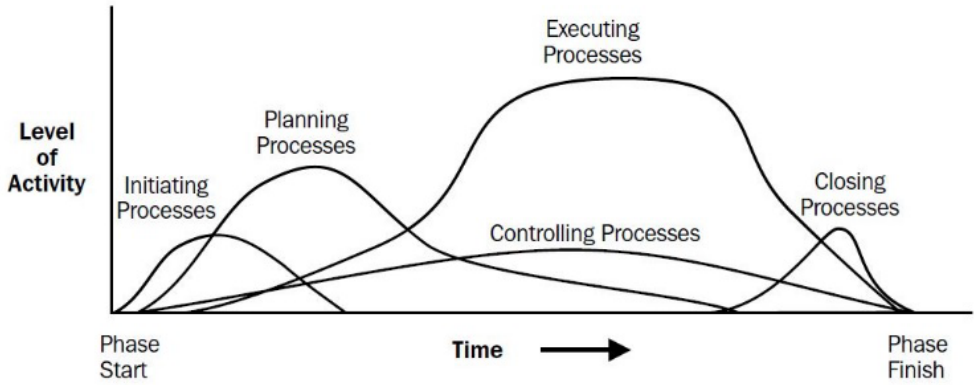

Figure 1. Overlap of Process Groups in a Phase [9]

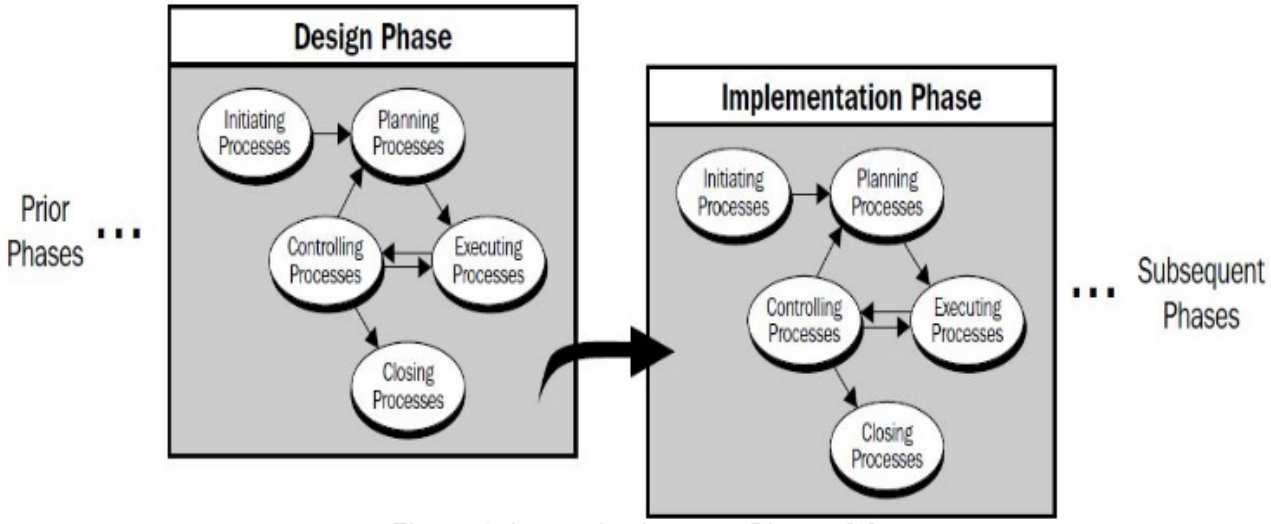

Figure 2. Interaction between Phases [9]

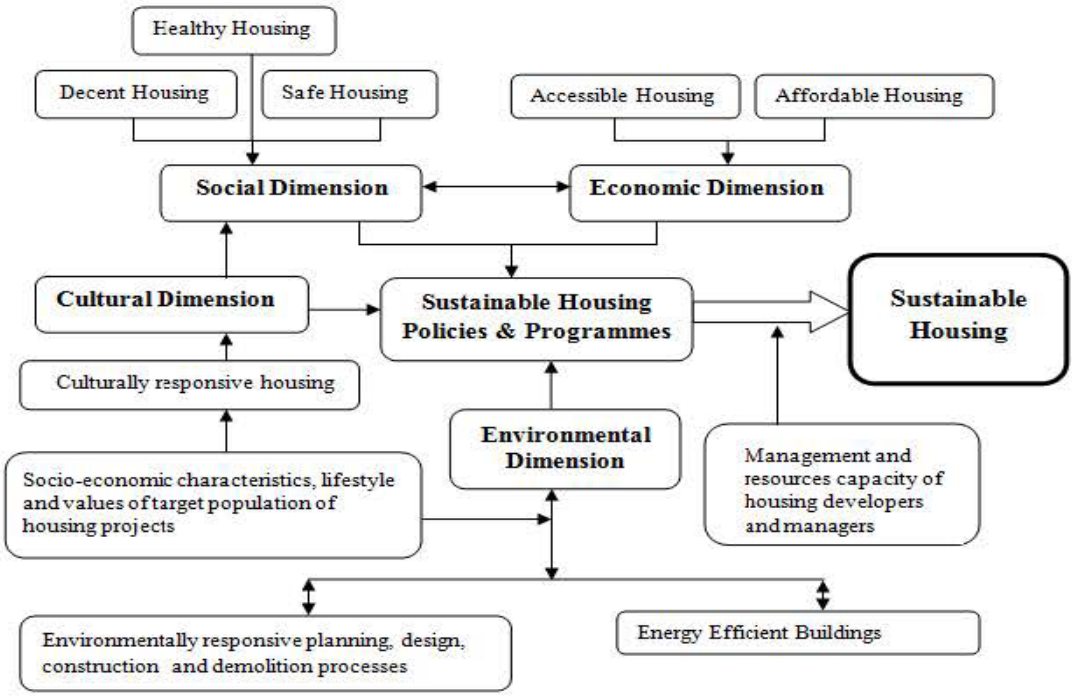

Figure 3. Sustainability of Housing [6]

Table 3. Questionnaire Section (1), Sustainability Factors (Economic Factor "EF", Social Factor "SF" and Environmental Factor "EnF") in Project Inception Stage [developed by author]

	Analysis on Likert Scale	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Sustainability Factor / Project Stage (Inception Stage)						
EF	1. Was the capital budget defined to plan and control project total cost (life cycle cost analysis)? Has it been extended to consider not only elementary cost but total cost for building-up, operating project over its life cycle?	9%	55.5%		35.5%	
	2. Was the planned profit extended beyond focusing on stage or sectional profits and considered total profit from operating a construction project across its life cycle?	9%	64.50%	12%	11.50%	3%
SF	3. Was land selection for project site based on cropland and natural resources protection?			18.75%	81.25%	
	4. Were negative impacts avoided from project development on any cultural and natural heritage?			18.75%	81.25%	
	5. Was the project able to provide local employment?				100%	
	6. Has the project improved local infrastructure capacity: drainage, sewage, power, roads … etc?		18.75%	37.50%	43.75%	
	7. Were end users cultural aspects considered (cultural background, financial category and their identity?	18.75%	25%	25%	31.25%	
EnF	8. Were potential air pollution from the proposed project and its impact on local climate examined?				100%	
	9. Was waste generation at both project construction and operation stages examined?				100%	

Table 4. Questionnaire Section (1), Sustainability Factors (Economic Factor "EF", Social Factor "SF" and Environmental Factor "EnF") in Project Design and Construction Stages [developed by author]

	Analysis on Likert Scale	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Sustainability Factor / Project Stage (Design Stage)						
EF	1. Was the total cost involved in PLC, i.e. site formation, construction, operation, maintenance cost considered?		46.25%	11.25%	42.50%	
	2. Were economic consideration given for durability and availability for material selection?		16.75%	34.75%	41%	7.50%
	3. How far clustering and prototype have been followed?			33.50%	32%	33%
	4. How much was the compliance with the site conditions considered (topography and site survey)?		18.50%	33%	48.50%	
	5. How do you evaluate the mistakes and discrepancies in delivered design documents?		15%	15%	70%	
SF	6. How do you evaluate the considerations in designing process for life safety and emergencies?				100%	
EnF	7. Is the designer knowledgeable of energy savings and environmental issues?		25%	16.50%	58.50%	
	8. Was modular and standardized components to enhance build ability and to reduce waste generation utilized?		25%	16.50%	58.50%	
Sustainability Factor / Project Stage (Construction Stage)						
EF	1. How far do you agree that the following expenses / cost is planned and well managed?					
	1.a. Materials cost (concrete, steel, timber, brick … etc)?		37.5%		62.50%	
	1.b. Energy cost?		37.50%		62.50%	
	1.c. Water resources cost?		37.50%		62.50%	
	1.d. Equipment costs for using various equipment, tools?		37.50%		62.50%	
	2. How far do you agree that the following expenses / cost is planned and well managed?					

Analysis on Likert Scale		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
	2.a. Labor cost?		32.50%		67.50%	
	2.b. Professional fees paid to various professionals?		31.25%	15%	53.75%	
	3. The afforded site security (various types of measures for protecting the site safety)?		37.50%	6.25%	56.25%	
SF	4. Are there standardized measures during for on-site health, site hygiene, safety measures and insurance?		50%	43.75%	6.25%	
SF	5. Is there a provision for public safety (warning boards and signal systems, safety measures)?		87.50%	6.25%	6.25%	
EnF	6. Is the application of renewable materials and materials reuse (rubble, earth, concrete, steel and timber) applied?	72.50%	24.50%		3.75%	
EnF	7. Are there a policy conditions / ISO conditions applied to manage the following:					
EnF	1.a. Air emission and pollution?				100%	
EnF	1.b. Waste produced from project operation?		80%	20%		
EnF	8. Are consideration being given to the reduction of earthwork and excavation, formwork, reinforcement, concreting and waste treatment during structural operation?			20%	80%	

Table 5. Questionnaire Section (1), Sustainability Factors (Economic Factor "EF", Social Factor "SF" and Environmental Factor "EnF") in Project Operation Stage [developed by author]

Analysis on Likert Scale Sustainability Factor / Project Stage (Operation Stage)					
Validity Evaluation	No	Don't Know	Yes		
1. Were you informed about the units handing over date?	61.25%	13.75%	25%		
2. Were you periodically notified about any delay in work progress and modified delivery date?	61.25%	13.75%	25%		
3. Were you able to follow up on the work progress?	41%	12.50%	46%		
4. Did you notice a change in master planning, facades design, residential units plan design, the finishing model you chose?	31.25%	12.50%	56.25%		
Satisfaction Evaluation	Very Dissatisfied	Dissatisfied	Neutral	Satisfied	Very Satisfied
5. How satisfied are you with the unit that was allocated to you by lottery system?	15%	13.75%	27.50%	25%	18.75%
6. How do rate the following (Price / m2)?	12.50%	33.75%	5%	26.25%	22.50%
7. How do you rate (Flat Area) and (Flat Interior Design)?	25%	25%	10%	30%	10%
8. How do you rate advantage of reserving at this sector?	16.25%	30%	10%	30%	13.75%

Table 6. Questionnaire Section (2), Project Management Knowledge Areas [developed by author]

Analysis on Likert Scale	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
PROJECT BUDGET					
1. Is the project budget according to contract?		63%		37%	
2. How much is the total actual project budget, the expenses incurred, sum m^2 of construction floor area, the rework costs?		75%		25%	
3. Do you think Green buildings cost more than traditional buildings?		75%		25%	
4. Do you think these are of financial benefit for green buildings: 4.a. Lower energy/water usage, less waste disposal					
4.b. Durability of building materials				100%	

Analysis on Likert Scale	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
CONTRACT CONDITIONS					
5. Are there any "Green" requirements in the contract?	100%				
6. Are you satisfied with Incentive/ Penalty clauses in contract?			25%	75%	
PROJECT TEAM CHARACTERISTICS					
7. Do you agree about the following:					
7.a. Importance of organizing team relationships in RFP?				100%	
7.b. The contractual terms for project team members?				100%	
7.c. The team member's experience in similar facilities, green buildings, delivery systems adequate?		75%	25%		
7.d. The team communication of this project?		25%	50%	25%	
DESIGN AND CONSTRUCTION PROCESS					
8. How is the timing of communication within team members, Is it satisfactory?		50%	25%	25%	
9. Do you agree about presence of a GB consultant? What do you think about his contractual position?			25%	75%	
10. How is the design charettes and commitment level of team members?		25%	50%	25%	
Analysis on Likert Scale	**Very Unsatisfactory**	**Unsatisfactory**	**Neutral**	**Satisfactory**	**Very Satisfactory**
PROJECT SCHEUDLE					
11. How do you evaluate the variance between the planned project duration and the actual project duration?		50%	25%	25%	
12. How far is the reflection of the speed of the following on project schedule:					
12.a. Construction (Actual duration/floor area)?			25%	75%	
12.b. Material availability (time delay because of supplying materials)?		70%	15%	15%	
12.c. Equipment availability (time delay because of lack of equipment)?		70%	15%	15%	
12.d. Labor availability (time delay because of lack of labor)?		75%	25%		
PROJECT QUALITY					
13. How do you valuate the difference in level between quality expectation of owner and real project quality?	15%	10%	15%	60%	
14. How do you evaluate the budget and time required to rework unsatisfied quality requirement works?	3.75%	30%	2.5%	63.75%	
DESIGN AND CONSTRUCTION INTEGRATION					
15. How are you satisfied with the consultants' / contractors' work integration?	10%	28.75%	37.50%	23.75%	
16. How do you evaluate the involvement of a "green" consultant?		87.50%	6.25%	6.25%	
17. How do you evaluate decision making process in this project?	10%	33.75%	17.50%	38.75%	

Table 7. Interviewees in visited projects in different cities

Number of Interviews /Questionnaires responses	Sherouk City		New Cairo City		6th October			New Administrative Capital	
	(***)	(*)	(***)	(**)	(*)	(***)	(**)	(****)	(****)
City Authority Engineer (Owner Representative)	1	1	1	1	1	1	1	5	5
Architects	3		3	5		3	5	5	3
Supervision Consultant				2			2	3	2
Owner's Management Consultant									1
City Authority Engineer (Supervision)		1		1	1		1		
Contractor	1	3	1	2	4	1	2	4	3
Technical Office	1	1	1	1	1	1	1	1	1
Contractor Project Management Consultant	2		2			2			
Sub-Contractor	2		2			2			
City Authority Engineer (External Works Supervision)	1		1			1			
Contractor (External Works)	1		1			1			
End User	25	20	20	14	25	30	19	10	5
TOTAL %	23%		33%		27%			18%	

3.1. Concluding the Current Gaps

The analysis of the received responses for the questionnaire resulted in supporting the authors hypothesis and revealed the gaps in the efficiency of the current projects performance to be sustainable due to the following analysis conclusions:

(i) The fragmentation in the management of PLC stages and the diversity of stakeholders causes implication in time, cost and risks evaluation as a consequence of conflicts in decision making.

(ii) GPM processes should ensure the comprehensive planning for PLC stages, while monitoring and controlling should overview the design, tender and construction stages. Sustainability performance can be assessed through sustainable project planning (SPP) which a new introduced project management knowledge area by the authors.

(iii) The lack of the integration between PLC stages supports the project management capacity to bridge this gap to have PLC stages streamlined with defined sustainable targets. Hence, stresses the importance of the chronological linear relationship between project management processes and PLC stages.

(iv) Project Managers should be responsible to plan for the mechanism for SP achievement, facilitate the collaboration among various professionals through PLC stages and have them consistent and coordinated.

3.2. The Places to Intervene

The sustainability criterions should be continuous through PLC stages. This would be achieved by successful planning that adopts an integrated process between project management processes and PLC stages, which is called Sustainable Project Planning (SPP). GPM framework is defined by the authors as the management process that maintains an integration concept based on a linear relationship between project management practices and sustainability criterions through PLC stages. The establishment of this comprehensive perspective is assumed to deliver the projects sustainably as will be validated in the coming section.

4. Validation of The Proposed Framework

Surveying the current status of project management practices has concluded the factors for managing the integration between Sustainability Triple Bottom Line and Project Management Processes through Project Life Cycle Stages in findings record which were interpreted into the analysis of the gap between the current practices and the proposed framework. These factors will boost the correlation between project management processes and sustainability principles through project life cycle stages.
The designed work plan which has been developed through the previous questionnaire, Table 8 will be put into A Guide Model to represent the structured approach for this integrated process based on the concluded current gaps, Table 9. For the validation of this Guide Model, it was evitable to conduct another questionnaire. The correlation between different variables was the basis of the construct, accordingly the mapping project management areas of knowledge to the project management processes through the project life cycle stages (PLC) that will be performed.

4.1 The Guide Model

The authors at this stage is looking to formulate the integration concept between project management processes and project

management knowledge areas through the project life cycle, therefore the establishment of the comprehensive perspective to deliver the adequate sustainable performance. The following Table 9 explains the proposed Guide Model illustrated through the adjusted mapping of the project management knowledge areas to the project life cycle stages (PLC) and the project management processes in a linear integrated form (one comprehensive stage) not fragmented stages with isolated project management processes.

The project stages (inception, design, tendering, construction and operation) are considered collectively as WBS (work breakdown structure) linked linearly with the project management basic processes in a chronological sequence. On the vertical line is the project management areas of management, they have been divided into groups then sub-groups and traced through the life cycle. This perspective is proposed to ensure the diligent delivery of green based construction projects. The performed mapping introduces (3) important goals that contradict with PMBOK: (1) new alignment of project management processes and areas of management, (2) A Guide Model for Green Project Management in housing projects and (3) defining Green Project Management Critical Success Factors. This necessitate the inevitability to validate this approach through conducting another questionnaire with the previous interviewees of the previous questionnaire.

4.2 Matrix Conformity

The Guide Model Matrix is introduced as an interpretation for the previously illustrated conclusions. The level of the conformity with the new defined mapping matrix which is between new project management knowledge areas through project life cycle and project management processes will define the place of the deficiency. The matrix details identify the green project management tasks through project life cycle stages towards green project management, Table 9.

5. Conclusions

Ensuring the streamline of sustainability vision in project management processes and practices through project life cycle stages can be achieved when maintaining the long-term vision which requires the project managers engagement to sustainability. This revert us back to the paper focal point which is to integrate the project management aspects and the sustainability principles introduced by researcher as integrity concept.

5.1 New alignment of PM Processes and adjusted PM Knowledge Areas through PLC Stages (Correlation Coefficient Method)

To introduce the new shift needed to apply and integrate sustainability in project management, the correlation between project management processes and project management adjusted knowledge areas through PLC stages. Interviewee will rate the linear relationship between the stages of PLC and PM processes with the new alignment of PM knowledge areas.

In the statistics science, Correlation Coefficients are used to determine how strong a relationship is between two variables, its value varies from +1 (means strong relationship) to negative correlation at -1, with a neutral relation at Zero (no relation). The ranges of respondents' responses were used to determine the correlation matrix between GPM knowledge areas through project life cycle stages and project management processes. This has refined the proposed Guide Model and turn it from draft version to a final version that will be considered as the work plan. Conclusions confirmed the agreement of the interviewees about the new alignment of PM processes and adjusted PM knowledge areas through PLC stages.

5.2 The performance matrix of green project management

The correlation coefficient values were defined for the relation between PM areas of knowledge through PLC stages which were agreed to be positive among the interviewees of the validation questionnaire. This helped in building the correlation matrix (correlation statistic method performed by Excel) and compare it with the proposed Guiding Model. In the same context, the need to identify the dominant factors and the less dominant factors in this matrix is the pillar for getting Guiding Model draft version into the final version, Table 8 and Table 9. The conformity with the performance matrix (Guide Model) reflects that the GPM practices is on the right track towards success. Therefore, guide the way for enhancing the green project management performance.

To reach this point, Guiding Model was discussed in the validation questionnaire and (3) questions was asked after the interviewee finalizes his review for the model about the following:

1. Defining GPM success criteria, Table 10.
2. Identification of critical success factors for green project management, where GPM success is considered as the dependent factor and GPM knowledge areas are considered as the independent factors, Table 11
3. Ranking the Critical Factors Influencing the Success of GPM, Table 12.

5.3 Critical Success Factors for Green Project Management (Ranking Method)

The final goal will seek the critical success factors for managing sustainable performance in housing projects through a systematic series of questions introduced in the validation questionnaire. The methodology of this questionnaire is to rate the variance of knowledge areas

contribution to green project management success, which is obtained from the knowledge areas as components of the green project management.

A crucial step to reach this was a question about Green Project Management (GPM) success criteria, where respondents replied with their level of agreement by ticking on ten-point Likert scale, 0 (not important) to 10 (very important) the area/areas of knowledge the respondent thinks they directly relate to the success of sustainable based project management, Table 10. Here, the most prominent knowledge areas were determined as variables determining the criterions of GPM success. The areas of knowledge which had below 5 grades were excluded (red highlighted). Respondents are then requested to re-assess their replies through the next question about identifying the critical factors influencing the success of GPM where respondents replied with their level of agreement by ticking on ten-point Likert scale, 0 (not important) to 10 (very important), for each of the proposed areas of knowledge according to the respondent believe about the success of sustainable based project management, Table 11. The result of this question was then computed to reflect the scores each area of knowledge has achieved.

The third question was about ranking the critical factors influencing the success of GPM in an ascending order starts from (1) to (9), where ranks equal to 5 grade and above were excluded, Table 12. This indicator was emphasized by asking the respondents to assume the weight of each factor towards the success of GPM according to its importance as they rated it. The given weight was based on their experience and related to their vision for an ambitious plan.

Table 8. Mapping Green Project Management (GPM) Areas of Knowledge to Project Life Cycle (PLC) and Project Management (PM) Processes [developed by author]

Project Management Areas of Knowledge		**Project Life Cycle Stages / Project Management Processes**				
			Planning, Execution and Monitoring & Controlling			
		Initiation	Design	Tender	Construction	Closing
1.Sustainable Project Planning	1.1 Plan Development					
	1.2 Plan Evolution					
	1.3 Assess & Control					
2. Project Integration Management						
3. Contract Management						
4. Scope Management						
5. Green Building Check listing						
6. Communication Management						
7. Constructability Management						
8. Sustainability Principles Activation	8.1.1 Time					
	8.1.2 Cost					
	8.2.1 Stakeholders					
	8.2.2 Culture					
	8.3.1 External Policy					
	8.3.2 Internal Procedures					
9. Product Management	9.1 Quality Management					
	9.2 Procurement Management					
10. Risks Management	10.1 Design Risks					
	10.2 Construction Risks					
11.Challenges Management	11.1 Impact Management					
	11.2 Solution Innovation					

Table 9. A Guide Model (Mapping Green Project Management (GPM) Areas of Knowledge to Project Life Cycle (PLC) and Project Management (PM) Processes [developed by author]

Project Management Areas of Knowledge		**Project Life Cycle Stages / Project Management Processes**				
			Planning, Execution and Monitoring & Controlling			
		Initiation	**Design**	**Tender**	**Construction**	**Closing**
1. Sustainable Project Planning	1.1 Plan Development	– Develop projects strategic objectives – Develop sustainability parameters				
	1.2 Plan Evolution		– Developing Project Management Plan – Develop the framework for integrating sustainability principles through project plan	– Direct and manage project work – Communication of project management plan and Sustainability Assessment System report		
	1.3 Assess & Control		– Develop sustainability assessment system	– Evaluate and update Project Management Plan – Evaluate the integration of sustainability goals		– Project Learned Lessons
2. Project Integration Management	2.1 Planning	– Develop project charter	– Develop IGBP-PDRI Model – Develop procurement method – Develop quality standard (QMIF) – Identify project constraints			
	2.2 Execution		– Identify stakeholders' interests – Develop stakeholders' requirements			
				– Maintain procurement method		
			– Ensuring quality management integrated framework (QMIF)			
	2.3 Monitoring & Control		– Monitor and control project work – Perform integrated change control			
3. Contract Management		– Development of contractual relationship guidelines (CRG)	– Contract drafting			
			– Issue green requests for			

Project Management Areas of Knowledge			Project Life Cycle Stages / Project Management Processes				
			Initiation	Planning, Execution and Monitoring & Controlling			Closing
				Design	Tender	Construction	
				proposals – Contract management			
4. Scope Management	4.1 Planning			– Collect stakeholders' requirements – Define scope – Plan scope management			
	4.2 Execution			– Create overall WBS for project milestones			
				– Create work breakdown for stage milestones			
	4.3 Monitoring & Control			– Scope validation and control – Reporting changes			
5. Communication Management			– Plan communication management	– Manage and control communications			
				– Manage integrated change control			
6. Sustainability Principles Activation (Economic Principle)	Projects Constants:	8.1.1 Time	– Initiating baseline time schedule				
				– Planning integrated time schedule			
				– Updating time schedule and include dated corrective actions			
		8.1.2 Cost	– Early stage design decisions – Identify target group capabilities				
			– Develop project budget scale with respect to sustainability				
				– Green building life-cycle analysis			
				– Direct and manage life-cycle analysis recommendations			
	Projects Variables (housing projects): Determining housing affordability		– Identify target group				
			– Performing feasibility study				
				– Direct and manage feasibility study recommendations – Implement sustainability assessment, evaluate and decide corrective actions			
6. Sustainability Principles Activation (Social Principle)	Projects Constants:	8.2.1 Stakeholders	– Identify Stakeholders				
			– Plan project team management – Manage stakeholder engagement and develop project team				
				– Control stakeholder's engagement and project team management			
		8.2.2 Culture	– Identify target group				

Project Management Areas of Knowledge			Project Life Cycle Stages / Project Management Processes				
			Initiation	Planning, Execution and Monitoring & Controlling			Closing
				Design	Tender	Construction	
			requirements				
			– Identify sustainability decisions orientation				
				– Sustain sustainability decisions orientation			
	Projects Variables (housing projects): Implement housing social criterions		– Determining density and urban form – Determining dwelling size				
				– Developing density and urban form – Developing dwelling size			
					– Direct and manage sustainability decisions		
						– Ensuring adaptability – Ensuring social acceptability	
				– Implement sustainability assessment, evaluate and decide corrective actions			
6. Sustainability Principles Activation (Environmental Principle)	Projects Constants:	8.3.1 External Policy	– Determining water conversation and energy efficiency methods				
				– Determining construction materials			
					– Determining construction methods		
		8.3.2 Internal Procedures	– Identify sustainability decisions orientation				
				– Develop internal procedures			
				– Implementing process and procedures regulations – Sustain sustainability decisions orientation			
	Projects Variables (housing projects): Maintaining quality of life criterions		– Developing housing indicators reflecting the acceptable quality of life				
				– Maintaining humanization in design development			
					– Direct and manage sustainability decisions		
				– Implement sustainability assessment, evaluate and decide corrective actions			
7. Quality Management				– Plan quality management			
				– Perform Quality Assurance – Control Quality			
8. Procurement Management				– Plan Procurement			

Project Management Areas of Knowledge	Project Life Cycle Stages / Project Management Processes				
		Planning, Execution and Monitoring & Controlling			
	Initiation	Design	Tender	Construction	Closing
		Management			
		– Conduct Procurements – Control Procurements			
					– Close Procurements
9. Risks Management	– Plan risk management – Plan preventive technique				
		– Identify risks – Perform qualitative & quantitative risk analysis – Plan risk responses	– Identify risks – Perform qualitative & quantitative risk analysis – Plan risk responses	– Identify risks – Perform qualitative & quantitative risk analysis – Plan risk responses	
		– Apply integrated remedial technique			

Table 10. GPM Success Criteria [developed by author]

Level of agreement	Sustainable Project Plan (SPP)	Integration Management	Contract Management	Scope Management	Communication Management	Sustainability Principles Activation	Product Management	Risk Management
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	5	0	0	0	0	0	0
4	5	5	0	7	0	0	5	17
5	5	25	10	25	7	7	25	25
6	15	10	10	5	7	7	17	5
7	30	28	5	35	28	11	35	35
8	15	20	20	20	22	20	10	10
9	15	3	17	5	18	22	5	5
10	12	1	35	0	15	30	0	0

Ten-point Likert scale 0 (not important) to 10 (very important)

Table 11. Identifying the Critical Factors influencing the success of GPM [developed by author]

Level of agreement	Sustainable Project Plan (SPP)	Integration Management	Contract Management	Scope Management	Communication Management	Sustainability Principles Activation	Quality Management	Procurement Management	Risk Management
0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0
4	0	7	0	7	0	0	5	17	17
5	10	25	10	25	7	7	25	25	25
6	15	5	10	5	7	7	17	5	5
7	25	35	5	35	28	11	35	35	35
8	20	20	20	20	22	20	10	10	10
9	15	5	17	5	18	22	5	5	5
10	12	0	35	0	15	30	0	0	0
Total Scores	97	97	97	97	97	97	97	97	97

Ten-point Likert scale 0 (not important) to 10 (very important)

Table 12. Ranking the Critical Factors Influencing the Success of GPM [developed by author]

	Scores	Rank	Average Rank	Weight Factor
Sustainable Project Plan (SPP)	60	3	3.5	0.23
Integration Management	55	5	6	0.04
Contract Management	60	3	3.5	0.20
Scope Management	55	5	6	0.04
Communication Management	65	1	1.5	0.21
Sustainability Principles Activation	65	1	1.5	0.18
Quality Management	55	5	6	0.04
Procurement Management	35	9	9	0.03
Risk Management	50	8	8	0.03

References

[1] Adnan, E., Bernd K. and Hadeel A., "Factors Affecting Sustainable Performance Of Construction Projects During Project Life Cycle Phases", International Journal of Sustainable Construction Engineering & Technology, Vol. 7, Issue 1, pp. 50-68, 2016.

[2] Chawlaa, V.K., Chandab A.K., Angraa, S. and Chawla, G.R., "The Sustainable Project Management: A Review and Future Possibilities", Journal of Project Management, Vol. 3, Issue 3, pp. 157-170, 2018.

[3] Dey, P.K., "Benchmarking Project Management Practices of Caribbean Organizations Using Analytic Hierarchy Process Benchmarking", An International Journal, Vol.9, No.3, pp. 326-356, 2002.

[4] Gareis, R., Heumann, M. and Martinuzzi, A., "Relating Sustainable Development And Project Management", IRNOPIX, Berlin, Germany, 2010.

[5] Grevelman, L. and Kluiwstra, M., "Sustainability In Project Management, A Case Study On Enexis", United Kingdom and The Netherlands: University of Greenwhich and Saxion University of Applied Sciences, 2009.

[6] Ibem, E. and Aduwo E., "A Framework for Understanding Sustainable Housing for Policy Development and Practical Actions", Architects Colloquium, Covenant University, Nigeria, 2015.

[7] KHATER, D., "A Holistic Framework for Green Project Management to Deliver Sustainable Housing", Journal of Engineering and Applied Science, Vol. 67, No. 3, Jun. 2020.

[8] Mauro L. and Marly M., "Key Factors Of Sustainability In Project Management Context", International Journal of Project Management, Vol. 35, Issue 6, pp. 1084-1102, 2016.

[9] Project Management Institute, "A Guide to The Project Management Body of Knowledge (PMBOK Guide)", Vol. 6, 2017.

[10] Ramabadron, R., Dean, J.W. Jr and Evans, Jr, "Benchmarking and Project Management: A Review and Organizational Model", Benchmarking for Quality Management of Technology, Vol. 4, pp. 47-58, 1997.

[11] Report of European Housing Ministry held in Czech Republic, Prague, VROM, "The 2005 Sustainable Refurbishment of High-Rise Residential Buildings and Of Surrounding Areas in Europe", 2005.

[12] Silvius, A.J.G., Brink, J. Van Den and Köhler, A., "Views On Sustainable Project Management", IPMA Scientific Research Paper Series. Helsinki, Finland, 2009.

[13] Silvius, G., Schipper, R., Planko, J., Brink, J. Van Den and Köhler, A., "Sustainability In Project Management", Gower Publishing Limited, Farnham, England, 2012.

[14] Sudha R. and Timea K., "Sustainability In Project Management", UMEA University, School of Business and Economics, MSc Strategic Project Management, European, 2017.