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INTEGRATING THE PRINCIPLES OF SUSTAINABILITY AND PROJECT MANAGEMENT AT THE EARLY STAGES OF CONSTRUCTION PROJECTS

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ABSTRACT
Sustainable construction (SC) is considerably new trend particularly in developing countries such as Egypt. So, applying project management (PM) to that new trend of construction requires the relevant stakeholders to consider the sustainability principles in implementing PM at the early phases of the project. This promotes for significant cost savings over time, and a unique marketing strategy. For construction projects, Feasibility stage (FS) is the first and most important stage before undertaking project design & construction and its effectiveness will affect directly the success of the project. A vast literature review revealed a number of essential elements that should be considered and a number of challenges that should be mitigated to integrate the principles of sustainability and PM in construction projects. Also, to investigate the current status for managing FS of SC projects in Egypt; such as the main benefits and barriers during managing FS of SC projects; the survey research method has been adopted and data were collected using designed structure questionnaire. This paper introduces a flowchart for applying PM Principles at the FS for SC projects. This flowchart outlines the necessary elements that enable project stakeholders to consider sustainability principles while making decisions in FS , also it justifies additional preplanning effort of sustainable construction projects. Additionally, the proposed flowchart provides a good base for projects that seek green accreditation to comply with Egyptian Green Pyramid Rating System (GPRS), and provides channels for overcoming the challenges of achieving SC project starting by FS. Consequently, the proposed flowchart works as a kick of for managing SC projects in its coming phases. Moreover, this paper provides several recommendations on how to enable project stakeholders overcoming the barriers of starting FS for SC projects in Egypt which will help for reducing cost and time overruns and increases the possibility of achieving SC.

KEYWORDS: Sustainable construction; Feasibility stage; Project management; Framework of Sustainable construction; Green rating systems.

INTRODUCTION:
Sustainable construction (SC) seeks for proper management to early embed all sustainability aspects into project life cycle. Proper management for feasibility stage (FS) should take into consideration during decision making all new determinates of sustainability in order to reduce the overall cost of a project throughout its life cycle(Kats ,2003). Many studies(Du Plessis ,2007;Lam et al. ,2010; Shen et al.,2010; and Robuchaud and Anantatmula , 2011) have revealed that the higher costs and many of challenges can generally be alleviated by the inclusion of green aspects from the earliest stages of the project. Therefore, the need for this research has been arisen to study what are the significant elements in managing the FS of SC

projects, and clarifying how it should be embedded in FS process through developing flow chart for managing FS for SC project to achieve the requirements and specifications of SC in Egypt. This outcome will reduce many obstacles of implementing SC, and will rationalize the excess effort during sustainable FS, which consequently will encourage project developers to start SC projects with clear steps and better awareness. To achieve this goal; this paper aims to achieve the following objectives: 1) Identifying the main key differences between traditional and SC projects, 2) Identifying the main elements and validating their importance for managing FS for SC which represent the core of proposed flowchart, and 3) Exploring the main benefits and barriers of managing FS for SC projects.

Methodology:

For achieving the research objectives; a theoretical study has been conducted through an intensive review of literature for managing SC project. The theoretical study is followed by a field study survey using a specially designed questionnaire distributed via a representative sample of experts of SC in Egypt.

Literature review and theoretical findings:

This section aims to clarify the main terminologies, and then addresses the main areas in the theoretical study that was the base to come up with suggested elements followed by developing flowchart for managing FS of SC projects. Herewith, It will identify the differences between traditional and SC projects. Moreover, it will compare eight of studies related to strategies of managing SC projects to conclude the common categories of models for managing SC projects.

Terminologies:

Reviewing the literature came up with some important definitions that need to be understood for the current research subject as follow: *Feasibility stage (FS)* is defined as the first and most important stage before undertaking project design and its effectiveness will affect directly the success of a project, this stage also includes defining and assessing the client's need into a structural brief, and identifying all key stakeholders (shen et al., 2010). *Sustainable construction (SC)* is defined as one of the integral processes of sustainable development (SD) and it is seen as a holistic process aiming to restore and maintain harmony between the natural and the built environment (Du Plessis, 2007). While, *sustainable construction management (SCM)* is defined as management framework to help construction practitioners in tackling the issue of sustainability with a set of principles, tools and techniques that integrate sustainable development into major processes of decision making and practices (Eid, 2009).*Green Rating Systems (GRS)* is presented as an important tool in measuring and evaluating the environmental performance of a building; where these systems are used to evaluate and benchmark sustainability. There are several GRS worldwide apply differently in different climatic and geographical conditions, to meet local needs for each country (Adler et al., 2006). *In Egypt, Green Pyramid Rating System (GPRS)* is the green rating has been developed by the end of 2010 by the Egyptian Green Building Council (EGBC) to be applied for new buildings (http://www.hbrc.edu.eg). There are four levels for GPRS certification: 1) GPRS Certified, 2) Silver pyramid, 3) Golden Pyramid, and 4) Green Pyramid (the highest level). GPRS can offer a roadmap that lead to sustainability goals and help align requirements by focusing on recognizing performance in seven key areas: (1)Sustainable Site, Accessibility, Ecology (15%), 2) Energy Efficiency (25%), 3) Water Efficiency (30%),4) Materials and Resources (10%), 5) Indoor Environmental Quality (10%), 6) Management (10%), and 7) Innovation and Added Value (Bonus).To focus on the unique practices of managing SC projects, next title will discuss briefly the key differences between traditional and SC.

Traditional vs. Sustainable construction:

It was necessary foremost to identify the main differences between traditional and SC; to spot more light on the new practices areas. Some studies have exposed to the differences between them (Du plessis, 2007; Kibert, 2005; Hwang and Tan, 2010). The researcher has defined the main differences in eleven key areas as shown in Table (1); which refer to the core behaviour of SC. Managing FS of SC should examine these additional issues ,consequently it will need more effort than the traditional one.

Table (1): Key Differences in sustainable construction

element	Key Differences	Sustainable project life cycle
Project scope	**1. Main goal of project participation**	The Main goal of project participation is minimum adverse effect on the surrounding environment while achieving its financial.
	2.Building Performance specifications	Defining building Performance specifications; allowing all stakeholders to share their experience and achieve the project sustainability goals in more creative ways.
Integrated design	**3. Design scope**	*Design charter* is a workshop for generating and discussing ideas in the planning and design process when people need to cut across boundaries and work on a large, collaborative project. *The design team examines* the integration of all building components and systems through three main design features (indoor *quality* (lighting, HVAC) , *building material* , *layout*), and determines how they best work together to save energy and reduce environmental impact. *Participants in the design charter, including all project stakeholders* will make early decisions related to project's location; orientation and envelope ,interior spaces; and water needs; heating, ventilating, and air-conditioning (HVAC) ,..... Such early investigation will lead to the selection of the most suitable alternatives for different project criteria.
	4.Building Information Modelling (BIM)	Building Information Modelling (BIM) including energy modelling and simulations as effective tools in predicting project performance upon completion and assisting with project commissioning.
	5. Life Cycle Costing (LCC)	Life Cycle Costing (LCC) is the main cost evaluation approaches for project selection and development.
	6. Value Engineering (VE)	VE application matching the sustainable project development, particularly if implemented at the early stages of project formulation and design.
Early Stakeholder involvement	**7. Stakeholders**	SC project involve many more players than just those traditionally identified, and should be early involved.
Early Decision making priorities	**8. Decision making criteria**	It embraces not just technological responses, but also the non-technical aspects related to social, environmental, and economic sustainability.
Early procurement strategies	**9. contracts**	SC tends to follow one form of a relational contract or another. Such forms of contracts include Integrated Project Delivery (IPD), Early Contractor Participation (ECP) or DA (Design Assist) where the Contractor is hired early, and his construction input is sought early through design progresses, thus eliminating the potential for change orders and fraudulent claims.
	10. Delivery systems	SC requires superlative communication; through delivery systems such as The design – build delivery system which is effective communication between project team members. Where it is carried out as a single entity, and a detailed integrated design process is employed at the start of the project. But least-cost delivery systems (design-bid-build); are unable to achieve effective communication since the design and construction are managed by two separate teams.
	11. Procurement	The implementation of the just in time (JIT) concept in traditional projects is not mandatory, While it is always good practice to apply this in green projects. Doing that will save both energy consumption and costs, this will help to achieve the corresponding credits in the rating systems. However, it requires a stable relation between the suppliers and the contractors.

Models and approaches for managing sustainable construction project:

There are some models have been developed to manage SC projects. It is noticed that some models focus on project success factors and defining the performance indicators as assessment tools. While other models developed framework for management strategies. Although these studies have handled management of SC in different strategies, they agreed on some categories which should be managed effectively for implementing SC. *The researcher has compared these studies* and *derived* the common categories between them as shown in Table (2) . By looking to this literature survey, it can be found that the most selected categories are: Environmental aspects 100%, then the Economical aspects and social aspects with equal share 50%, where they are the main principles of SD. while other elements are selected with about 38%. That because most of studies concentrated on indicators and parameters for project sustainability assessment not for how managing projects to deliver SC. That can be clear, when noticing that, the studies that use the Environmental, Economical, and social aspect; don't use the enablers and vice versa. While achieving SC project needs both assessment criteria and enablers for delivering these projects in feasible way. Therefore, this research is willing to fill in this gap by developing flowchart combing assessment criteria and enablers for delivering SC in sequential processes to be applied in sustainable FS.

Table (2): comparison between studies related to SC project management

Study reference / Categories	Du plessis 2007	Aysin 2009	Lam et.al. 2010	Shen, et.al., 2010	Silvius and Schipper, 2010	Robichaud & Anantatmula 2011	Schmedes 2011	Huang & Hsu 2011
Sustainability principles								
Environmental aspects.	✓	✓	✓	✓	✓	✓	✓	✓
Economic aspects.				✓	✓		✓	✓
Social aspects.				✓	✓		✓	✓
Stakeholder involvement								
Stakeholder involvement	✓		✓			✓		
Green design and sustainable procurement								
Project life cycle analysis		✓	✓			✓		
Green Technology and Techniques.	✓	✓	✓					
Project scope								
Guide and Benchmarking (GRS)	✓		✓			✓		

Elements for managing the sustainable feasibility stage:

This paper has extracted the most effective elements for managing the sustainable FS. This extraction based on the theoretical study reviewing the key differences between traditional and SC projects ,the project success factors, challenges and mitigation strategies for managing SC project. These six suggested elements are set as following: (*sustainable project scope, early stakeholder involvement, conceptual integrated design, procurement strategy for SC, Decision making considering sustainability priorities, and Archive data base for recording and documentation*). These extracted elements are used to formulate a flowchart for purpose of managing sustainable FS .this is achieved by allocating these elements to the phases of FS , and then decomposed to sequential process represented as flowchart. The researcher has represented this conceptual framework in Fig.(1) as pre-step for developing the flow chart for managing FS of SC project.

Field study :

The questionnaire has been designed to invite the consultants, project managers and contractors of SC projects to contribute to the hypothesis of the research with their expert

views. Especially, this trend is still recent in Egypt and the number of experts is still limited. After the questionnaire has been designed, a pilot sample (5 experts) has been investigated and based on their response some adjustments were made. The designed questionnaire was distributed to 25 experts in Egyptian SC projects from March 2014 to June 2014. A total of 17 out of 25 questionnaires were returned and be ready to be analyzed (68 % response rate). This questionnaire has been developed to: 1) to validate the importance of the suggested elements for managing sustainable FS which were derived from the literature review, and 2) to identify the main benefits and barriers of managing FS for SC projects. Statistical analyses were performed using software (SPSS) V.16, the main statistical analysis used descriptive and correlation analysis.

Data analysis and discussion:

Sample profile:

The sample includes 11 consultants (64%), 3 project managers (18%) and 3 contractors (18%). 35% of the respondents have more than 5 years experience on SC projects (5-10) years experience. Those having experience between 11 to 15 years and less than 5 years represent 24%, and 18% has an experience over 15 years. This distribution reflects how recent is the practice of SC in Egypt.

Importance of elements for managing sustainable feasibility stage:

Based on the deep literature review; this research has extracted six main elements to be represented in the main phases of sustainable FS. The respondents were asked to rate to what extent it is important to study these six elements during FS of SC project.

Table (3) illustrates the Mean value of scores ranges from 2.82"Archive Data base for recording and documentation" to 3.82 "Sustainable project scope" , with Mode values Four and Three (important and very important). Also, it can be noticed there is a small standard deviation ranges from 0.39 to 0.89; referring to the responses are clustered closely around the mean. To estimate the reliability of these elements; Cronbach's Alpha coefficient was calculated to determine how each element reflects the reliability of the scale of its importance by calculating the coefficient alpha after deleting each variable independently from the scale. The Cronbach's Alpha for all elements is more than **0.7**. Therefore, the information from the questionnaire survey is considered reliable (Cronbach, 1951).

Table (3): Importance degree for elements of sustainable feasibility stage

No.	Elements of sustainable feasibility stage	Mean	Mode	SD	N
1	**Sustainable project scope.** project vision, site selection, selected green rating system, …	**3.82**	4	0.39	17
2	**Early stakeholder involvement** Coordination and defining roles , Designation of Skilled team, …	**3.47**	4	0.87	17
3	**Conceptual integrated design.** Integrated design processes, Environmental and social impacts, Sustainability matrix, life cycle analysis, life cycle cost, ….	**3.47**	4	0.80	17
4	**Procurement strategy for sustainable construction.** Innovative green technology , Contract and delivery method , Sustainability plan , Environmental procurement decisions , …	3.24	3	0.66	17
5	**Decision making considering sustainability priorities.**	3.29	3	0.59	17
6	**Archive Data base for recording and documentation.** Documentation process for each decision making process.	**2.82**	3	0.73	17

(1) Not important, (2) Fairly important, (3) Important, (4) Very important.

Relation between suggested elements of FS and GPRS categories:

To explore the effect of studying the suggested elements and achieving more credits for GPRS categories; A pearson Chi-square has been conducted and summarized in table (4) to measure the correlation between them.

Table (4): Correlation between suggested elements and GRS categories.

Elements / GPRS Categories	Pearson Correlation	1.Sustainable project scope	2.Early stakeholder involvement	3.Conceptual integrated design	4.Procurement strategy for sustainable construction	5.Decision making considering sustainability priorities	6. Archive Data base for recording and documentation
1.Sustainable Site, Accessibility, Ecology	Sig.(2-tailed)	0.96	0.647	0.94	0.467	0.892	0.156
2.Energy Efficiency	Sig.(2-tailed)	0.005*	0.044	0.025*	0.97	0.101	0.864
3.Water Efficiency	Sig.(2-tailed)	0.016*	0.138	0.007*	0.339	0.042*	0.851
4.Materials and Resources	Sig.(2-tailed)	0.053	0.005*	0.075	0.091	0.937	0.798
5.Indoor Environmental Quality	Sig.(2-tailed)	0.124	0.193	0.059	0.274	0.701	0.938
6. Management	Sig.(2-tailed)	0.336	0.808	0.4	0.615	0.874	0.673
7.Innovation and Added Value	Sig.(2-tailed)	0.194	0.144	0.209	0.153	0.739	0.059

*. Correlation is significant at the 0.05 level (2-tailed).

By analysing these data it is noticed that there are four elements affect on getting more credits in three of GPRS categories which are Energy, Water efficiency and Materials & Resources.It is remarkable to notice that both of project scope and integrated design and the correlated categories have been highly ranked. Also, the element of "Decision making considering sustainability priorities" has a significant relation with the category of "water efficiency". This can be attributed to the high credit points (30%) of water efficiency as category in GPRS. Moreover, the element of "Early stakeholder involvement" has a high significant association with category of "Materials and resources". It is a logic result; where assessing and studying this category requires the early views of all stakeholders. This result supports the importance and the feasibility of suggested elements.

Relation between benefits and barriers of managing FS of SC project:

Understanding why it is necessary to mange sustainable FS efficiently will help to develop the proper management system during FS. On other hand, identifying the challenges to achieve any of these benefits is crucial for bridging this gap during developing the management system during sustainable FS.

Therefore, a Pearson Chi-square correlation has been examined to identify the significant relation between each of them. Fig.2 shows the correlated barriers and benefits and the mean value of their significant impact (between brackets) according to the Likert scale from one to four.

It is noticed that two obstacles " **O7**: *Lack of information and absence of Data base of SC in Egypt* " and "**O10**: *Lack of awareness of SC cost savings*" have a significant correlation with four benefits. So it can be concluded that these barriers are responsible for hindering achieving the following benefits: **B1:** *Reducing total time and cost*, **B5:** *maximizing added value of the project*, **B8:** *selection of best alternatives*, and finally **B7**: *evaluate the methodology for achieving selected GRS*. This significant correlation refers to the importance of the necessity to overcome these barriers during developing the management system of sustainable FS in order to achieve these benefits. Moreover, this result supports the importance of suggested elements and their role for archiving the process of decision making (working as database), and considering the sustainable priorities during making decisions.

Benefits of managing sustainable FS .	Correlated barriers	Barriers of managing sustainable FS .
B1: Reducing total time and cost.(3.18)	O6,O7,O8, O10	**O1:** Lack of client demand and owner support (3.65).
B2: Considering the social, environmental, and economic impact of the project during making decision of starting project or not.(3.41)	O11,O12	**O2:** Insufficient time allocated for incorporating SC in feasibility stage (3.12).
B3: Maximize the role of life cycle cost and cost benefit analysis during decisions making. (3.24)	O16,O17	**O4:** Absence of government support and incentives in Egypt (3.47).
B4: Preparing the sustainable design criteria and mitigation measures for sustainability assessment.(3.53)	O1	**O5:**Lack of awareness of sustainable construction requirements (3.41).
B5: Maximizing the added value of the project.(3.12)	O7,O10	**O6:** Less environmental and social concerns at feasibility project stage(2.94).
B6: Applying sustainability throughout all project phases .(3.41)	O4,O8,O9,O13,O17	**O7:** Lack of information and absence of Data base of SC in Egypt (3.29).
B7: Explore and evaluate methodology for achieving selected GRS .(2.59)	O6,O7,O12,O13,O15	**O8:** Lack of knowledge of the methods for integrating sustainability principles during Feasibility stage (3.18).
B8: Selection of best alternatives for achieving SC project within effective time and cost.(2.76)	O5,O7,O10,O16	**O9:** Lack of awareness and availability of local sustainable resources (3.24).
B9: Early involvement of all project stakeholders and commitment their views towards SC project.(3.53)	O2	**O10:** Lack of awareness of sustainable construction cost savings (3.12).
		O11: Traditional culture and attitude(2.71).
		O12: Difficulty to early integrate all project stakeholders with defined responsibilities (3.24).
		O13: The fact that sustainability issues are largely procedural and highly initial cost (3.24).
		O15: Lack of understanding the assessment tools and GRS for sustainable construction. (2.94)
		O16: Lack of ability to transform environmental and social information into monetary values. (3)
		O17: The need for structured guidelines to manage feasibility stage for sustainable construction project. (3.18)

Fig.(2): Correlated barriers and benefits of managing sustainable FS .

Managing SC project during FS:

Based on both theoretical and field study, the research has developed a flowchart for managing Sc project during FS. The proposed flowchart as illustrated in Fig.3 is divided into five phases: 1) Initiation, 2) Initial conceptual design, 3) Integrated sustainability plan, 4) Procurement issues, and finally 5) preparing Feasibility study report. For each phase, the required processes are identified, and key decisions are to be made (selected alternatives). These processes begin with the client's need to be defined and assessed, Then the GRS to be selected. The statement

of needs is then developed into a structural brief (business case) and all key stakeholders are identified with defined roles and responsibilities, also their needs are considered to be satisfied. Subsequently, team work is appointed. Then translating the business case to appropriate design solutions, followed by screening of potential design solutions to select the best sustainable solution by technical, Social & environmental and at the last economical assessment; the optimum design options that meet the sustainability requirement to be selected. Documentation and recording for decision making process is required for effective FS management. It is also necessary to secure the outline financial and time authority; with considering the integrated sustainable issues as agreed in phase three "integrated sustainability plan". The sustainable procurement plan will then be determined by studying the procurement alternatives for all financial, human, material and equipment resources throughout the project life cycle. Finally phase five, preparing the feasibility study report to be peer reviewed before delivering to the owner.

Conclusion:

This paper introduces a flowchart that facilitates managing FS for achieving SC project and being accredited by GPRS certificate, moreover it concerns overcoming the main barriers hindering the managing of sustainable FS. The divided sequential scheme represented by the flowchart enables the user to consider all the needed elements in their right order and to avoid the expecting risk as much as possible. This flowchart allows greater communication among all project stakeholders and illustrates the mechanism for making decisions in order to achieve SC. Also, it concerns with the decisions at design phase as well as procurement plan; where both need more sustainable assessment. Moreover this flowchart has embedded the documentation and recording for data base as a main process for each decision making; it aids as learned lessons for current and future projects. This approach makes the taken decisions explicit and transparent to all stakeholders. Hence, the successful implementation of this flow chart will recommend providing more requirements in addition to the traditional feasibility study requirements as following: 1)Team work specialties (human resources): require additional specialties , 2)Data collection and analysis (material resources): require additional data and more analysis. 3)Time duration for feasibility study; which is influenced by the complexity of the project and the time needed to complete specialized studies. For further studies, this flow chart can be computerized for more effective implementation.

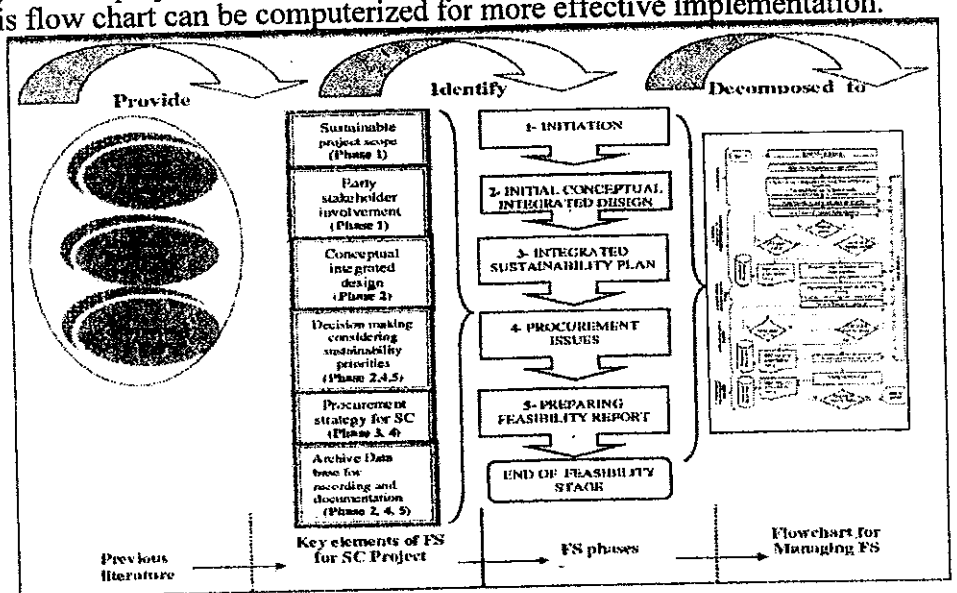

Fig. (1): Conceptual Framework for developing flowchart for managing FS of SC project.

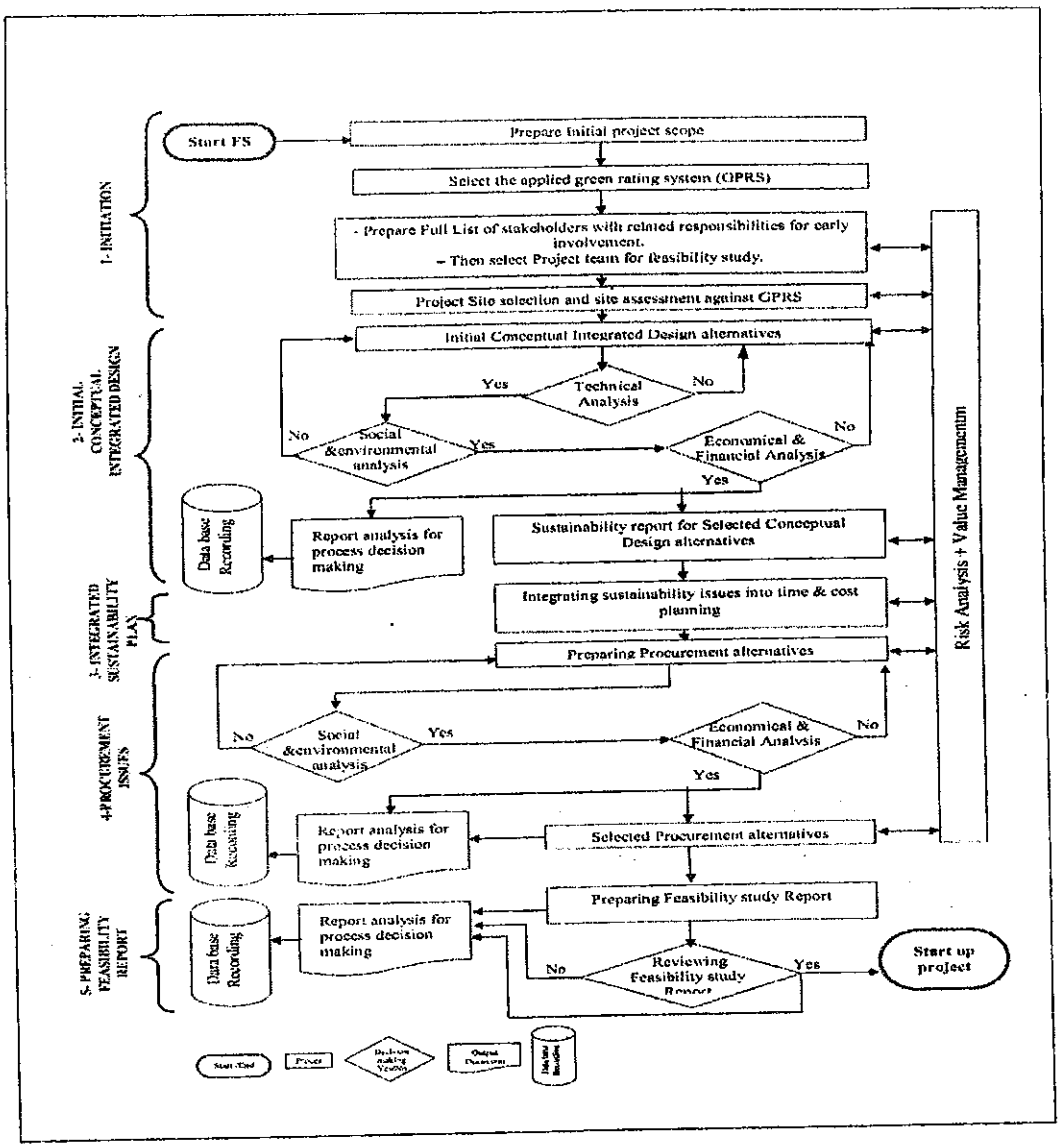

Fig. 3: Proposed flow chart for managing the FS for SC projects

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