BIM

with Green Building Standard

Salah Aldein Dirweesh

BCE,MSc.CPM,PRINCE2®[P],MPM®,
FAAPM®,PMOC®,CSPM,CPM, PPM, ABET Acc.
Freyssinet Saudi Arabia, Riyadh Branch Office.

ABSTRACT

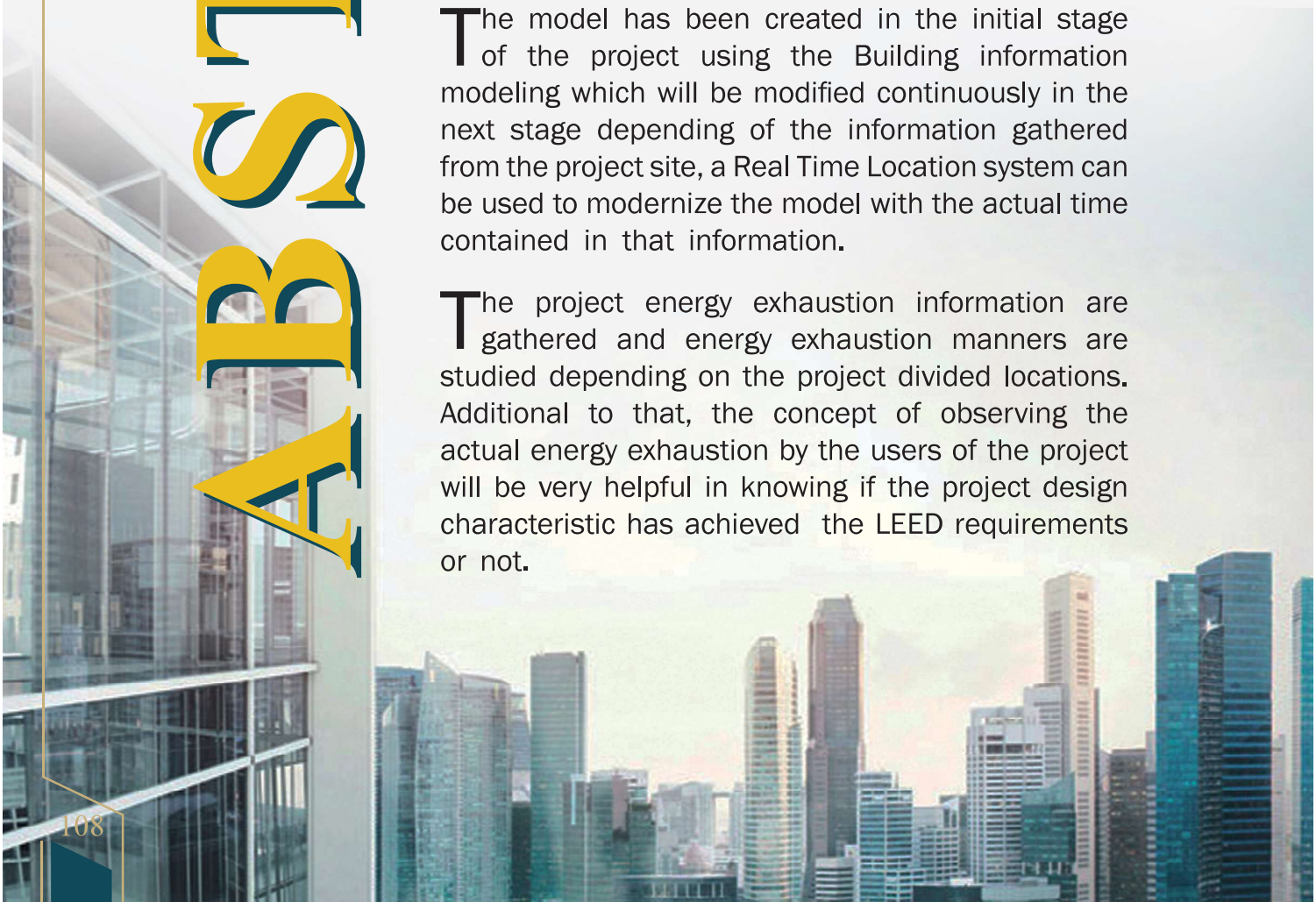
The current research concentrates on assessment of a sustainable project under Leadership in Energy and Environmental Design.

The aim from it is to produce a sufficient and easier solutions to the various people connected to the specific project during all the project phases to execute it completely and to gain the idea of sustainable buildings, this various people usually are the project designers, project managers, main or sub-contractors, project owners and the project end users. Enhancing the project operations was required that is why BIM (Building Information Modeling) is chosen to merge all the data of that project.

From the initial stages of the project model created in Building Information Modeling the Green Building will be present to make sure that this stages will satisfy the requirements. New system is created to help in monitoring the sustainable project conditions and to give alternative solutions to upgrade the project grades related to the LEED.

The model has been created in the initial stage of the project using the Building information modeling which will be modified continuously in the next stage depending of the information gathered from the project site, a Real Time Location system can be used to modernize the model with the actual time contained in that information.

The project energy exhaustion information are gathered and energy exhaustion manners are studied depending on the project divided locations. Additional to that, the concept of observing the actual energy exhaustion by the users of the project will be very helpful in knowing if the project design characteristic has achieved the LEED requirements or not.



1.INTRODUCTION

People who are involved in a certain project consider the problem of sustainability as a very critical one to seek for satisfied relationship between the monetary side of the design and the environment side for that project. Over than forty percent from the universal energy is used by building projects depending on the environmental UN program, and also buildings consider as a main source for a 1/3 of the universal gases like Carbon dioxide that contributes for the green-house (UNEP 2009).

Building second and third phases (Construction and operation phase respectively) have the biggest environmental effect on the building during the related phases because of the energy exhaustion (Khasreen et al. 2009). The need for scales to measure the sustainable projects was necessary that is why in the last twenty years a new evaluation scales, standards, and principles related to thathave appeared. By year of two-thousand the Council of green buildings in US established a new evaluation system for that purpose knew as LEED (Leadership in Energy and Environmental Design).

In spite of the fact that this scales or principles provide obvious paths to reach the green building necessary goals, people involved in the design not always applied this scales in all the project design steps and that can be revered to the short time that they have and the difficulty that always goes with the design phase. In most of the big, hard and difficult projects, people involved in the project design have no escape from canceling some of the project sustainability steps and it is also not easy for them to choose the suitable design depending just on their experiences, that can be for the reason that the steps of studying several design values and evaluation the sustainability of the projects are complicated and hard to manage (Iwaro et al. 2014).

Additional to that, small focusing should be applied for the sustainable buildings

under estimation when it is relative to the construction phase.

The goals of the sustainability projects is to enhance the materials and resources managing and to lower the effect on the projects outdoor environment (Wang et al. 2014).

Furthermore, a shortage of far-range sustainability execution observation obeyed with the project design parts gives not really environmental friendly projects or unsustainability projects. The huge different in the LEED certificate numbers between the projects second phase and the third phase (ten to one respectively) as the main reason for sustainability to be disappeared in the operation phase (Li et al. 2013).

All the previous elements estop the correct attainments of projects sustainability. AEC industry (Architecture,Engineering and Construction) worked to increase the exciting of the sustainable projects, and that when AEC defined the BIM and LCA (Life Cycle Analysis) in the sustainable projects (Jrade and Jalaer 2013).

Life Cycle Analysis is an organized procedures helps the projects effect on the environmental factors from different views, design phase, construction phase and operation phase. BIM (Building Information Modeling) is considered as the latest platform for companies to manage, design and construct in a sufficient way that gives a numeric visualization for the project activates that helps in making the import and export of the data easier as a numeric form (Eastman et al. 2011).

Building Information Modeling can be performed in the analysis for a sustainable projects by taking in the account as e.g. the required materials for the projects and projects trends (Kryegiel and Nies 2008).

By the year of 2013 Chen and Hsieh set a new Building Information Modeling method depending on the rules to measure the green-house gas caused by the projects. Furthermore, Building Information Modeling make the relationship between the people involved in the project to be more powerful and it gives a wider basis for the project data that make the required estimation process for the project easier and with less errors.

Building Information Modeling is switching from ordinary data storage to a new concept that allows several types of checking depending on the initial data (Motawa and Carter 2013).

Within the current research, evaluation for a sustainable building phases is suggested, building parts for a sustainable building design like chosen of the recyclable materials, and far-range running observation for example the exhaustion of energy, waste water, and locative analysis merged with the Building Information Modeling.

At the beginning, the project parts which will not be parameters will be taken out and evaluated by previous known basics. When the numbers of project parts taken into the account to help in the system increase it also increases persuasive the inclusive sustainable evaluation outcomes.

Above on that, this classification pushes the people involved in the design to be more mindful about those demands that would not change to numeric format. After that, the situation of the building sustainability will be observe during the full building phases. The evaluation involves the yearly energy and water exhaustion and users survey.

The collected data can be listed and kept to help in evaluation of the sustainable building and also to be used as references for upcoming LEED design. At several cases, the users conduct may produce an additional power exhaustion more than the design of the project, and the data gathered from constant evaluation can assist to discover the main reasons behind the exhaustion of that additional power.

This current research have a clear target which is to discuss the combining of BIM

and the sustainable project analysis that depends on the LEED "Leadership in Energy and Environmental Design", from LCA platform "Life Cycle Analysis".

For better outcomes the above target can perform in some sub-assignments as

- to suggest a new system of procedures depending on the sustainability evaluation rules;
- to classify the Leadership in Energy and Environmental Design credits depending on the cooperation between the several building phases and the credit standards;
- to discuss and seek the combining of the Building Information Modeling and Leadership in Energy and Environmental Design credits and
- to conclude an introductory application to check feasibility of the suggested new system.

2.METHODOLOGY

For the first step in the design stage, all the papers related to the Leadership in Energy and Environmental Design are checked carefully, and initial convention should be set between the people related to the design and the owner regarding to the sustainable building and to assessment the foreseeable sustainability.

Two separate classes had been selected for the credits in Leadership in Energy and Environmental Design papers.

The demands for several credits can be helped by restoring parametric parts of a certain elements from the building model created in the Building Information Modeling.

E.g., for 7.2 credit a sustainability site, SRI "Solar Reflectance Index" for a roof and any region of that class can be restored from the element parametric exemplification.

At this situation, the cooperation among the elements parametric magnitude and the LEED credits can be introduced and explained in the design phase.

When the rest of the credits counted on extra data and it is required inserting by hands. E.g. credit two is the ratio for construction and destruction wreckage in MR "Materials and Resources" that is a follow up to industrialization operations have to be calculated and designed.

At this situation, a new link is designed to assist in the inserting of the outer information.

Figure (1) below shows the design stage sustainability evaluation, as it concluded after restoring information from the generated model in Building Information Modeling and several helping data depending on the Leadership in Energy and Environmental Design standards. After that the generated model is transferred it to the next phase (Construction).

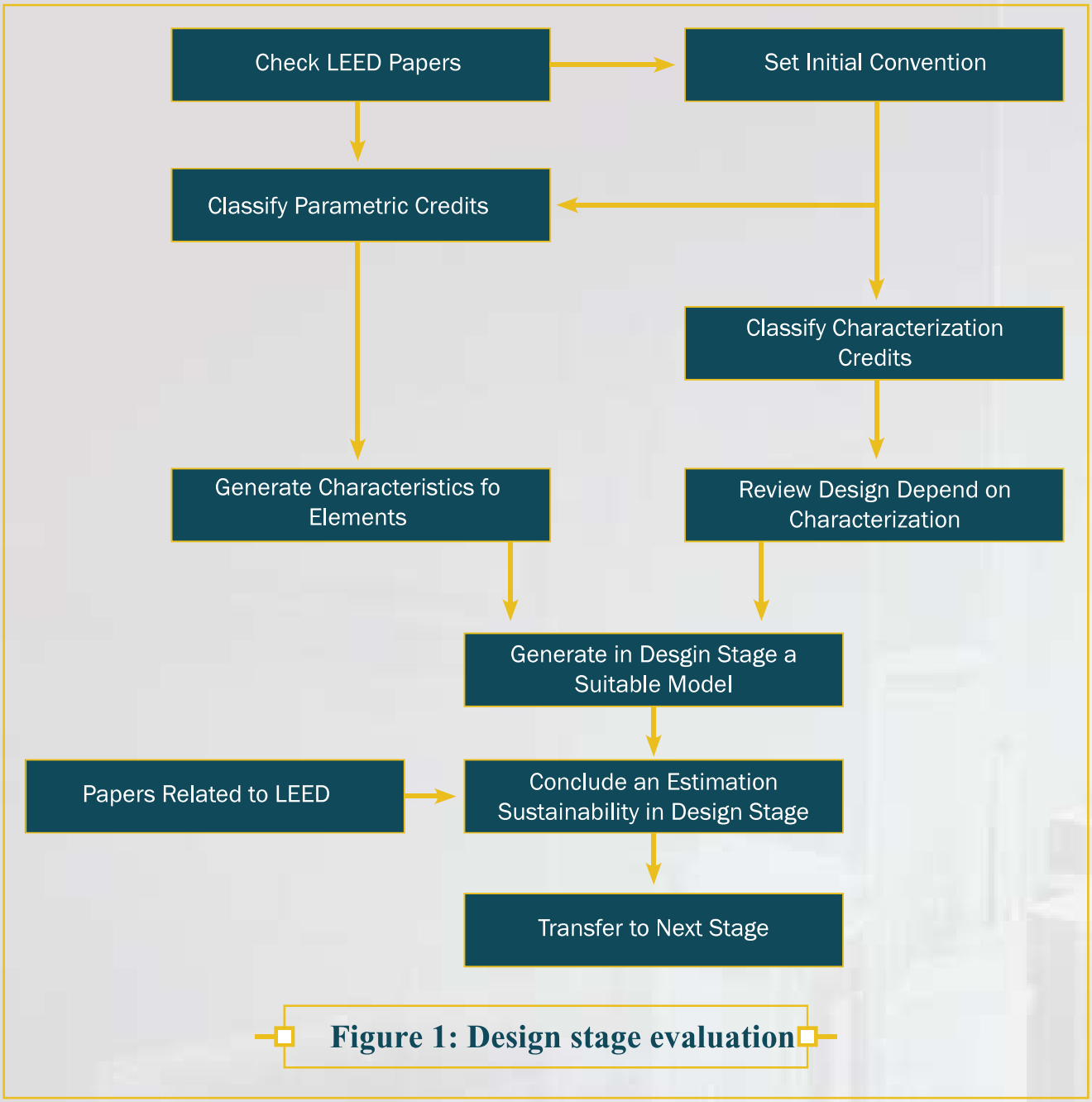


Figure 1: Design stage evaluation

For the construction stage, the sustainable building arrangements have to be handled and existing of the resources have to be reviewed by the managers to obtain more LEED credits related only to this stage, and modifications may appear if necessary.

And if that happened, those modifications should be applied on BIM generated model and the foreseeable sustainability will be also modified to upgrade the obtained credits.

Some controlling-methods like waste-management, construct-schedule and construct-method have to be documented and applied on the generated model.

Latest researches have shown that the shortage in the relationship between the people involved in the project causes the lost and inability in the construction stage. By clarifying a preliminary relationship and adopting the Building Information

Information Modeling Tools, an extra incorporated, interacting, realistic way to set building stages is rising, "Real Time Location System" added in the present research to collect the data from the building resources (Zhang et al. 2013).

Architecture, Structure, (Mechanical, Electrical and Plumping) and other major features are used to create the system.

The gathered information as mentioned before will help to enhance the generated model in Building Information Modeling and it will make the process of re-estimation easier depending on the present project status. (Figure 2) illustrates the evaluation at construction stage.

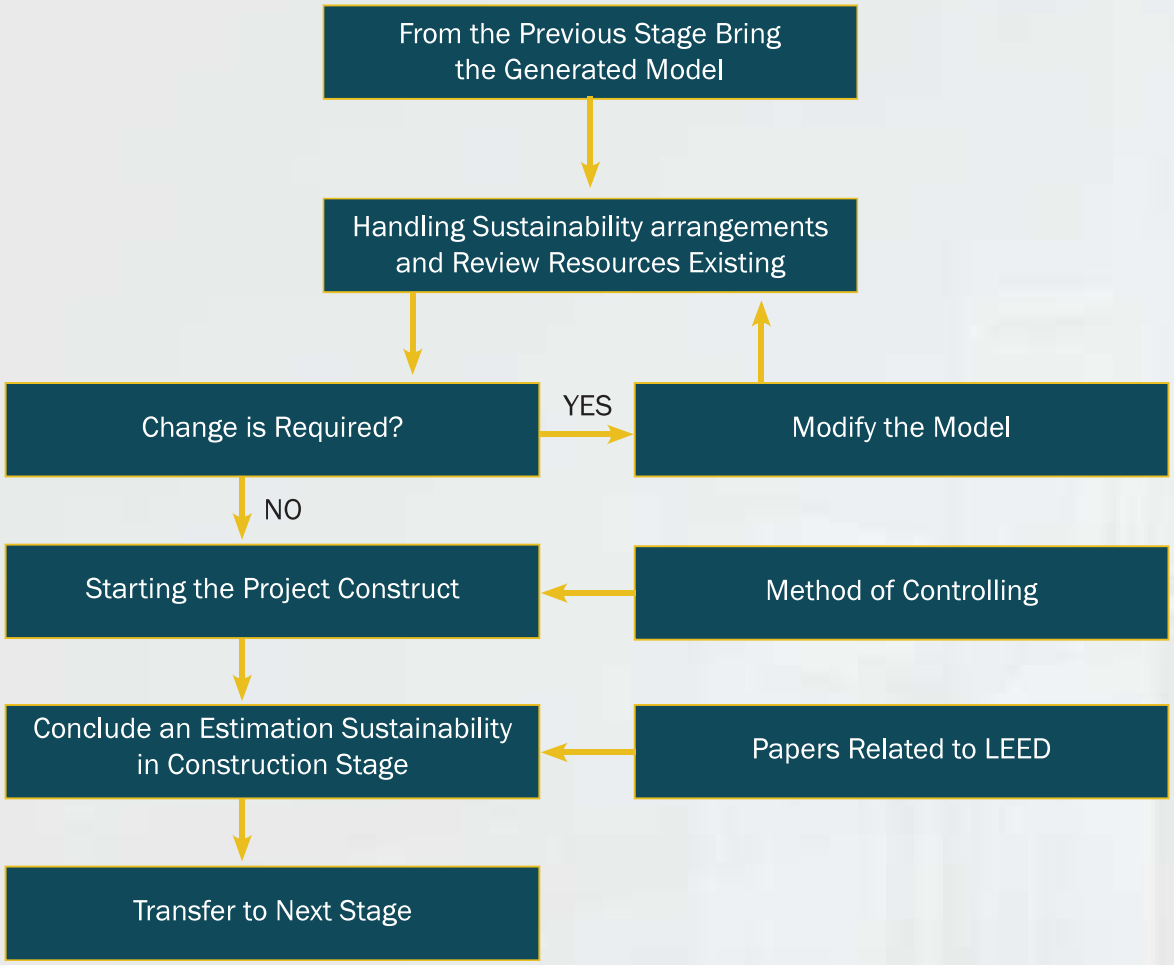
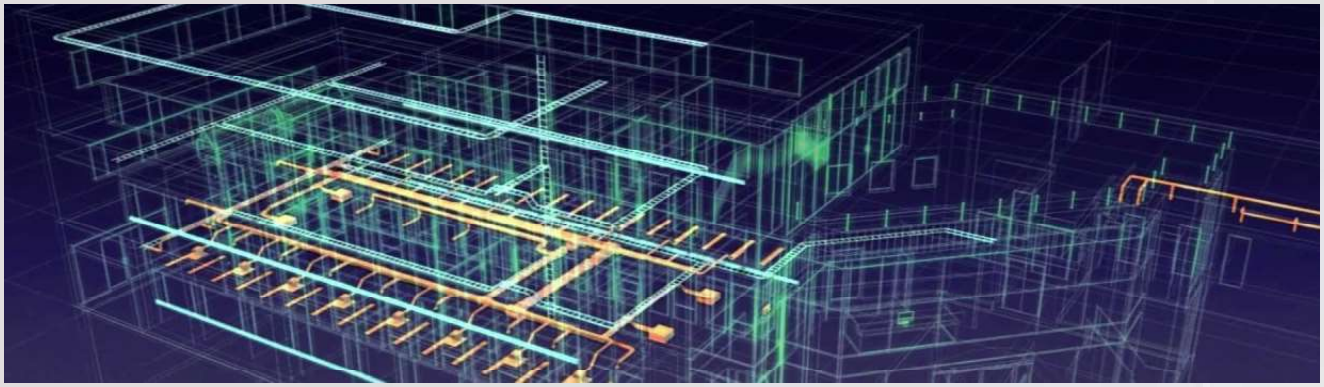


Figure 2: Construction stage evaluation

At last, in the operation stage, data regarding to the yearly power and water exhaustion are gathered, and surveys on the users were recommended to help in the evaluation of the users experiment, e.g. survey for Indoor Environmental Quality (IEQ) 7.2 credit Thermal Comfort are usually done during six to eighteen months after the action to gathered unknown reactions from the buildings related to it.



Above on that, the real sustainability should be observed and checked with the foreseeable sustainability that will grant a clear path for the next-time projects, (Figure 3) illustrate the evaluation at operation stage.

A region (rooms, zones, areas) created in the model of Building Information Modeling which helps with energy exhaustion data can be considered as an example, that will grant a clear path for upcoming designs.

Power exhaustion style will be studied in expression of locative properties of (regions, zones, and areas). Extra studies should be adopted to start a new platform for exhaustion of the power and to set a time-tables for inspections.

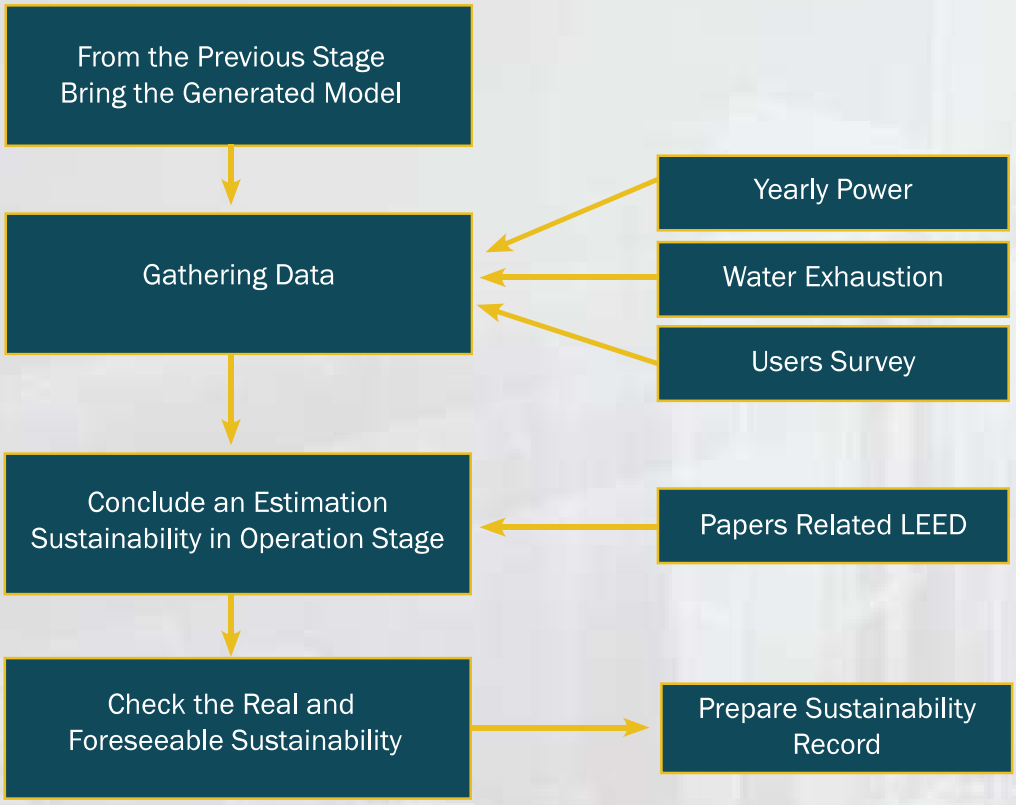


Figure 3: Operation stage evaluation

3.LEED Sustainability Analysis System

Leadership in Energy and Environmental Design credits reach all the building stages (design, construction and operation), still the needs for each item are based on the several group of stages. At first, the credits of LEED investigated and classified based on the building stages (design, construction and operation), (Table 1) illustrates the classified stages with the LEED credits. Main conditions and LEED credit set seven subjects as:

1.Sustainable Locations;

2. Water Effectively;

3.Power and Weather;

4.MR; Materials and Resources

5,IEQ; Indoor Environmental Design

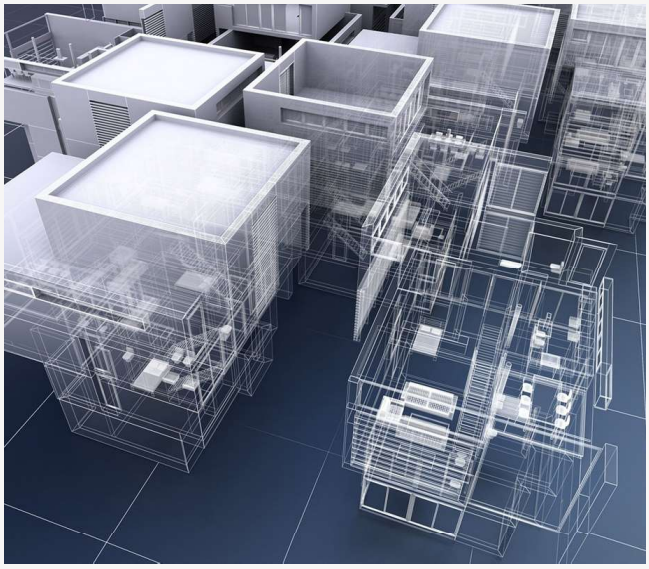
6.Creativity in Design and

7.Regional Priority.

The other credits which are obtained from several stages will be added by gathering data while connected stages. Above on that, in the operation stage, new information can be obtained by surveying the building users, e.g. to know if the users use normal transportation, or they prefer the bicycle more; and more data can gathered using the end-users experiences.

LEED Sustainble Analysis New Construction and Main Renovation	Sustainble Analysis for the Building three Stage		
	Design	Construction	Operation
Sustainble Locations			
Precondition 1 Construction Activity Pollution Prevention Required	X		
Precondition 1 Enviromental Location Required	X		
Credit 1 Location Selection	X		
Credit 2 improvement Density and Community Connnectivity	X		
Credit 3 Brownfeild Redevelopment	X		
Credit 4.1 Altimative Transportation - Public Transportation Access	X		X
Credit 4.2 Altimative Transportation - Bicyde Storge	X		X
Credit 4.3 Altimative Transportation - Low - Emtting and Fuel - Effective vehicles	X		
Credit 4.4 Altimative Transportation - Parking Area	X		X
Credit 5.1 Location Improvement - Reserve Homeland	X		
Credit 5.2 Location Improvement - Maximize Open Area	X		
Credit 6.1 Stormwater Design - QC	X		
Credit 6.2 Stormwater Design - QC	X		
Credit 7.1 Heatisland Empact - Nonroof	X		
Credit 7.2 Heatisland Empact - Roof	X		
Credit 8 Lowering Light Deflement	X		
Credit 9 Location Actual Plan	X		
Credit 10 Conbined Use of Fadlties	X		
Water Effectively			
Precondition 1 Lowering Water Use	X		
Credit 1 Water Effective Landscaping	X		
Credit 2 Innovative Wastewater Technologies	X		
Credit 3 Lowering Water Use	X		
Credit 4 Process Lowering Wter Use	X		
Power and Weather			
Preconditiom 1 Fundamertal Commissioning of Building Power Systems	X	X	X
Precondition 2 Less Power Perfomance	X		
Preconditiom 3 Fundamertal Refrigerant Management	X		
Credit 1 Optmize Power Performance	X		
Credit 2 On - Site Renewable Power	X	X	
Credit 3 Improved Commissionig	X	X	
Credit 4 Improved Refrigerant Management	X		X
Credit 5 Measurement and Vertication	X		X
Credit 6 Green Energy	X		X
MR (Materials and Resources)			
Precondition 1 Store and Gathering of Recyclables	X	X	X
Credit 1.1 Building Reuse - Preserve Existing Walls, Floors and Roof	X		
Credit 1.2 Building Reuse - Preerve Existing Nostructural Interior Opjects	X		
Credit 2 Construction Waste Management	X	X	
Credit 3 Materialis Re - Use	X		
Credit 4 Recycled Content	X	X	
Credit 5 Reglonal Materials	X	X	
Credit 6 Quikly Renewable Materials	X	X	
Credit 7 Certified Wood	X	X	
IEQ (Indoor Envirnomental Design)			
Precondition 1 Minimum Indoor Qualty Performance	X		
Precondition 2 Enveromental Tabacoo Smoke (ETS) Control	X		X
Precondition 3 Minimum Acoustical Performance	X		
Credit 1 Outdoor Air Delivery Montoring	X		X
Credit 2 Increase Ventation	X		
Credit 3.1 Construction Indoor Air Quality Management Plan - During Construction	X	X	
Credit 3.2 Construction Indoor Air Quality Management Plan - Before Residency	X		X
Credit 4 Low - Emiliting Materials	X	X	
Credit 5 Indoor Chemical and Pollutant Source Control	X	X	
Credit 6.1 Controlability of Systems - lighting	X		
Credit 6.2 Controlability of Systems - Thermal Comfort	X		
Credit 7.1 Thermal Comfort - Design	X		
Credit 7.2 Thermal Comfort - Verflcation	X		X
Credit 8.1 Daylight and Views - Daylight	X		
Credit 8.2 Daylight and Views - Views	X		
Credit 9 Improved Acoustcal Performance	X		
Credit 10 Moid Prevention	X	X	
Creativity in Design			
Credit 1 Innovation in Design	X		
Credit 2 LEED Accredted Professional	X	X	
Credit 3 Building as a Teaching Tool	X		X
Regional Priorty			
Credit 1 Reglonal Priorty	X		

Table 1: LEED Credits for Building Stages



4.Evaluation of the New System Depending on the Rules

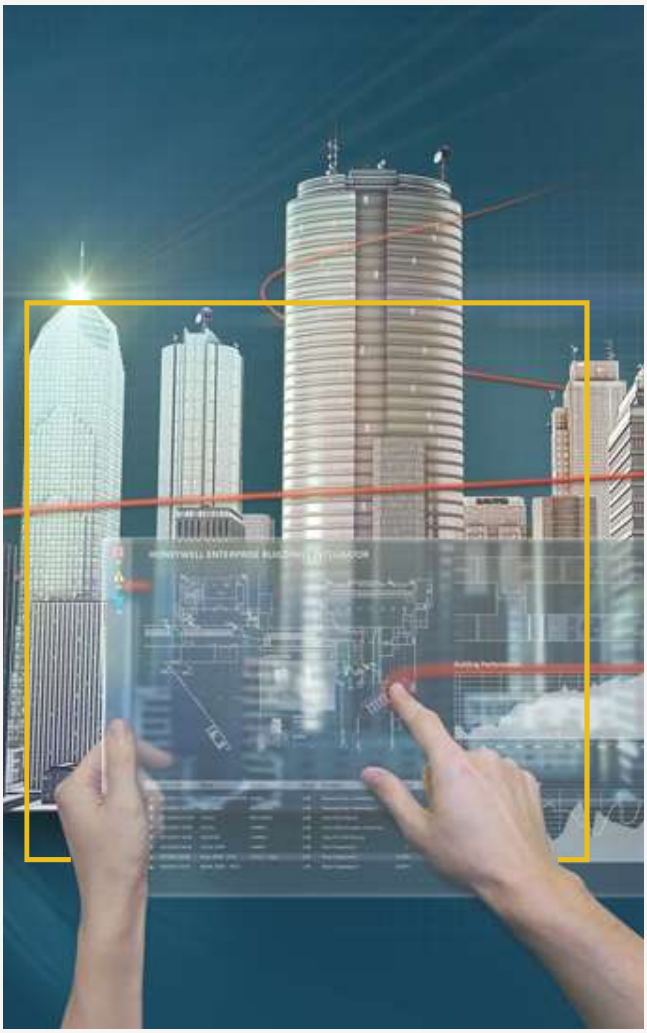
The Main aspect for the assessment of the new system is depended on the rules progress following the demand of Leadership in Energy and Environmental Design, Input, Analysis and Output are considered as the 3 major procedures for the new-system depending on the rules.

Depending on the credit demands, the Inputs change from each other. E.g. for that credit three for materials and resources give the ratio for the recyclable materials in the building from cost point of view comparing with the overall amount of the building materials. In a theory way, this data can be restored by the features of the building parameters or by hand characterization. If it is gathered from features of the parameters, the recyclable materials related to a single case or kind should be determined, and the entire ratio will be easy to be determined.

Instead of that, people related to the design can input immediately the ratio of the recyclable materials in the entire building by using interface.

More additional, data are involve in the inputs like “RSMeans Database”, that can be referred to the data essential in determining the ratio for a material depending on the cost from the entire building materials.

Depending on the Input procedure and the LEED credits rules which are included already in the Building Information Modeling, the outcomes can be determined in the Analysis procedure. Using the impact of HeatIsland assessment on roof as a simple example, choices from 3 used to satisfy the LEED credits demands, (Figure 4) illustrates the 3 choices in sequences of formulas in LEED standard. The last major procedure is the Output, which gives the related parameters (roof zone or roof area) for the LEED credit.



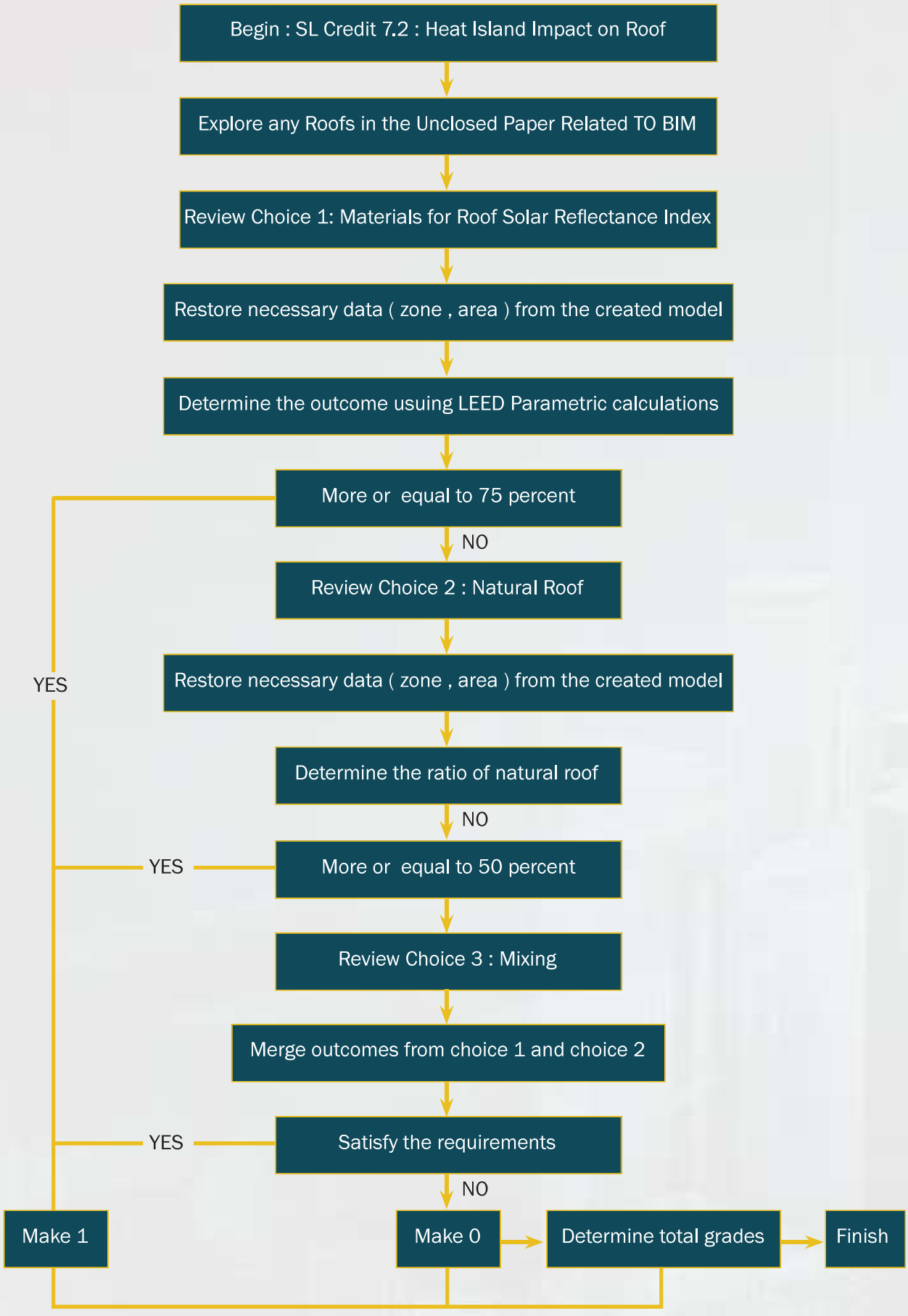


Figure 4: Sample for the new system

5.Combining BIM and LEED Sustainability Analysis System

The major concentrates for this paper is on creating a new system depending on the rules for the materials sustainability analysis, like choosing of the material depending on the sustainability, lowering the waste of the materials, and the ratio of recyclable materials to the building total materials.

Because the aim of this paper is to make the assessment of the sustainability work automatically, data is foreseeable to be restored as far as likely from the model created in Building Information Modeling.

Many beneficial data can be restored simply for the created model like the quantity takeoff. Some LEED credits assessments depend on the cost, and that needs an extensive analysis for the project quantities. Like the purpose of three credit "Materials and Resources" to motivate the materials recirculation of a project, and that to decrease the needs for natural materials and also to decrease the materials wasting.

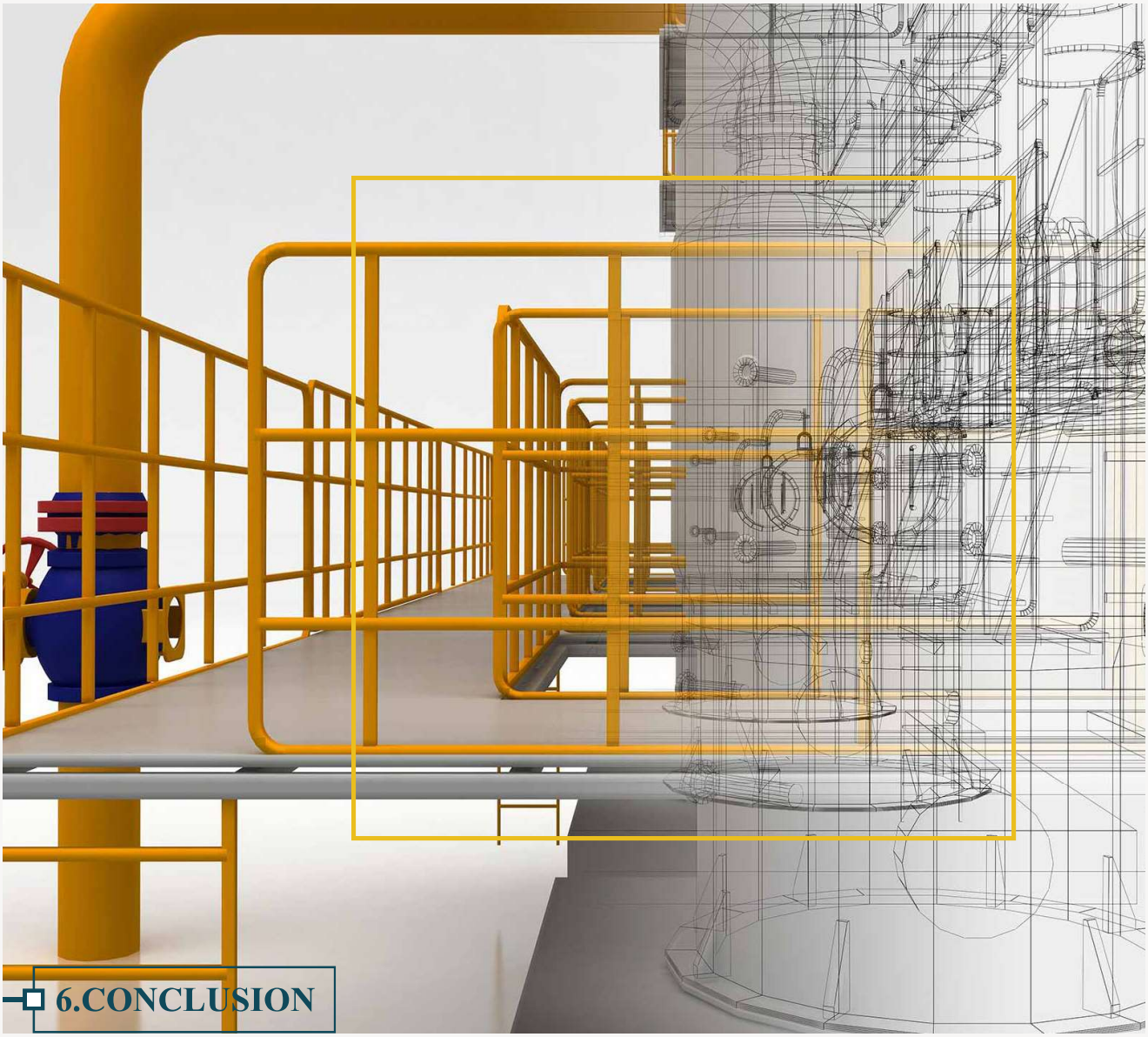
LEED credit demands at minimum five to ten ratio between the amount of the recyclable materials depending on the cost and the overall amount of the building materials. For this situation, quantities takeoff restored from the BIM model and the element price that inserted manually depending on the market can be used to determine the cost related to the project materials.

The needed data are categorized for all the project elements (like Windows, Doors and Roof) after checking the papers related to the Leadership in Energy and Environmental Design.

That additional data need to be inserted manually while the design stage on going. The idea of the design parametric and the elements arrangements existed in the Building Information Modeling give further effectiveness to this procedure.

The arrangements of the elements are mostly Types, Categories, and Families. The second one (Categories) provides elements with fixed properties that non-adjustable like windows, doors and walls. Families on other hand are considered as an additional diversion of the elements in certain Category, as example for that, fixed windows and precast walls. .

Families are also divided into two, components and systems which are accepted to change in order to satisfy the user needs. E.g. in estimating the impact of a HeatIsland of roof, additional data like SRI for the objects related to the roof have to be inserted in the design stage. For future assessment, the amount of the (Solar Reflectance Index) should be inserted and kept as a reference.



6.CONCLUSION

The present research is under improvement. The data gathered from the first and second stages will be merged into the Building Information Modeling and the new system in order to modernize the LEED credits

The advantage from the current paper may be summarized in four points as:

1.To give a sufficient guide which helps in the assessment for variable cases in the first stage to stay away from repeating the process and to enhance the LEED credits;

2.Repeat the building assessment depending on the constructed work and give a sufficient guide to assess the steps in second stage;

3.Allow the stakeholders to predict and analyze the energy exhaustion and to reach the competence in power;

4. Supply the project end users with a suitable consciousness to learn dealing with the characteristic of the design and to decrease the use of power.

7. REFERENCES

A. UNEP. 2009. Buildings and Climate Change, Summary for Decision-Makers. UNEP Sustainable Buildings and Climate Initiative.

B. Khasreen, M, Banfill, P., and Menzies, G. 2009. "Life-cycle Assessment and the Environmental Impact of Buildings: A Review." Sustainability. 3) 1 ,2009): pp.704-671.

C. Iwaro, J., Mwasha, A., Williams, R., and Zico, R. 2014. "An Integrated Criteria Weighting Framework for the Sustainable Performance Assessment and Design of Building Envelope." Renewable and Sustainable Energy Reviews. 29: pp.435-415.

D. Wang, J., Li, Z., and Tam, V. 2014. "Critical Factors in Effective Construction Waste Minimization at the Design Stage: A Shenzhen Case Study, China." Resources, Conservation and Recycling. 82: pp.6-1.

E, Li, Y., Yang, L., He, B., and Zhao, D. 2013. "Green Building in China: Needs Great Promotion." Sustainable Cities and Society. 2013.

F. Jrade, A. and Jalaei, F. 2013. "Integrating Building Information Modelling with Sustainability to Design Building Projects at the Conceptual Stage." Building Simulation. 4) 6): pp.446-427.

G. Eastman, C.M. and Eastman C. 2011. BIM handbook: a guide to building information modeling for owners, managers, designers, engineers, and contractors, John Wiley and Sons.

H. Krygiel, E., and Nies, B. 2008. Green BIM: Successful Sustainable Design with Building Information Modeling. WILEY.

I. Chen, Y., and Hsieh, S. 2013. "A BIM Assisted Rule Based Approach for Checking of Green Building Design." In Proceedings of the 13th International Conference on Construction Applications of Virtual Reality, London, UK.

J. Motawa, I. and Carter, K. 2013. "Sustainable BIM-based Evaluation of Buildings." Procedia-Social and Behavioral Sciences. 74: pp.125-115.

K. Zhang, C., Hammad, A., Chen, J., and Yang, Y. 2013. "Experimental Investigation of Using RFID Integrated BIM Model for Safety and Facility Management." In Proceedings of the 13th International Conference on Construction Applications of Virtual Reality, London, UK.

L. Zabalza Bribian I, Valero Capilla A, Aranda Uson A. 2011. "Life cycle assessment of building materials: comparative analysis of energy and environmental impacts and evaluation of the eco-efficiency improvement potential. Building and Environment." 46 5)): pp.1141-1131.