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# BIM-based iterative tool for sustainable building design: a conceptual framework

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**Abstract**

Building sustainability is a multi-dimensional concept that is increasingly becoming a focus of the mainstream construction industry. The choice of right materials, techniques, and systems for a building project was always important to ensure built environment sustainability but these days it has also become a difficult and confusing task owing to the availability of a wide array of processes, systems, techniques and materials (PSTM). To achieve sustainable design a responsive design process able to assess and optimize the use of a variety of available PSTM options is required. The purpose of the study reported in this paper is to develop a conceptual framework of a futuristic BIM-based Design Iteration (BIM-DIT) tool for selecting PSTM combinations during design. Such development can support decision-making process during the design stage of residential buildings by assisting the design team in the generation of design alternatives. The model development includes discussion of various components necessary for development and successful working of the hypothetical tool. The conceptual model development exercise shows that the hypothetical BIM-DIT tool can significantly benefit from the pre-existing design approaches in the built environment. The discussion shows that the PSTM combination selection approach used for BIM-DIT tool will help decision makers with precise knowledge of available options for achieving truly sustainable building projects. Although model development is largely inspired by pre-existing approaches, the use of these approaches for finding appropriate PSTM combinations through the involvement of all three sustainability dimensions is relatively new. Further development in this area can play a significant role in building design related decision-making.



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*Keywords:* PSTM combinations; building sustainable design; BIM; decision-making; tool development

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## 1. Introduction

With 30 and 47 percent world population living in urban areas in 1950 and 2000 respectively, a projected population rise of 60 percent (about 5 billion people) is estimated for the year 2030 [1, 2]. The rise in urbanization demands a growth in infrastructure including residential building developments as a priority. At the same time, there are increasing concerns regarding the impact of buildings on the economy, society, and environment. With the ever increasing maturity of the housing market, demand for quality internal environment and micro-surroundings has become a primary issue not just for potential house-buyers but also for property developers. The terms like eco-architecture, sustainable building, and green building have entered the daily vocabulary of both the house-buyers and building designers [3]. With continuous growth in economy and population, builders and designers are faced with the challenge to meet demands of new and renovated facilities which are expected to be productive, secure, accessible, healthy and with minimum environmental impact [4].

However, sustainable building design is not straightforward as all buildings are unique and no prototypes exist [5]. There exists a combination of processes, systems, techniques and materials (PSTM combination) necessary to realize building functionality while ensuring sustainability. While in functional terms some systems and techniques have unique functionalities and are mutually exclusive, others add value to each other and are substitutable. Selection and adequate use of systems and techniques in building design process, is extremely important, as doing so can result in an optimized sustainable building design and avoiding it can endanger the project [6].

It is possible that a large variety of PSTM combination can effectively fulfill functional requirements in a building, but may not perform well in one or more of the three sustainability dimensions i.e. social, economic and environmental sustainability. A wide variety of available combinations can also make the selection of an appropriate design option for a building difficult. However, PSTM combination decisions need to be made at the early design stage in order to effectively influence the project throughout its life cycle. An inappropriate selection of a PSTM combination from an overwhelming number of available options can negatively affect project sustainability. The problem created by a large number of available PSTM options can be addressed by leveraging the potential offered by advanced digital technologies. Accordingly, the purpose of this paper is to propose the development of a BIM-based multi-objective decision support tool called BIM-based Design Iteration Tool (BIM-DIT) for selecting processes, systems, techniques and materials (PSTM) combinations during design.

This paper develops a conceptual framework of the BIM-based Design Iteration Tool. The tool should facilitate decision-making process during the design stage of residential buildings by providing a manageable number of PSTM combinations according to pre-defined sustainability requirements set in the early stage of building design.

## 2. Literature Review

In developing the BIM-DIT tool, this study will draw on approaches implemented for solving similar multi-objective decision-making problems by existing tools. Two major developments reviewed include SimulEICon and BEES (Building for Environmental and Economic Sustainability). SimulEICon is a tool designed for supporting decision-making processes during the design stage. This tool produces optimal design options according to construction time, initial construction cost and carbon emissions and therefore enable designers to make a selection of different design products and materials. Moreover, in order to support the design, SimulEICon is integrated with BIM [7]. Although an inspiration from SimulEICon, the proposed BIM-DIT tool will consider a more holistic view of the economic, social and environmental dimension of sustainability.

In a slightly different context, BEES is an online web-based application developed by the NIST (National Institute of Standards and Technology) Engineering Laboratory's Applied Economics Office. BEES framework appears thorough, adaptable and practical with a clear and understandable process. This is because it includes a hierarchical approach towards sustainability, turning the concept into a cumulative value of many parameters. In order to select cost-effective and environmentally preferable building products this application makes use of a well-organized, rational technique based on consensus standards. Designed for building professionals, it incorporates actual economic and environmental performance data for a variety of building products across a range of functional applications and has an analysis range across all the life stages of a project from raw material acquisition to waste management. Finally using the ASTM standard for multi-attribute decision analysis (E1765), environmental and economic performance are combined into an overall performance measure [8].

For the BIM-DIT framework development, it is necessary to explore published works where multi-objective optimization is involved especially with respect to sustainability parameters. In considering this, different optimization studies performed on domestic building projects are listed in Table 1. When compared with other building types, domestic buildings are found to have more straightforward design problems. Limiting the investigations to such buildings comes with the potential advantage in that it can make it possible to conduct holistic optimizations that cover a greater number of important parameters. In this area, many works are found to have optimized different groups of properties in separate stages [5]. The optimization studies listed in Table 1 show that there already exists some meaningful research in this area. However, the limitation of these previous studies is that they consider only a few sustainability parameters as objectives while providing optimum solutions. These limited parameters are not sufficient to ensure sustainability in building design. In view of this, a tool is required that considers all important sustainability design parameters as objectives within its framework.

Table 1: Studies related to use of optimizations in domestic buildings

| Source | Optimisation type | Objective/s | Variables | Process Stages | Process Explanation |
|---|---|---|---|---|---|
| Bichiou and Krarti [9] | Single objective | Life- cycle cost | Envelope and HVAC system | Both single and two stage | Compared holistic approach with optimising the envelope first then the systems separately |
| Verbeeck and Hens [10] | Multi-objective | Energy use, ecological impact, cost of dwellings | Envelope properties (constructions, shading, glazing area and airtightness), System properties (CHP, heat pumps, storage, and controls) | Two-stage | First optimising envelope properties, then optimising system properties |
| Evins et al. [11] | Multi-objective | Costs, carbon emissions | All highly significant variables of a residential building based on UK building regulations compliance | Two step optimization | An initial coarse optimisation (21variables) and a detailed optimisation (14 variables) |
| Hamdy et al. [12], Hamdy et al. [13] | Multi-objective | Carbon emissions, investment cost | Eight variables relating to insulation, glazing, shading, heat recovery and system choice | Three stages | A multi-objective genetic algorithm was applied to the problem in three stages: envelope, systems, renewables |
| Griego et al. [14] | Multi-objective | Running costs, energy use | Variables included fabric properties, air tightness, internal loads, provision of renewables | | |

## 3. Model Development

To realize the objective of this study, the various attributes, scenarios and challenges associated with planning, development, and functioning of the BIM-DIT tool will be discussed. Relevant practices, features of pre-existing tools, and published works that could be incorporated into the BIM-DIT tool will be considered where necessary. The conceptual framework comprises the following components:

- Exploration of scenarios of tool development and how the tool will be used. This will explore ways in which the challenges posed by the complex activities of sustainable building design will be handled.
- A thorough exploration of issues related to building design approaches. This is fundamental as it would inspire the design of a new tool. In doing so, logical relationships among PSTM elements will be explored.
- The importance of limiting sustainable design within certain ranges (i.e. conformance of the building design to some pre-set holistic sustainability standards) , as well as the need of sustainability hierarchy (i.e. division of sustainability into requisite dimensions further divided into parameters), will be discussed. The importance of stakeholders input in terms of the shortlisting of PSTMs within pre-set sustainability range will also be explored.
- The importance of developing the proposed tool as a Building Information Modelling (BIM) extension will be discussed in the light of the existing role of BIM in sustainable development.
- The various components of the model development will provide an insight into the potential the hypothetical tool might hold and these will also help to highlight the challenges and limitations of the tool.

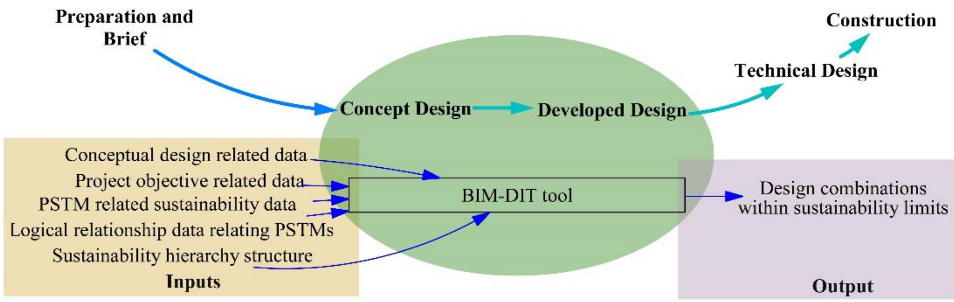


Fig. 1: A holistic view of the BIM-DIT tool

Fig. 1 provides an overall view of the BIM-DIT tool. As elaborated, the tool can be implemented at the concept design as well as developed design stage in building projects. The different stages of design as suggested in the figure correspond to "RIBA plan of work 2013" [15]. BIM-DIT tool will be operational in the conceptual design stage but it will also use some conceptual design related data to initiate its operation. Furthermore, it will also require project objective related data from Preparation and Brief stage as input. This will also include sustainability limit related data. Conceptual design related data as well as project objective related data will be project specific. On the other hand, the other three inputs i.e. PSTM related sustainability data, logical relationship data, and sustainability hierarchy data will not be project specific. This data will be initially developed for the tool to be workable and it will have only minor revisions in it when the tool is operated from project to project. The final output of the tool will be design combinations within already established sustainability limits. The final output of the tool will then be used to refine developed building design which then will move to the stage of technical design. The inputs required for the tool will be explained in detail in subsequent sections.

### *3.1. Defining PSTM*

PSTM in this study stands for processes, systems, techniques and materials. Since model development is majorly about preparing PSTM-based design combinations, it is necessary to define the term further, for sake of clarity.

- "Process" stands for building related processes that will occur in the operational life of the building. Heating, cooling, ventilation, and drainage can be considered 'process'. Processes within a building are supposed to directly or indirectly affect requirements and expectations from a building. For instance, healthy indoor environment is a building requirement. Air conditioning processes will help meet this requirement.
- "System" stands for a well-synchronized combination of techniques and materials used for a certain building process. A system alone or in combination with other systems will contribute towards a building process subsequently linked with a building requirement. For instance, CCTV system within a building will contribute to security (building requirement) by providing surveillance (building process).
- The term "Technique" basically stands for different methods used in building construction process. On the other hand, "Material" in general means building construction material. In this study, the term "Technique" and "Material" are almost exclusively linked with building construction stage in term of use and installation. However, the use of these systems and techniques will affect the building operational life passively. For example, while using brick as a construction material there are different possible construction techniques for building a wall resulting in solid walls, veneered walls as well as cavity walls.

In general, different construction materials will use different techniques that will help the building project execution. On the other hand, systems will contribute towards building processes which when performed will fulfill the requirements of a building in its operational stage. The definitions used for PSTM components in this study are simplistic and meant for this study alone. Further development of the conceptual framework which is beyond the scope of this paper may result in a revision of these definitions.

### 3.2. Scenarios of tool operation

In this paper, two scenarios will be explored by means of which BIM-DIT tool may be able to support decision-making in building design. These scenarios are prepared to actually suggest different stages of building design when the iteration process for combination preparation can take place using the BIM-DIT tool (i.e. linking and optimizing different PSTM combinations together for building design).

#### 3.2.1. Scenario-1

Scenario-1 is about running iterations to find appropriate PSTM combinations upon completion of basic building design. Since the iterations will involve a large number of PSTM options to run through, there exists the possibility of generating an overwhelmingly large number of appropriate PSTM combinations (within preset sustainability limits), a number so huge that perhaps including all of them in the decision-making process might have a negative influence on the process rather than support it.

#### 3.2.2. Scenario-2

In Scenario-2 as shown in Fig. 2, the building design process is broken into different steps that can progressively lead to increased level of details in building design. Each intermediate step (between basic design and iteration running step) in this case will result in the selection of some of the influential elements from the many available PSTM options. Here, the term “influential” means the capacity of effectively placing a positive or negative impact on one of the three sustainability dimensions, it also may be used for things that are decided earlier in the chain of building design. For example, building substructure and superstructure PSTM choices being more influential as compared to HVAC systems and elevator system because of earlier occurrence in the design process.

Steps closer to the basic design will be more influential and this characteristic will gradually drop in each subsequent steps. Such intermediate steps will shortlist the number of available options to such lengths that the iterations, when performed on the left behind PSTM options, will help create a reasonably manageable set of PSTM combinations for much easier decision-making as compared to the large numbers PSTM combinations possibly created in Scenario-1.

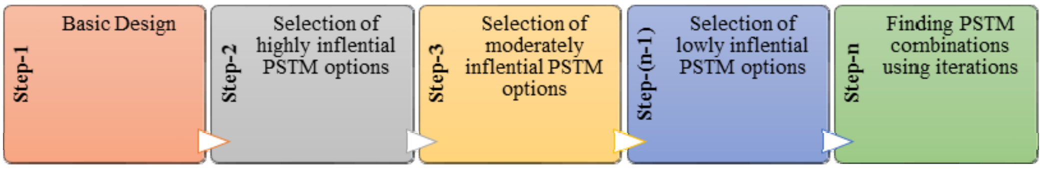


Fig. 2: Division of building design into various steps corresponding to Scenario-2

### 3.3. Logical relationships among PSTM elements

Many different kinds of relationships might exist among the general categories of process, system, and material and also within the categories. Such kind of relationships extracted from the knowledge relating common building practices must be fed within the developed tool. For example, while using daylight or artificial light (process) to illuminate the indoor environment, the indoor surfaces must have a minimum amount of gloss finishes (material) to avoid glare. This is the kind of logical relationship which upon including within BIM-DIT tool will result in PSTM combinations which will include any finish other than gloss while the selection of indoor illumination is made.

Fig. 3 shows the different ways in which PSTM combinations might be obtained owing to the freedom as well as restriction created by logical relationships. Not only the approach of using sustainability limits can be effective in decreasing the solution space to a manageable size, the logical relationships can also play an important role in this regard by effectively filtering the intermediate results.

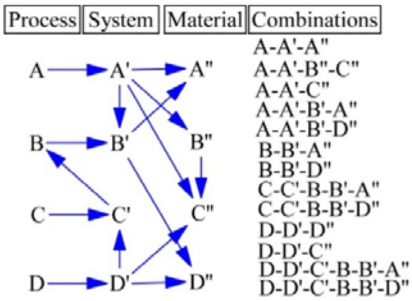


Fig. 3: PSTM combinations

*3.4. Limits on sustainable design*

The careful selection of representative parameters of three sustainability dimensions can significantly help assess various PSTM options with a thorough consideration towards sustainable development. It is also necessary to consider the option of setting limits on sustainability needs. Setting such limits are important to help avoid a large number of PSTM combinations that perform well in one or two sustainability dimensions but have a drastic impact on the other dimension/s. Setting limits can bring down the number of PSTM combinations within such a range of options that can receive serious thought in decision-making. An important example in this regard is that of SimulEICon which has an optimization procedure that is conducted after all options of components are determined. The possibility of arriving at a large number of possible solutions exists and has been reported in a case study which had between 16 activities, in total over 2.7 million possible solutions [7]. Therefore, it is important to make use of some mechanism for reducing the number of possible solutions so that decision-making can effectively take place.

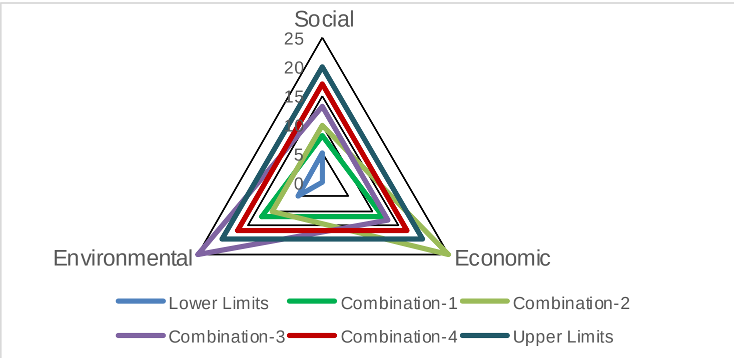


Fig. 4: An assumed example of PSTM combinations plotted on a sustainability radar along with lower and upper limits

In order to visually present various combination cases in terms of sustainable performance, a radar diagram can be employed. Such a diagram can also help identify visually the preset upper and lower limits of sustainable performance. Sustainability radar as shown in Fig. 4, plots four number of hypothetical PSTM combinations with respect to lower and upper limits of sustainability dimensions. Since combinations 2 and 3 can be seen as crossing preset upper limits of sustainability dimensions (as highlighted within Fig. 4), they get excluded and the decision-making will only include combinations 1 and 4. This is how sustainability limits are supposed to ease the decision-making process by limiting the solution space.

The possibility of selecting influential PSTM options for each different building project and creating limits on sustainable design exists by segregating sustainability concept for PSTM (Processes, Systems, Techniques and Materials) into measurable attributes and using stakeholder opinion to weigh these attributes. The input of decision-makers can effectively change the final solution set according to the preferences set by them and this can also decrease the number of combinations within a manageable and analyzable limit. The decision about the sustainability limits of PSTM combinations can be formulated by specifying preferences. One such example is illustrated in Table 2 where a weight evaluation matrix is developed for different attributes of construction materials which relate to three sustainability dimensions. Such a matrix is intended to provide stakeholders' perspective and therefore will have subjective inputs and will help provide limits. The final score is a cumulative value of all scores for different attributes found in the grid. The attributes with high scores will play a decisive role in the selection of materials. An alternative comparison matrix is also shown in Table 2. In this matrix, objective values relating different attributes of a material are multiplied with weights of corresponding attributes to obtain weighted values. All the weighted values are then aggregated to provide conclusive performance value of different materials. In case the comparison is between materials of same functionality, then the alternatives with highest aggregate values can be shortlisted for final combination of PSTMs, hence limiting the design solution set within a manageable range of alternatives.

Table 2: Weighted evaluation matrix for different properties of construction materials

| Weighted Evaluation Matrix | | | | | | | | | | Alternative Comparison Matrix | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Attribute | A | B | C | D | E | F | Score | Percentage | Material-X | Material-Y |
| A | Using locally available materials | | B-2 | C-1 | D-2 | A-1 | A-1 | 2 | 11% | 2 (Objective Value) | 3 |
| | | | | | | | | | | 22 (Weighted. Value) | 33 |
| B | Using healthy materials (low VOC) | | | B-1 | B-1 | B-1 | B-1 | 6 | 33% | 5 | 6 |
| | | | | | | | | | | 165 | 198 |
| C | Using more reliable/ easier to apply materials | | | | C-1 | C-1 | C-1 | 4 | 22% | 6 | 4 |
| | | | | | | | | | | 132 | 88 |
| D | Using materials with low LCI values | | | | | D-2 | D-1 | 5 | 28% | 3 | 2 |
| | | | | | | | | | | 84 | 56 |
| E | Reducing quantity of construction materials | | | | | | E-1 | 1 | 6% | 4 | 4 |
| | | | | | | | | | | 24 | 24 |
| F | Using less expensive materials | | | | | | | 0 | 0% | 2 | 5 |
| | | | | | | | | | | 0 | 0 |
| Score legend: 0-not preferable; 1-slightly preferable; 2-moderately preferable; 3-highly preferable | | | | | | | | | | 427 (Aggregate) | 399 |

### *3.5. Breaking down sustainability dimensions*

Similar to "sustainability" term, each sustainability dimension i.e. economic, environmental and social dimension provide a vague idea of sustainability. To help with sustainability assessment, these dimensions are further divided into components that are actually measurable and understandable. Breaking sustainability dimensions into subsequent hierarchy elements i.e. indicators or parameters is useful as such an approach in the framework can deliver a quantitative measure of each dimension. Hierarchy elements need to be selected based on following considerations:

- Each of the sustainability hierarchy element will have a role in design optimization. So it is necessary to include all such significant elements.
- Such values (indicators or parameters) that correspond to PSTM options must be readily available in form of published/unpublished data or readily producible and extractable.
- A system of aggregation must exist to sum these values up into a number that demonstrates sustainability of one dimension for one of the options among all the available PSTM.
- Sustainability performance value of overall PSTM combination should represent each individual PSTM component.

The BEES model is a demonstration of the breakdown approach of sustainability dimensions employed in the case of BEES Online application. The BEES model derives overall sustainability score of construction products from environmental and economic performance scores. Economic performance score in its case depends on 2 parameters i.e. first cost and future cost. Environmental performance score, on the other hand, depends on 12 parameters i.e. water intake, global warming potential, etc. For the framework development in this study, it is implied that aggregation approach similar to that of BEES will be used, accumulating the environmental and economic impact related data into respective performance scores and consequently into an overall score.

### *3.6. Overall building performance simulation*

As shown by the sustainability radar in Fig. 4, there are two combinations out of a total number of four, which can be used in the decision-making process. The overall building performance simulation is a time-consuming process even when used for a single PSTM combination, therefore it is necessary to limit its use for only those combinations that reside within the pre-established sustainability ranges for three dimensions. So it can be stated that the constraints of time (required for design and decision-making) and the requirement of efficient decision-making and design process points towards the two-step sustainability assessment which is more time efficient. The first step of assessment performed for building related products (similar to assessment used by BEES model) and a second step of assessment (performed on already shortlisted PSTM combinations) for overall building sustainability assessment.

### *3.7. Use of BIM*

BIM can play an ideal role of delivering information necessary for improved building design and performance. Sustainable building design can significantly benefit from BIM by integrated project delivery (IPD) as well as design optimization. BIM-enabled solutions can significantly contribute to the selection of best solutions for reducing energy and consumption of resources [16]. The importance of BIM in model development is because the rapid application of combinations in BIM model (enabled by BIM platform) will make the combination visualization and performance simulation readily available for the decision-making purpose. This expectation from BIM is actually owing to the current role of BIM in regards to building sustainability as exhibited in Table 3.

Table 3: Development of BIM in terms of sustainability dimensions (D)

| D | Development of BIM in sustainability dimension |
|---|---|
| Economic | Rapid cost feedback throughout the building lifecycle is generated when using BIM for cost estimation. Although it requires the cooperation of the architect and engineer while designing the digital model, BIM can make estimation simpler and more accurate, providing estimates with increased detail within lesser time and expenses [17, 18]. While recognizing actual materials used in construction, BIM software has the potential to perform the quantity take-offs and pricing necessary for cost estimating. And often, the cost estimation accuracy positively correlates with the amount of available project information [17, 19]. |
| Environmental | When it comes to BIM enabled Life Cycle Impact Analysis (LCIA), one very important case to mention is that of Tally®, the first application for Autodesk Revit® which quantified environmental impact of building materials, enabling Life Cycle Assessment (LCA) on demand throughout the BIM process (i.e. design through construction) while tracking information across eight life cycle impact categories that align with LEED® v4 and other rating systems. By leveraging and extending BIM material take-off capabilities, Tally® boosts user ability to create a realistic bill of materials and offer quick insight into ecological trade-offs of different design scenarios [20].<br>As far as environmental sustainability is concerned, some relevant research within BIM discipline exists and is continuously expanding. For instance, Kulahcioglu et al. [21] presented a prototype software for 3D analysis of LCA of the whole construction process and for better managing and communicating data, the prototype adopted BIM, allowing users to work with a 3D model of the building and interactively analyze its environmental impact. Further, the methods for visualizing and monitoring embodied carbon footprint during construction using n-dimensional augmented reality models were explored by Memarzadeh and Golparvar-Fard [22]. And in terms of energy concerns Kim and Anderson (2012) reported using BIM and DOE-2 for building energy analysis. |
| Social | BIM is starting to add value through some indirect means in social sustainability. For example, in order to support building fire emergency response operations, Li et al. [23] developed a BIM centered indoor localization algorithm. BIM along with critical path method was also used by Shan and Goodrum [24] to simulate overall impact of temperature and humidity on a construction project. There is also some research relating BIM with indoor air quality. For instance, Altaf et al. [25] proposed a method of predicting air pollutant concentration during construction activities using BIM. Finally, in terms of BIM use in building safety the work of Park and Kim [26] is worthy of mention as they focused on resolving building safety issues by proposing a BIM-based quality checking process.<br>Although BIM seems to tangentially address some issues related with social sustainability in built environment, there still is a huge gap that BIM needs to fill in terms of this dimension. |

## 4. Discussion

### *4.1. Challenges and limitations to proposed model components*

The material level sustainability assessment as exhibited by BEES and similar tools helps to decide among a material and its counterparts. Assessments among alternative materials for a single building component are complex and resultantly the overall sustainability performance of different PSTM combinations of entire building can be much more complex and time-consuming.

Regarding economic and environmental dimensions, the aggregate sustainability performance value of different PSTM elements in the combination can be a representative value of the overall combination. However, this is not the case with social sustainability dimension. First of all, the mostly subjective social sustainability dimension is hard to rationally determine in the case of the overall building project (mostly an account of user satisfaction) let alone the various individual PSTM elements. Secondly, even if an account of it exists for each individual PSTM element, the value of the combination might not be obtainable by aggregating respective values of constituent PSTM elements. This is because social sustainability appears to be related to emergent properties of a system. According to systems theory, emergent properties are the attributes existing for the system as a whole, instead of individual system parts [27, 28]. It seems that most relevant scale of analysis to understand emergent properties is facility and its site as a complete system [28]. To elaborate this on a relatively smaller scale, an example of a room can be used. Everything constituting a room i.e. walls, floor, ceiling, finishes etc. has certain associated monetary value so that aggregate cost of all components can be a measure of economic performance; similarly each component has its individual LCI value and aggregate of these values can provide overall environmental impact; however, for social aspects individual components hardly matter and hence social assessment of each individual component cannot bring the same kind of results as in case of economic and environmental assessment. In assessing social sustainability, the whole matters.

### *4.2. Use of the developed framework, limitations, and challenges*

By operating the tool in two steps to assess sustainability there exists a solution with regards to social sustainability dimension i.e. to only incorporate it in the second step of overall building sustainability assessment rather than also incorporating it in the first step of assessing building product related sustainability. The overall approach of sustainability assessment used by the developed framework and to be employed in BIM-DIT tool is shown in Fig. 5 which shows two means of approaching Step-1 Analyses i.e. through Scenario-1 or through Scenario-2. If Scenario-2 is used, then it would mean that the combinations have passed through three kinds of filters (Scenario-2, Step-1 Analyses, and Step-2 Analyses) before reaching the decision-making level. Such filtering would result in limiting the combinations to a number effectively assessable and considerable in decision-making.

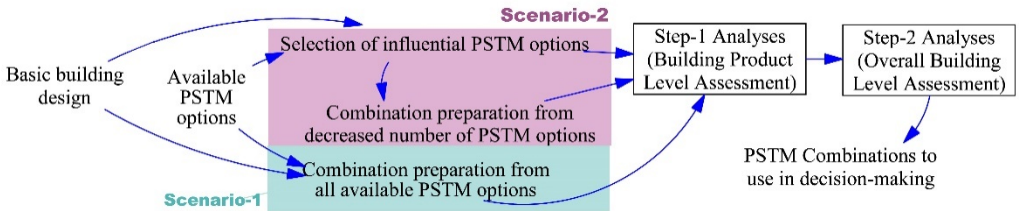


Fig. 5: Overall approach of sustainability assessment used by developed framework

## 5. Conclusion

The large variety of available options in building design has made it hard to distinguish which building design is actually the best proposal within the defined limits of sustainability dimensions i.e. economic, environmental and social sustainability. While considering the need of a comprehensive decision-making approach towards sustainable building design owing to rising demand for performance standards and the very large numbers of applicable PSTM options, components of a conceptual model for the working of BIM-DIT tool are discussed in this paper. The primary contribution of this study is that it explores the role of BIM in optimizing building design for sustainability.

Moreover, the study brings to attention the possibility of achieving sustainable design outcomes by optimization of PSTMs through iterations among combinations. BIM-DIT tool can potentially provide better design solutions for sustainable development due to it iterative methodology of preparing PSTM options within preset sustainability limits. The model for the tool is proposed, explaining what the tool is supposed to accomplish and how it can accomplish it using the functional approaches of various existing BIM/ non-BIM based tools. Using examples of pre-existing tools and research, this paper shows that the development of hypothesized tool is a possibility employing in part the pre-existing approaches and in part new approaches and while making use of rapid computing technology which is a presumption as well as an important requirement for the operation of the hypothetical tool.

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