Ecologically Sustainable Development and Architecture: the impact of rating tools

Chris Lamborn, Sergio Altomonte, Mark B. Luther and Robert Fuller

School of Architecture and Building, Deakin University, Geelong, Victoria, Australia

ABSTRACT: The concept of Ecologically Sustainable Development (ESD) has become an important issue – albeit often scarcely applied – in the design of commercial buildings. To encourage the adoption of sustainable strategies in the practice of design and to address the environmental problems caused by these developments, governments and organisations of various countries have proposed the adoption of scorecard rating tools to inform designers of the impact of their decisions and to present a way of establishing project goals and objectives early in the design process. In Australia, the recent introduction of the Green Star Rating Tool (Office Design) is believed to provide the architects with a 'whole-of-building' assessment of the environmental impact of their design by creating a checklist against which to benchmark performance. This paper follows the design of a commercial building, evaluating the impact of Green Star in the overall process. The results of the study suggest the need to include the use of scorecard rating tools in a more integrated model, where ESD is considered at every stage of design and construction rather than being a separate component applied only to promote the 'greenness' of a building. Rating tools can be an asset to the design team, provided sustainable requirements are reinforced throughout the entire process.

Keywords: Sustainability, Rating Tools, Design Process

1. INTRODUCTION

The concept of Ecologically Sustainable Development (ESD) has become an important issue for architects and designers of commercial buildings.

Various governments and business organisations have recently tried to encourage the implementation of sustainable strategies in the commercial building industry by funding the development of performance assessment or rating tools. These tools represent one of the latest initiatives to encourage 'green' solutions in the construction sector, providing a method of predicting and assessing a building's performance during the design stages and informing designers of the environmental impact of their decisions.

There are various examples of internationally available rating tools, ranging from simulation and correlation programs to scorecard systems. Two of the most widely cited rating tools for building assessment are the British BREEAM [1] and the American LEED [2]. These scorecard tools offer a 'whole-of-building' assessment approach to the environmental aspects of buildings. They provide a thorough checklist for new and existing constructions and have had a significant influence on the development of other rating tools around the world.

In Australia, the inclusion of performance assessment tools in design practice has largely focused on domestic structures. However, the recent introduction of rating tools for commercial buildings has created much discussion within this sector.

Due to the infancy of these tools, several questions remain unanswered on how environmental strategies can become a regular part of the design approach of architectural firms and how these principles can be incorporated into actual projects.

Through a documented field study, this research aims specifically to determine if the implementation of rating tools constitutes a design asset or a liability to designers of commercial buildings, and if these tools can actually provide an effective framework to encourage the inclusion of ESD strategies within the building industry.

2. ESD AND ARCHITECTURAL DESIGN

2.1 Commercial Buildings and the Environment

The environmental issues associated with commercial buildings have been widely documented all over the world. Although the initial environmental concerns were associated mainly with dwindling energy resources, now areas such as water, waste management and material use together with the physical, physiological and psychological needs of the users of commercial buildings all require attention.

Design decisions through the duration of a project are numerous and areas relating to form, orientation, material selection, through to energy and water usage, all can have consequences to be measured locally and globally. Buildings constructed on the environmental, social and economic foundations of sustainable growth can minimise the impact on the environment and reduce greenhouse gas emissions, whilst the utilisation of non-toxic materials for interior finishes can increase worker health and satisfaction (and thus productivity) by moderating the level of exposure to harmful toxins. In addition, environmental issues have the potential to enrich the architectural quality of a building and inspire innovating solutions.

However, for this to occur several design barriers still need to be surmounted. First of all, integrating an extra design component such as environmental strategies into an already complex process is a difficult task, and many architects are still not committed to its adoption. In addition, financially, commercial business attitudes are still generally driven by the short-term dollar gains rather than the long-term quality of building ventures. Company profits tend to be spent on tangible areas such as staff, equipment, or business promotion rather than on features that address environmental needs, because often the expenses on energy amount to a fraction of the cost of other commercial requirements.

Designer attitudes are also a common hindrance to the inclusion of ESD in commercial buildings. Misconceptions about environmentally responsive buildings still mean they are perceived as aesthetically poor, so, regardless of best intent, a more "conventional" approach is often preferred.

Hence, if this lack of knowledge and commitment is to be overcome, architects and clients must firstly develop a clear understanding of how to implement sustainable strategies and the benefits that come with these, starting directly from their design approach.

Typically, a building process goes through three phases: design, construction and operation. Clearly, the longest stage is the operational phase, which can amount to the greatest proportional impact a building can have on the environment. This suggests that poor decisions at the early stages of a project can have enormous impact on the life cycle of a building. Change, thus, needs to start at the Design Stage.

2.2 Traditional Architecture Design Processes

For an architect, design requires an understanding of knowledge and skill to formulate and resolve ideas. There are numerous approaches towards design and it can be developed in a number of ways: it can be a part of a style methodology; the product of a design agenda; can be inspired from various sources; or be a reactionary approach developed through sketching. Regardless of how a design is developed, producing architecture requires a series of steps to achieve a final output (Pre-Sketch Design, Sketch Design, Developed Design, Documentation and Contract).

There have been many documented maps to describe the architectural design process and what is involved, and, recently, some models have also been developed in an attempt to include ESD principles.

In general, schemes focus on establishing targets and optimising project goals by enhancing the review aspect of the process through an iterative approach. However, merely integrating the activities of the various players and providing the opportunity for iteration in the process does not necessarily mean that ESD is included in an appropriate way.

For instance, Figure 1 schematically shows a current conceptual model describing factors that might be prominent in a building design. A number of influences are considered in the model and the sustainable issues (ESD) are typically evaluated at a position equal to other components, meaning that they might also be added just as an after-thought, or, more often, removed without assessing the implications to the design. This is likely to occur when financial constraints begin to manipulate decisions.

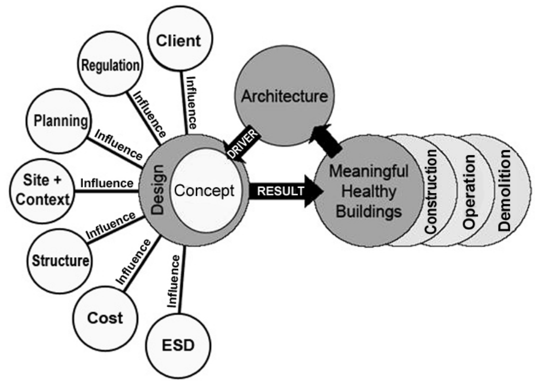

Figure 1: A current conceptual design process model

Obviously, for ESD to be thoroughly implemented in the design of commercial buildings, it needs to be considered from the outset and regularly reviewed. One possible method that is proposed here could be through the use of a rating tool. This would be in the form of a checklist of the strategies applied in the project which could potentially inform each of the aspects of the design and, in effect, overlay the whole process, allowing architects to make crucial decisions without loosing overall design intent.

2.2 Current Methods of Rating Tools Assessment

Rating tools provide a method of assessing the environmental standard of a proposed or existing building and assist the architects in understanding what effect a design decision will have on the environment. This enables them to identity potential shortcomings and to address problematic issues. There are various examples of rating tools. However, generally they fall into three categories: simulation models, correlation tools and scorecard rating tools.

Simulation models are computer programs which are used to generate a performance prediction from calculations. A modelled scenario is simulated against pre-recorded data - typically relating to materials, equipment and climate - in order to establish the likely performance and determine the efficiency of a design.

Correlation tools, often referred to as labelling or performance-based tools, usually measure a particular element such as energy efficiency or thermal comfort and focus on providing a quick evaluation of a proposed design in the form of a simple indicator. These tools have often been derived from multiple results generated by simulation models.

Finally, *scorecard rating tools* provide an assessment where performance is measured through a point scoring system. Points are achieved by meeting established criteria and the level of compliance determines the performance outcome. Scorecard programs are effectively checklists which focus on a holistic approach and outline intent and requirements. In addition, they also have the potential to incorporate possible design solutions by listing suggested methods to achieve the desired result. The various categories are often weighted depending on perceived importance and local requirements, and the total points are calculated to give a final star rating.

Of the scorecard rating tools available worldwide, the British BREEAM [1] and the American LEED [2] have set an environmental performance standard for the development of other systems.

BREEAM and LEED are both voluntary tools that provide a 'whole-of-building' assessment approach to the environmental aspects of new and existing buildings. A final score is calculated by combining all individual component credits to produce a single overall score and rating for the building. The success of these two programs lies in their ability to address a number of environmental performance criteria and not focus on just a single element. Moreover, their generic structure also enables them to adapt to different locations and conditions, whilst weightings and scoring can be adjusted to local contingencies.

3. ASSESSING THE GREEN STAR TOOL

3.1 Green Star Rating Tool Scoring System

In the short history of rating tools in Australia, their focus has predominantly been on the domestic sector. Nevertheless, since the late 1990s there has been an increase in the development of rating tools for commercial buildings, although, due to their infancy, they have only had minimal use so far.

In 2003, the Green Star Rating Tool (Office Design) was launched [3]. Developed by the Green Building Council of Australia (GBCA), the tool is intended to assess the design of new commercial buildings over a range of ESD issues, in order to establish benchmarks early in the process and to inform decisions at various stages of development.

Green Star provides an indication of the environmental performance of a proposed design by considering a range of different criteria. These factors are covered over nine categories, each comprising a number of points: *Management, Indoor Environmental Quality, Energy*, *Transport, Water*, *Materials*, *Land Use & Ecology*, *Emissions*, and *Innovation* (Figure 2).

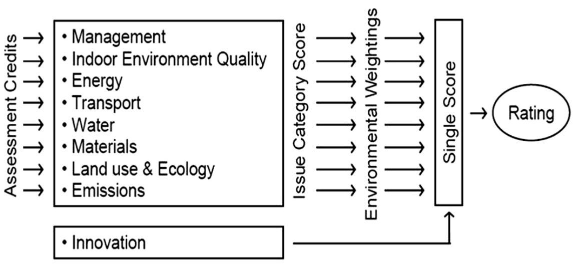

Figure 2: The Green Star Assessment Process

The scorecard assessment approach adopted means the tool is effectively a checklist of the ecological performance in these categories. A rating in Green Star is determined by a credit scoring system. Credits are awarded in each category depending on the level of performance achieved.

There are also prescriptive areas that must be met for certification to be awarded. Once all the credits in a category have been summed, the final percentage is then weighted (by predetermined figures) to give a single category score. The weighting system is used to differentiate and balance various environmental achievements within the tool. In fact, although all categories need to be addressed, some provide greater benefits at a particular time or place. Weightings can vary depending on the environmental importance standard set for the tool and are applied to reward significant areas in specific contexts, thus giving the tool more flexibility and accuracy.

Following the initial scores, the weighted credits are added together in order to provide a total single score and a final rating standard. The *Innovation* section is not included with the main categories, nor is it considered in the weighting system, so as to encourage the inclusion of creative design solutions.

To earn Green Star certification, a design must satisfy all of the system's conditional areas and obtain a minimum number of credits to achieve a defined rating. *Four Stars* acknowledges best practice in building environmental initiatives, *Five Stars* recognises Australian excellence, and *Six Stars* rewards international leadership (Green Star does not classify any star achievement below four).

3.2 Research Method and Field Study Project

This study is based upon the assumption that the inclusion of a scorecard rating tool has the potential to increase the implementation of ESD principles in the design of commercial buildings. To substantiate this statement, a method to assess the use of a rating tool in a design process has been established, combining both qualitative and quantitative approaches.

A quantitative method is utilised to provide an understanding of various design related aspects in the project. Recorded results through various stages of the design give perspective to the rating tool and the environmental strategies. Also, various rating tool assessments are conducted to test the tool and measure the inclusion of ESD in the design. In conjunction with the quantitative research, a qualitative method consisting of design team interviews is used to establish the impact of the tool on the process from the designer's perspective.

The research method has been applied to a field study to record the findings of the design process and enable the research aims to be tested through an actual assessment. The selection of the field study required a building of appropriate size and scale to include and assess the Green Star Rating Tool.

The International Centre and School of Business (ICBB), a multi-storey and multi-function building on Deakin University's Burwood campus in Melbourne, was selected as an appropriate subject for the study. The project required the construction of a new commercial building consisting of work spaces and other multi-purpose facilities, incorporating offices, teaching rooms, administration areas, a 220 seat lecture theatre, a cafeteria, and a car park.

The key design requirements were that the learning and work spaces needed to be functional, durable, accessible, flexible, cost effective and embrace sustainable principles. In particular, a part of the client building policy required the inclusion of an

ESD brief and that the use of the Green Star Rating Tool be incorporated at the design stages to measure the implementation of environmental strategies.

The selected evaluation period comprised the various stages of progression of the design up to the end of the Developed Design Stage, a timeline that provided the opportunity to assess the use of the rating tool in a realistic situation. The research method involved three main components: a Multi-Criteria Decision-Making Tool, a Green Star rating assessment, and Design Team interviews. The results of these studies offered evidence to determine whether the Green Star Rating Tool was an asset or a hindrance to the design of a commercial building and whether it was effective in assisting designers with the inclusion of ESD principles in the process.

The *Multi-Criteria Decision-Making Tool* (MCDM-23) was used to establish and record the results of the design's objectives (set up by the team members) and to monitor the design team priorities throughout the various stages [4]. The tool works by participation from the design team, as they list, record and rank their objectives for a project from the outset. The design team then uses the program to evaluate design scenarios and monitor progress. The MCDM-23 offered a method of understanding the level of designer success in achieving their goals and in determining the impact of the rating tool. Three survey recordings were required to evaluate the development of priority areas, respectively at Pre-Sketch, Sketch Design and Developed Design Stage.

A number of *Green Star rating assessments* were completed during the design stages of the project to measure the success of the implemented ESD. The initial assessment was carried out at the beginning of the project to establish benchmarks, the second assessment was conducted at the end of the Sketch Design Stage to evaluate the ESD performance, and the final assessment was completed at the end of the Developed Design Stage to obtain the final rating.

Finally, at the completion of the Developed Design Stage of the project, *interviews* with the main design team members occurred to provide the basis for understanding the impact of using Green Star in the design process and to analyse the participants' thoughts on the tool, the strategies applied and their relevance. The interviews also provided a comparison of the outcomes established from the MCDM-23 tool, confirming the efficacy of the framework supplied.

3.3 Results of the Evaluations

The first stage of the design process (*Pre-Sketch Design Stage*) defined the objectives for the project, as decided by the design team in a series of meetings. Ideas were discussed at length to outline the range of features envisaged for the building. The meetings were sometimes extended into expanded forums to discuss various aspects of the design, providing an understanding of the scope for the project and enabling the process to progress quickly.

The MCDM-23 tool was used to establish and document the initial goals and objectives from these meetings. The design participants were asked to rank the aspects of the design with a score between four (least importance) and ten. Six categories were identified as being priorities for the project: *Site Layout and Orientation*; *Lighting*; *HVAC*; *Architectural Quality*; *Environmental Performance* and *Cost.*

All categories obtained a good score, indicating they were all considered to be important - a result to be expected at this early stage of the project. In detail, *Architectural Quality* was regarded as the most important aspect, scoring 8.67, the *Cost* closely followed with a score of 8.58, whilst *Site Layout*, *HVAC* and *Lighting* were of a lesser priority, scoring 7.68 on average. *Environmental Performance* was the lowest ranked, scoring only 7.53, a surprising result considering the time and effort spent on ESD issues.

The overall score for the project was 7.97 out of 10, a relatively high score and a likely consequence of the initial optimism at the beginning of the process.

At the end of the Pre-Sketch Design Stage, a preliminary Green Star 'charette' was conducted to discuss and record specific environmental design requirements for the project and to establish ESD targets. It was determined by the design team that a minimum of a 5-star rating was to be achieved.

Through the development of the design process (*Sketch Design Stage*), under the guidance of the ESD brief and the Green Star tool, on-going design team meetings discussed, tested and developed the initial ideas of the project. At the end of this stage, another MCDM-23 survey was used to document the project's progression and to report any changes to the design goals. The results concluded that the same main categories were still the priority areas for the project, although their ranking had changed. *Cost* was clearly the most important aspect, scoring 8.57. *HVAC*, *Architectural Quality* and *Lighting* followed with a slightly lower score, but all were very close scoring 7.67 on average. *Environmental Performance* was again the lowest ranked area, dropping down to 6.80. The overall score was 7.59, a decrease of around 4% from the initial survey. Although lower than expected, the total result was still relatively high.

At the completion of Sketch Design, a Green Star assessment was formally conducted, achieving a rating of 4.0 stars. Specifically, the assessment was characterised by very good performances in the *Management* and *Water* areas, achieving 67% and 73% respectively. All the remaining categories obtained poor scores, with no more than 40-50% of the available credits. Regardless of the strong commitment by the client and the designers, the result was not satisfactory and indicated that various areas still required much attention (especially *Indoor Environmental Quality* and *Energy*). However, the *Innovation* category, earning 3 out of 5 credits with the choice of a hybrid ventilation system (including hollow-core concrete floors) and a modular structure, showed substantial improvements were still possible.

At the end of the *Developed Design Stage*, the team members were again involved to list and rank their final record of how the project had progressed. This MCDM-23 survey was used as the last measure of the design outcome to provide a critical comparison to the initial evaluations and an indicator of the progressions from the previous reviews. The same categories were identified as priority areas, but again their ranking had changed. *Site*, *Layout and*

Orientation became the most important category, scoring 9.18, while the *Cost* also scored highly with 8.59. The *Lighting* category had become more important than in the previous survey, scoring 8.20, whilst *HVAC* and *Architectural Quality* scored less, 7.71 and 7.59 respectively. The *Environmental Performance* category remained the lowest ranked, scoring 6.90, although its importance had increased.

The overall score was 8.03, an improvement of about 5% from the previous survey, which shows how achieving the brief and establishing a cost effective design had become a priority at this stage (Figure 3).

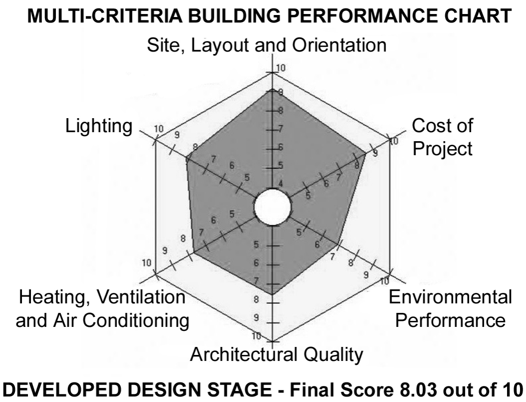

Figure 3: MCDM-23 at Developed Design Stage

The second Green Star assessment of the ICBB project was conducted at the end of the Developed Design Stage achieving a 4.5 stars rating, a slight increase in performances from the initial assessment.

The improvement recorded substantial progress in the *Indoor Environmental Quality* and *Transport* areas. Actually, the IEQ Category achieved 62% of the available credits, an increase of 20%, and *Transport* obtained 64%, a progress of 14%. However, the *Management*, *Water* and *Material* categories all had a reduction in performance from the previous assessment, whilst the remaining categories all maintained their previous scores. This result reflects a consistent approach but probably greater follow-up and commitment could have improved the performances and the rating achieved. The final scoring did not attain the 5 stars, but still it was recognised as “best practice” by GBCA.

The final part of this evaluation consisted of the interviews conducted at the completion of the Developed Design Stage. These interviews provided a set of discussion points through questions to team members about their design approach, their attitude towards ESD, and the inclusion of Green Star. The responses were generally positive; many team members regarded the tool as a valuable asset, while others thought it merely provided a good checking or reference point.

All things considered, the field study showed evidence that the iterative application of a rating tool in the design process of a commercial building can effectively provide guidance and represents an asset for the architects and the design team, although a more integrated approach to design, together with a thorough communication and coordination of skills, are essential to overcome any lack of commitment to ESD by some of the team members.

4. INTEGRATING ESD IN DESIGN PRACTICE

4.1 A Collaborative Approach to Design Practice

There is a multitude of strategies and theoretical approaches towards design processes, as there is no correct method of design or an exact process model to follow. During design practice, a designer has to process many inputs in a complex, accumulative, unpredictable and difficult task. The incorporation of sustainability obviously means further considerations for architects, which may often lead to a re-thinking of the way buildings are designed.

An iterative design approach can encourage ideas to develop and can enhance communication between team members, consultants and clients as they outline and define the scope of the work. Minimal communication could mean a designer missing out on vital information or not understanding issues in context, with expensive changes required later in the process. Since buildings have become increasingly complex, a holistic method can provide an efficient way to deal with unexpected modifications, and integrating requirements before construction starts.

The design approach adopted on the ICBB project has demonstrated the level of complexity involved in the design of a commercial building, where technical, practical, financial and social elements have to be balanced and valued in reference to one another. The difficulties inherent in managing such factors require a method of integrating these needs and coordinating contributions. The field study showed evidence that increasing knowledge and understanding design intent through communication and collaboration – albeit controlled – was vital to bridge the gap between professionals and achieve the desired outcomes.

This approach becomes even more significant with ESD becoming not only increasingly important, but also mandatory for design practices. Obviously, since the range of options and standards of practice are uncountable, it is important to clearly benchmark performances for a project from the outset, defining what can be delivered in terms of potential benefits.

The ICBB project showed that a target to aim for could help to define levels of performance and measure the impact of decisions, also informing of any shortcomings in a particular sector. Moreover, the use of a rating tool at the various stages of design has effectively enabled the design team to resolve complex issues from the start and provide a point of reference as the design progressed, whilst also establishing a right attitude amongst the participants.

To thoroughly implement ESD in practice, the design process must evolve to accommodate new requirements. Traditional linear models seem inappropriate for practices today due to the number of participants involved and the many issues to be considered concurrently, which can mean sustainable strategies are being lost. For this reason, Figure 4 proposes a new design model where ESD envelops the entire process, ensuring that all components are equally inspired by environmental awareness.

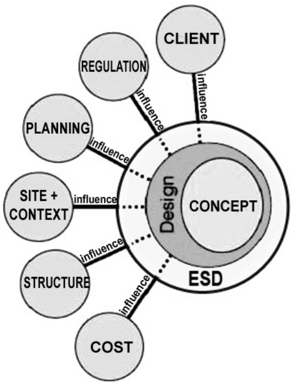

Figure 4: A design model integrating ESD in practice

This more comprehensive and integrated design model obviously has to come with a high level of control and communication within the team. If this approach can be adopted and well lead by architects, then there is the potential to increase the number of sustainable solutions in commercial projects.

4.2 ESD in Design and Building Processes

Establishing a cultural change in the 'industry' of commercial buildings is fundamental for the successful inclusion of sustainable strategies, as often they are seen as an extra or add-on rather than an integral part of the design. Therefore, as a result of this research, a new process model is proposed concerning the implementation of ESD in building development and construction (Figure 5).

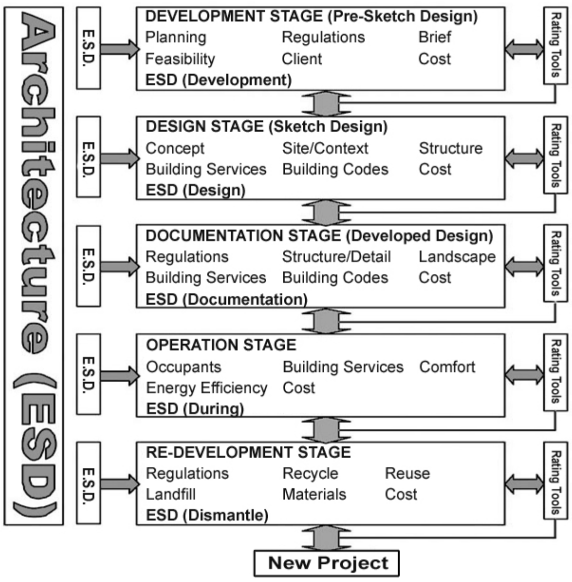

Figure 5: A proposed process model for buildings

The proposed model embraces the various stages of design and extends beyond them to include the entire life cycle of the building and its components. It operates by overlaying the environmental strategies throughout the design and construction processes to become a driver for the whole life-cycle of the building, establishing benchmarks and providing regular reviews of performance. ESD is embraced at two levels; a stage-by-stage design model to continuously inform the designers and guide their decisions (described in Figure 4), and an overarching approach to inspire the development of the building.

Instead of isolating each component in a 'plug-in' scheme where everything can be added or removed, the model addresses not only the specific needs of the various design stages, but the entire building process, listing the important influences at every level of progression. As different information is required at each stage, ESD acquires different meanings and objectives once the project and its level of complexity develop. The process thus continues and adjusts throughout the life of the building, up to the re-development stage where it would start again.

The acronym ESD assumes here a wider sense, becoming respectively "Ecologically Sustainable Development" (at Pre-Sketch Design Stage), "Ecologically Sustainable Design" (at Sketch Design Stage), "Ecologically Sustainable Documentation" (at Developed Design Stage), "Ecologically Sustainable Dismantle" (at Re-Development Stage), etc.

Moreover, to continuously enhance the inclusion of ESD - rather than just label the 'greenness' of the building at the end of the process - an iterative rating tool exercise is set at each stage to inform on and review objectives. This would assist in establishing benchmarks to target design goals and enable an on-going analysis of the results achieved. This method has the potential to enrich the holistic approach proposed by creating a broad assessment scope, and allowing design flexibility. At the completion of each phase, the rating tool would be applied before proceeding, with the awareness that the design may need to be re-developed if the achieved performances do not match the desired objectives.

In conclusion, in the proposed process model, ESD, instead of being an acronym of vague meaning, becomes an integral influence on each stage of the building development, a term intended to express the richness and the mixture of inputs that in the past has often been simply referred to as 'Architecture'.

ACKNOWLEDGEMENT

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