INVOLVEMENT AND INFLUENCE OF CONSTRUCTION PROFESSIONALS FOR ENVIRONMENTALLY SUSTAINABLE DESIGN OUTCOMES

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ABSTRACT

Environmental sustainability is concerned with protecting and conserving both biodiversity and the environment, by reducing waste, preventing pollution and using water and other natural resources as efficiently as possible. Environmental sustainable objectives can be achieved by making appropriate decisions at the design stage with the involvement of different design professionals. Therefore, it is vital to attain the environmentally sustainable design target with the concept of integration. Integration is the combination of involvement and influence for decision making by design professionals. This integration should have to be executed at each stage of the decision-making process to achieve environmentally sustainable design outcomes.

Hence, the aim of this research study is to investigate the level of involvement and influence of construction professionals at the design stage in achieving environmentally sustainable design outcomes. Firstly, a literature synthesis was carried out to study the concept of integrated decision making. Subsequently, the process of decision making is identified from the literature synthesis. Then, a case study strategy was conducted to investigate the general involvement of key professionals for decision making in the design stage and to investigate the level of influence of professionals for decision making in the design stage

The findings revealed that Architect is the key decision maker and the professional who has the highest influence on decision making. Quantity Surveyors and Engineers have the second and third highest levels of influence for decision making at the design stage respectively.

Keywords: *Construction Industry; Design Stage; Environmental Sustainability; Integrated Decision Making.*

1. INTRODUCTION

Sustainable development in construction industry aims to attain the best quality of a construction product by using resources in an efficient way (Office of Government Commerce [OGC], 2007). Currently, "Sustainability" has become a significant issue incorporated with designing (Hill and Bowen, 1997). Hill and Bowen (1997) has further noted that in present community priorities, authorities and developers draw their attention to this issue of "Sustainability", while the public are more keenly aware of the environmental issue. Sustainability comprises three main pillars as environmental sustainability, social sustainability and economic sustainability (Longden *et al*., 2009). Among these three pillars the main focus of this research is on environmental sustainability as it is a universal necessity in the current era (Buhovac and Epistein, 2014).

Environmentally sustainable outputs are not a novel experience to the world as it has been in use for a long time (Chapman, 2015). Dedeurwaerdere (2014) mentioned five notable stages of a sustainable construction project. They are design, construction, operation, facility management/maintenance and facility disposal. As stated by Longden *et al*. (2009), design plays a key role out of all the other phases while facilitating sustainability through reducing cost, improving safety and health as well the image. Further, Hill and Bowen (1997) described that sustainable output at the design stage implies an intention to find the best solution while balancing functional, technical, financial, environmental factors and aesthetic appearance.

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Designing is a team work and joint decisions should have to be taken to achieve the design goals while improving coorporation among individuals (Lahdenpera, 2012). Generally, a professional team in the design stage comprise with Architects, Structural Engineers, Quantity Surveyors, Project Managers, Interior Designers, Landscape Architects, Hydraulic Engineers, Mechanical and Electrical Engineers, etc. (Lahdenpera, 2012). Kibert (2012) noted that as sustainable construction requires joint decisions in the team to achieve common goals effectively. Ratcheva (2009) mentioned that these professionals in the design stage make a 'design team' by combining interpersonal interactions, knowledge diversity and work practices.

A better sustainable design output requires multiple professional skills and judgments, which could be facilitated through integrated decision making (Baiden and Price, 2011). Herein, "integration" can be taken as a combination of 'involvement' and 'influence'. According to the Oxford Dictionary of English (2010), "involvement" is the contribution for a process, whereas, "influence" is the capacity of making an effect on any kind of a process. Integrated decision making provides benefits such as sharing financial and other risks jointly, reducing cost overruns, setting a target cost, reducing time overruns etc. (Lahdenpera, 2012). Integrated decision making should have to be done at each stage of the decision-making process. Karsak and Ozogul (2009) argued the necessity of integration in decision making rose in order to prevent of having unrealistic independent assumptions and to have the most appropriate decision with required cost, quality and the time period. Therefore, as Baiden and Price (2011) mentioned, a better sustainable design output can be attained through integrated decision making on a well-defined decision making process.

Relatively less attention has been given in literature on exploring the decision making process of professionals' to make decisions at the design stage towards sustainability goals. Even the researchers who have addressed this area tend to talk only about the "involvement" aspect instead of "integration" (Polgaspitiya, 2007). Therefore, the need of addressing on integrated decision making concept along with decision making process is identified. Therefore, the aim of this paper is to fill this research gap by exploring the involvement as well as the level of influence for decision making by selected key professionals at the design stage in achieving environmentally sustainable design outcomes. In addressing this aim, the paper first provides a review the concept of "integrated decision making" and its necessity for achieving sustainable design outcomes. It then goes on to discuss the general involvement and the level of influence of key professionals for sustainable decision making in the design stage.

2. DECISION MAKING APPROACHES FOR ENVIRONMENTALLY SUSTAINABLE DESIGNS

As Bader *et al*. (2005) mentioned decision making process starts from formulation. Then sequentially, analysis (making predictions), search (gather potential solutions for requirements), then development of decision making stages (each solution evaluated to find the best alternative), finally specification and modifications should be done. Above facts show that "decision making" become one of those steps in the above-mentioned formulation to specification and modification process. This research is focused on decision making during the design stage by professionals, towards an environmentally sustainable output.

Chen *et al*. (2015) mentioned that there are two approaches of decision making namely, Conventional and Integrated decision making approach. As they identified, in conventional approach, a single entrepreneur is doing all the planning, directing and controlling of activities of subordinates. In the integrated approach, tasks are divided into sub tasks. Sub tasks are managed by individuals with the use of involvement and influence of each other (Akintoye *et al*., 2000). Herein, integration is involves a 'rethinking' of traditional way of doing things in the construction industry. Therefore, decision making through integration will be a new direction to enhance the performance in the construction industry (Malczewski and Rinner, 2015). The American Institute of Architects [AIA] (2007) has highlighted that in integrated decision making, the ability of decision making should not vest in a single team member. All should participate for decision making and only in that occasion the real integration occurs. Further, AIA (2007) described that all decisions should have to be taken in the best interest of the project.

When compared these two approaches integrated approach provides benefits such as saving of time, motivation to attain goals, reduction of conflicts, high commitment, mutual trust and customers' satisfaction than conventional approach (Malczewski and Rinner, 2015).

3. INTEGRATED DECISION MAKING OF PROFESSIONALS IN THE DESIGN STAGE

Decision making power in the design stage is mainly incorporated with the design professionals Davis and Goetsch (2014). Although end user has the chance of expressing their opinions, they do not have the decision-making power (Hansson *et al*., 2010). Hill and Bowen (2007) mentioned that multitude of decision makers are getting together for integrated decision making. The a professional integration phases to achieve a better design outcome can be shown as given in Figure 1.

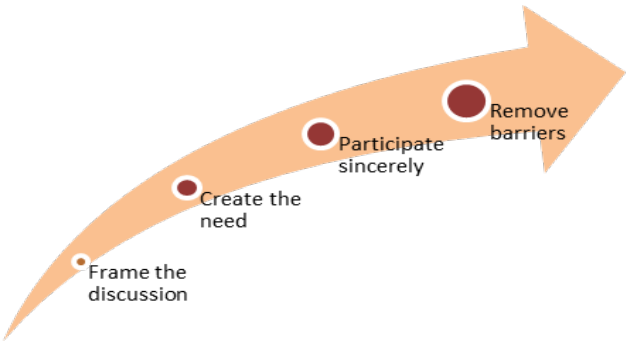

Figure 1: Steps of Better Professional Integration

(Source: Sive, 2009)

Hill and Bowen (1997) discovered that a design professional who wishes to influence a project, should initially involve in discussion as well in decision making. Professionals in the design stage required a better guidance for this complex decision making process (Hill and Bowen, 1997). In that occasion, the requirement of a conceptual decision making process come to the stage. In integrated design decision making whole design professionals has relative responsibility for whole task and they should possess variety of task related skills (Freeman *et al*., 2008).

4. DECISION MAKING PROCESS AT THE DESIGN STAGE FOR ACHIEVING ENVIRONMENTALLY SUSTAINABLE DESIGN OUTCOMES

Decision making process is a listing which supports to define the prevailing functioning background of a specific work load (Boone and Snowden, 2007). Further, a proper decision making process enables professionals to make required decisions in a contextually appropriate manner in separate stages of the process (Boone and Snowden, 2007). As Davis and Goetsch (2014) mentioned when a decision is taken, there should be a structured tool to guide it. Therefore, in an integrated decision making process, requirement of a well-defined decision making process becomes more vital concern. A decision-making process to achieve sustainable outcomes in construction projects incorporates the steps shown in Figure 2 and these key steps are explained below:

Define the problem (Identification of the decision/s to be made) to achieve environmentally sustainable design: Defining the problem is the initial stage of the decision-making process (Refer Figure 2). When it is applied for design decision making, design professionals first get together and define the problem with high design professional agreement. Then solution should have to be proposed to satisfy professionals (Duecker and Khalili, 2013). The availability of information always matter the design decisions as well cost related decisions (Hill and Bowen, 1997). When design affects for a change, cost matter effects on the design change.

Identify design objectives: In order to identify the effective solution, the prior identification of objectives becomes vital (Freeman *et al*., 2008). Environmentally sustainable objectives can be defined according to the client's brief (Refer Figure 2).

Define Criteria for Selection and Prioritize Criteria: Criteria can be set according to the professional judgments (Duecker and Khalili, 2013). Therefore, professionals in the design stage should integrate to set criteria related to the decision to be made (Refer Figure 2). Compare the elements accordingly what gives most benefit, opportunities, most cost and risk (Demirtas and Utsun, 2008).

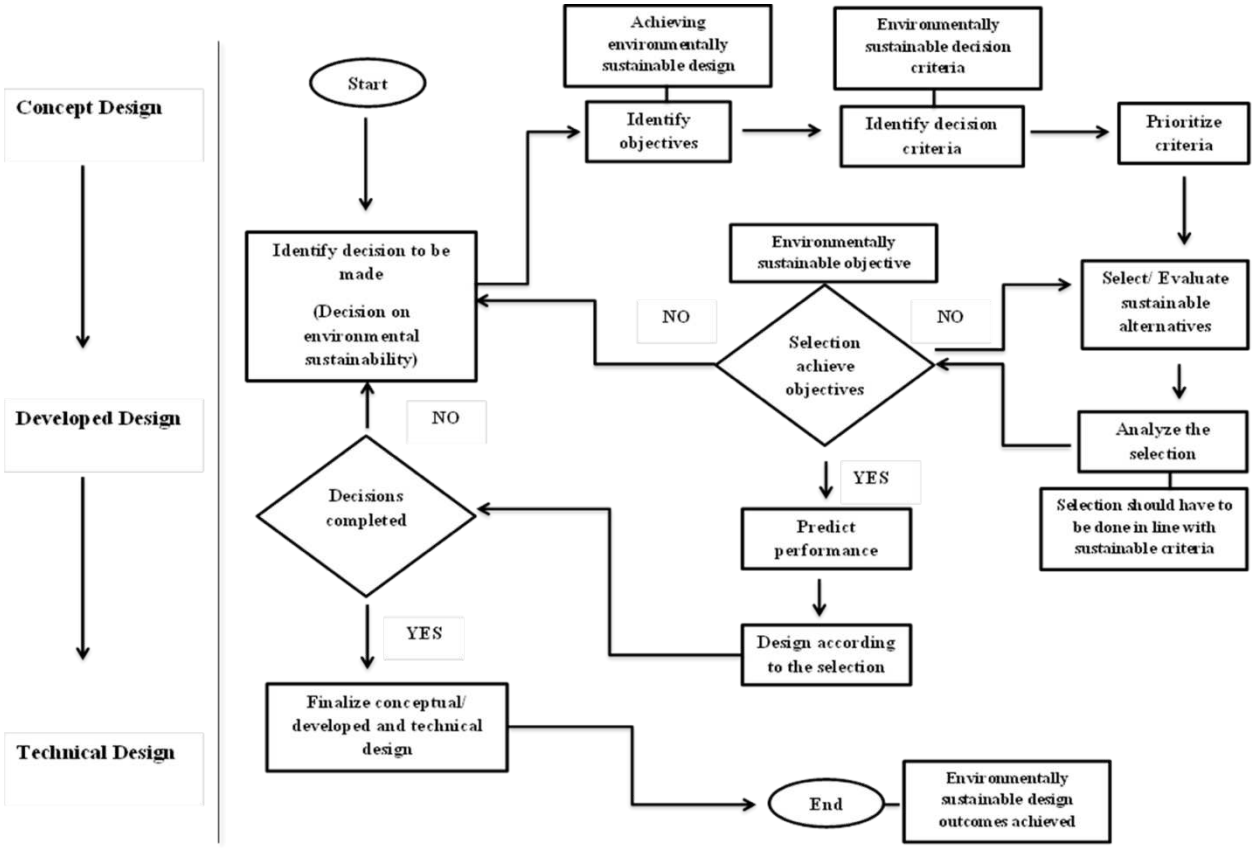

Figure 2: Decision Making Process to Achieve Sustainable Outcomes

Source: Davis and Goetsch (2014)

Examine, evaluate and choose alternatives: As Paveglio and Prato (2014) mentioned examining, evaluation and choosing alternatives can be named as stimulating various objectives taken by various patterns considering different alternatives. This idea can be implemented in this stage while ranking feasible patterns and determine the best. This stage will be an input for the next stage of design decision making process (Refer Figure 1). Alternatives should be generated with the integration of design professionals (Duecker and Khalili, 2013).

Choosing Alternatives:

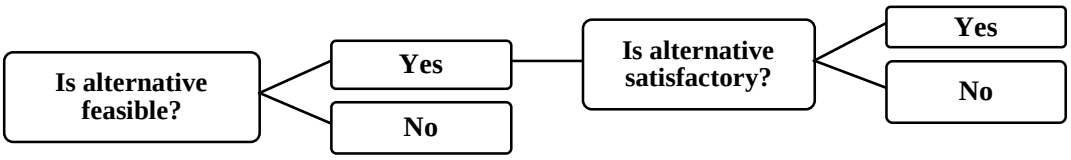

Figure 3: Choosing Most Possible Alternatives
Source: Freeman *et al.* (2008)

As Freeman *et al.* (2008) mentioned this feasibility can be in monetary, legal and ethical forms to achieve environmentally sustainable outcomes (Refer Figure 3). After weighting alternatives, this method can be used to find out most possible design alternatives.

Implement and Monitor Decisions: Freeman *et al.* (2008) further stated that, in order to implement and monitor decisions first there should be the identification of who decides. That can be measured by role of professionals for decision making at all stages. It is better if there is a leading professional for decision making at each stage. Then required resources, budget, schedules for work, detailed plans for uncertain situations and steps to deal with consequences should be made (Freeman *et al.*, 2008). This decision-making process should be done continuously until design is completed and environmentally sustainable design outcomes achieved. It is vital to monitor every stage closely by the professionals with client's requirements to have the best design outcome.

5. RESEARCH METHODOLOGY

This research aims to investigate the level of influence and involvement of construction professionals at the design stage in achieving environmentally sustainable design outcomes. Therefore, a qualitative approach using case studies was adopted for this research. Initially, a comprehensive literature review was carried out to gain the knowledge in integrated decision making concept and to investigate decision making process at the design stage.

Then, preliminary interviews were conducted with expert professionals from two different reputed consultancy firms who have had experience in environmentally sustainable construction projects locally. The data collected through preliminary interviews were used to develop the interview guideline and to identify the professionals to be interviewed at case study stage. According to the professionals' opinions Architects, Engineers and Quantity Surveyors (QS) are the professional categories who majorly involve at the design stage. As Engineer category is comprised with various Engineering disciplines, preliminary interviews guided the researcher to conduct interviews with Engineers in various natures (Structural, Service Engineers etc.).

Then, three case studies were selected in order to investigate the general involvement of key professionals for decision making in the design stage. Environmentally sustainable projects at the design stage are encountered as cases. The selected three cases for this research are given in below Table 1.

The data which was collected through semi structured interviews within case studies were used to analyze by content analysis using QSR NVivo (Version 10).

Table 1: Description of Selected Cases

Case Study No	Project Location	Building Type	Project Cost (Sri Lankan Rupees)	Identified Environmentally Sustainable Features	Interviewee Details
1	Galle (Kosgoda)	Hotel Building	125millions	**Indoor Environment Quality** – Indoor Air Quality and Lighting Environment **Material Usage** -Eco friendly materials usage (Re usable/ Natural/ Used materials) **Building Amenities** – Visual Quality and Comfort (Proper day light quality and comfort) **Water Management –** Water Conservation	Project QS (Q1) Chartered Architect (A1) Chartered Engineer (E1)
2	Colombo (Homagama)	University Building	8.6 Billions	**Indoor Environment Quality** - Health and Hygiene, Indoor Air Quality, Lighting Environment **Building Amenities** –Adaptability **Resource Use -** Energy Efficiency **Water Management** - Water Conservation **Material Usage -** Eco Friendly material Usage **Solid Waste Management** - Waste sorting and storage	Chartered QS (Q2) Chartered Architect (A2) Chartered Engineer (E2)
3	Colombo 6	Office Building	150 millions	**Water Management** - Water Conservation **Solid Waste Management -** Waste sorting and storage **Material Usage** -Eco friendly materials usage	Chartered QS (Q3) Chartered Architect (A3) Chartered Engineer (E3)

6. ANALYSIS AND RESEARCH FINDINGS

6.1. INVOLVEMENT OF PROFESSIONALS IN DECISION MAKING DURING DIFFERENT STAGES OF THE RIBA PLAN OF WORK: CASE STUDY FINDINGS

RIBA plan of work is the most common plan of work used in the construction industry due to its benefits such as RIBA provides clear boundaries, details of tasks and required outputs at each stage. Therefore, it is better and advisable to follow RIBA plan of work at the design stage to have the best outcome while taking design stage decisions. Practically in industry RIBA plan of work is practiced within limits but not restricted to it. According to the interviews the role of each professional in relation to decision making in design stages can be divided into several sections such as;

a. Key decision maker – Professional who act as the key personnel in decision making
b. Responsible for overseeing activities – Professional who responsible to take decisions considering future risk involvement as well future activities
c. Responsible for documentation
d. Advising – Professional who advice other professionals regarding the decisions to be taken or already taken
e. Responsible for assessments – Professional who responsible on evaluating the decisions already taken

Figure 4 shows the involvement of Architects, Quantity Surveyors and Engineers in terms of the aforementioned roles in design stage decision making.

Professional	Concept Design	Developed Design	Technical Design
Architects	(a) (b) (c) (e)	(a) (c) (d) (e)	(a) (c) (d) (e)
Quantity Surveyors	(b) (d) (c)	(b) (c) (d)	(b) (c) (d)
Engineers	(d) (b) (e)	(b) (e) (d)	(a) (b) (d) (e)

Figure 4: Industry Practice of RIBA Plan of Work at Design Stage

The findings of above Figure 4 can be summarised follows:

- All the professionals in every case are involving in each stage in the RIBA plan of work.
- In each case, Architects are the professionals who make key decisions at every design stage.
- Irrespectively, every professional should be responsible for overseeing activities before taking decisions.
- Although, Architects are the key decision makers, Quantity Surveyors and Engineers are the key advisers at each design stage.

6.2. DECISION MAKING FOR SUSTAINABLE PROJECTS AT THE DESIGN STAGE: CASE STUDY FINDINGS

Environmentally sustainable project characteristics required better level of decision making to resolve design stage obstructions. Therefore, design stage problems required lot of structuring and rational problem solving. Normally in the construction industry decisions are taken in the design stage within several phases as shown in below Figure 5.

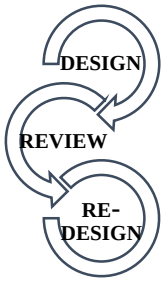

Figure 5: Project Development Stages

According to Figure 5, at the end of each design stage in the RIBA plan of work, the design team should ensure that all the design issues are addressed through the completed design at the reviewing stage.

Interviewee Q1, Q3 and A3 described below as factors affecting for the involvement of decision making process;

- Knowledge access and the management
- Thinking skills and communication skills (Meetings, informal gatherings etc. assists to enhance the involvement for decision making)
- Use of strategy to solve problems and the way of giving solutions

According to the above bullet points, the professionals who are with better knowledge and management skills, communication and thinking skills, problem solving skills and solution providing skills are able to involve for decision making than others.

6.3. PROFESSIONAL INVOLVEMENT FOR DECISION MAKING AT THE DESIGN STAGE: CASE STUDY FINDINGS

Each interviewee in each case study defined themselves and their role for decision making in terms of a) a leading role, b) a combination of leader and supportive roles, c) a role with supportive characteristics and d) a combination of supportive and follower roles (refer Table 2).

Table 2: Professional Opinion for Decision Making (Cross case analysis)

Professional Opinion	**Architect Category**			**QS Category**			**Engineers Category**		
Interviewee	A1	A2	A3	Q1	Q2	Q3	E1	E2	E3
• Leader	Y	Y	Y						
• Leader/ Supportive						Y	Y		Y
• Supportive				Y	Y			Y	
• Supportive/ Follower				Y					

*Y- Yes

As per Table 2 above, it was identified that among all the professionals, Architects play a dominant role in decision making. Respondents also noted that Architects, sometimes have over involvement in decision making particularly in relation to drawing development and documentation. This over involvement directly affects the Quantity Surveyors' involvement. Therefore, Architect's involvement for decision making can be defined as a "Leading Role" in most of the design decision making stages.

Generally, Quantity Surveyor's involvement can be defined as "Supportive Role". However, at times Quantity Surveyors become "Leader plus a Supportive Role" particularly in relation to cost related decisions. The Quantity Surveyor basically supports the decisions of commercial aspects, which influence the Architect and the Engineer in the design stage. The respondents also noted that the practicability and the sustainability of the construction project mainly depend on the Quantity Surveyor's involvement, as other professionals' typically are not much concerned with meeting required regulations and achieving budget limits.

Engineer is a professional who is mainly involved in decision making regarding structural matters, services, mechanical and Electrical works. In other stages, the Engineer has a supportive role and is an identical active member in the design team. Engineers generally involve for design review decisions, design coordination, structural integrity related decisions while understanding budget constraints. Further, he is a flexible character in decision making with respect to the Architects' and Quantity Surveyor's ideas. Therefore, in general, Engineer's involvement for decision making can be defined as "Leader plus a Supportive Role".

7. CONCLUSIONS

The aim of having Environmentally Sustainable outcomes has been vastly increased in current years due to the knowledge and understanding of local as well international issues related to environmental sustainability.

Obtaining environmentally sustainable outcome is a group task which require lots of professional skills and experiences required. Therefore, this research introduces the term "integration" which makes the combination of professional involvement and influence. Best skills and experiences make professionals to have best decisions towards the productive project outcome. Therefore, integrated decision making is, the involvement and influence of professionals for decision making towards a specific goal. The design stage can be defined as an utmost important stage in RIBA plan of work. Therefore, a decision-making process for the design stage is a guidance for environmentally sustainable design outcomes. As identified in Figure 2, decision making process comprises with seven notable stages for the design stage, such as identifying decisions to be made, identify client's objectives, identifying and prioritizing decision criteria, selecting and proposing alternatives analyzing the selection made, predicting performance and finalizing the design. According to the analysis, all three professional categories (Architects, Engineers and Quantity Surveyors) are involving for each stage of the decision-making process. But the highest involvement can be identified from the Architect, compared to other two professional categories. Architect is the key decision maker and other two professionals are acting as supporters in the decision-making process toward environmentally sustainable outcomes. In some cases, Engineer and Quantity Surveyor too act as leaders in decision making. But as an overall picture, the highest involvement for decision making is from the Architect. Involvement for decision making by Quantity Surveyors and Engineers can be seen in an average equal state towards environmentally sustainable outcomes.

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