UNDERSTANDING THE INNOVATION PROCESS IN DESIGN PROJECTS

Mohamed Baom, MSc. Project Management, mohamed.baom@gmail.com
The British University in Dubai, Dubai, UAE

ABSTRACT:

This study is concerned with the issues that influence innovation in design of construction projects in UAE. The study focuses on the early phases of design projects which usually begin with a client's request and end with detailed drawings or construction documents. The study began by developing a conceptual model that links the different factors influencing the design process to help understand how innovation is affected in each phase, what triggers it and how to maintain it. To develop a better understanding, the study applied this conceptual model on a current project. The findings revealed that the organization culture plays a major role in preparing project teams for innovation. A conducive culture for innovation requires management support through investing in expanding the company's knowledge base, enhancing employees relations, and maintaining an enthusiastic atmosphere for innovation. In addition the role of the client, knowledge, team's collaboration, and technology had a key role in triggering and maintaining innovation. The client's demand, team's established knowledge, and participants' relations had more influence than others in triggering innovation. On the other hand, utilizing technology, and sustaining healthy relations amongst the design team had more influence than other factors in maintaining innovation.

Keywords: Innovation, Design process, construction industry

1. INTRODUCTION

The Architecture industry has been through many changes which are mainly attributed to the competition amongst architecture firms. Thus, most firms aim to be distinguished by their innovative design solutions. Most architecture consultant firms realize that innovation in the design process and products is what differentiate them from others and add to their competitive advantage.

Generally, each architecture project begins with a client's request. Whether the client is a public sector or private, their demand is what sets the basic framework for the project. This phase is usually followed by research and site analysis to understand the context and set the project's objectives. The conceptual design phase, where the project team begins preliminary design idea, comes afterwards. After that, the concept solidifies in the schematic design phase and becomes clearer. Once the concept is ready, the project team begins on the design development to produce more accurate drawings with detailed specifications. Later, the design team prepares the construction documents to submit them for bidding or to the selected contractor. Usually the project team offers supervisory services to insure quality of implementation. Here is where the consultant's part ends in a project. At each step during the design phase there is an opportunity to exploit innovation to produce a uniquely valuable end product. However, these opportunities vary from one phase to another. A successful innovation management would figure where and how to invest the capital innovation at each phase.

1.1. Problem Statement, Aims and Objectives

There are several researches done about innovation examining the factors that influence it in organizations. However, not many have researched innovation focusing on design projects especially during the design process. Moreover, most architecture consultant firms claim innovation as one of their core values and seek to achieve competitive advantage by innovation in their projects. However, not all of them deploy the right atmosphere for it to prosper in their project teams.

The paper aims to develop a clearer understanding of the innovation process in architecture projects during the design phase. This will be achieved by developing a conceptual model that clarifies the innovation process and its major influential factors during the design phase, then by applying it on a case study to understand what factors have more influence than others.

2. CONCEPTUAL MODEL

The model, which will be used as a tool to analyze the case study, is a result of a thorough study of several literatures written around the subject of innovation. It explains the innovation process in four major phases. The four phases are 'setting up for innovation', 'igniting innovation', 'maintaining innovation', and 'implementation'. These phases correspond to the phases of the design process. Setting up for innovation discusses the organizational conditions. Igniting innovation corresponds to the design phases beginning with the research phase to the end of the conceptual phase, while maintaining innovation corresponds to the phases after the conceptual design until the end of the design process. Implementation phase corresponds to the actual implementation manifested in the construction of the design. The major influential factors in each phase will be examined in the case study to understand their effects in real projects.

Setting up for innovation phase addresses the readiness of an organization to support innovation in project teams. It examines three major factors including organization's culture and climate for innovation, senior leadership in supporting innovation, and management for innovation.

For innovation to exist in any project run by an organization, the organization should have a culture with high appetite for innovation. Several articles indicated that a culture enables innovation through building healthy relations amongst employees, tolerating risk taking with new ideas, promoting open communication regardless ranks and hierarchy, and keeping high level of motivation amongst employees (Ahmed, 1998; Schulte et al, 2010; Halepota, 2005; Harkink & Tijhuis, 2006).

The role of senior leadership will be examined in how they support innovation. Leaders in such organizations should support innovation by empowering, guiding and motivating employees to explore opportunities. Also, they have a significant role in promoting collaborations in the organization and eliminating job hygiene factors, such as disputes between employees. (Tang,1998; Mumford and Licuanan, 2004; Jogulu & Wood, 2007; Lyons, 2007; Found & Harvey, 2007).

Investigating the major factor, management for innovation, the paper will explore the efforts that management does to encourage innovation in an organization and its flexibility in adapting to market changing demands and development. A good management for innovation usually invest in research and development, provide guidance and support for the operation teams, manage relations amongst employees and with external entities to the organization, and adapts to the industry's development (Ahmed, 1998; Tang, 1998; Caerteling et al, 2006).

Design Process

establishing a need	research & analysis	conceptual design phase		embodiment design phase	detailed design		implementation

Setting up for innovation		Igniting innovation		Maintaining innovation		Implementation

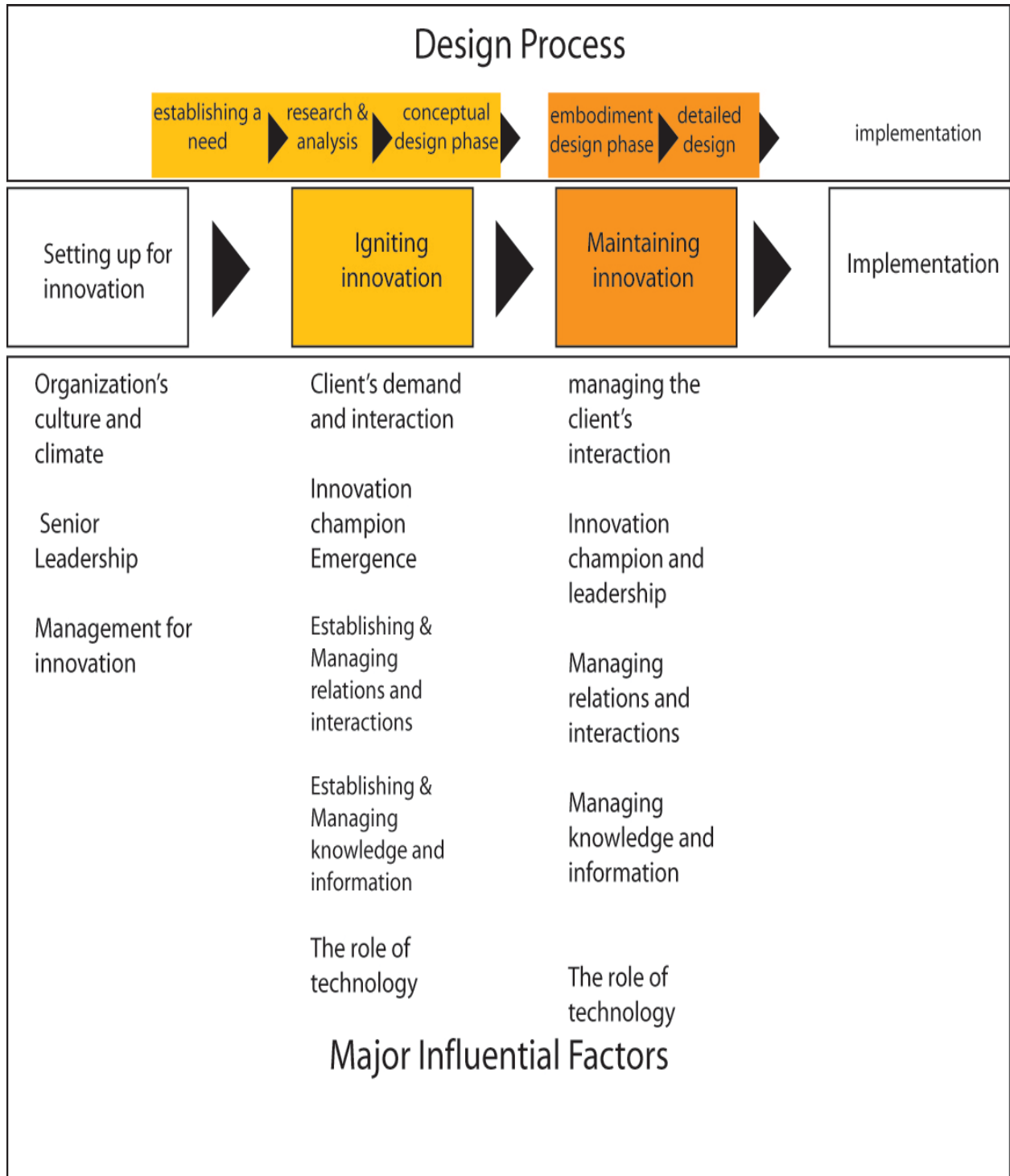| Organization's culture and climate	Client's demand and interaction	managing the client's interaction
Senior Leadership	Innovation champion Emergence	Innovation champion and leadership
Management for innovation	Establishing & Managing relations and interactions	Managing relations and interactions
	Establishing & Managing knowledge and information	Managing knowledge and information
	The role of technology	The role of technology

Major Influential Factors

Figure 1

Igniting innovation phase in the developed conceptual model examines factors related to the idea initiation and development. Factors affecting this phase include the client's demand and interaction, the role of innovation champions and their emergence, establishing and managing relations, establishing and managing knowledge and information, and the role of technology in defusing design ideas.

In any design project, the client's demand is what sets the problem which the design team should solve within the proposed parameters. Hence, client's demand is a major factor for defusing innovation in design projects. Examining this factor, the paper will investigate how the client's demand and interaction were handled in the presented project to come up with the design concept. The strength of a collaborative process with the client usually results from clearly defining his/her role, exceeding his/her demand, involving him/her in evaluating the idea, and maintaining a healthy relations (Enkel et al, 2005; Ulwick, 2002; Bettencourt and Ulwick, 2008; Manley, 2006; Johnsen et al, 2006)

Also in this phase, there are those individuals who trigger ideas, find opportunities, and enthusiastically take the lead in a project to come up with an innovative solution. Those are called innovation champions who have a significant role in leading and defusing innovation. The paper will address these individuals and how they contributed in initiating the design concepts and opportunities in the case study. Champions of innovation are those individuals who visualize an opportunity or an idea, promote it, support it, and lead it to gainful outcomes (Howell and Boies, 2004; Howell, 2005; Bailetti and Guild, 1991).

Establishing and managing relations and interactions for a project is a major trigger for innovation, especially with entities external to the organization. This factor is investigated in the case study to see how it helped in initiating innovation in this phase. The strength of relations amongst employees allows good information flow, and sustains an enthusiastic atmosphere for innovation, while establishing good relations with external entities related to the industry can bring on board special skills, and new ideas. (Swan et al, 1999; Johnsen et al, 2006; Manley, 2006; Cockaday, 2004; Friedman, 2005)

Knowledge is a significant factor in defusing and shaping innovation. Indeed, several articles emphasized the special attention that should be drawn to managing knowledge and information for the success of innovation in a project. In managing this factor, attention should be drawn to the sources of knowledge and ways of sharing knowledge and information. Knowledge sources may include organization's previous experience, researches, and updates from the industry. Sharing knowledge and project information can be encouraged by means of community networking and the use of technology. (Tang,1998; Udeaja et al, 2006; Tuncer et al, 2006; Swan et al, 1999)

The model also discusses how Technology was deployed in defusing innovation in a design project. Technology can be used in managing information, planning projects, and generating design ideas. (Marasini et al, 2006; Udeaja et al, 2006; Tuncer et al, 2006;Sebastian, 2011; Fox, 2011; Park et al, 2004)

After initiating the design concept, innovation has to be maintained until the delivery of a realistic outcome. In the model used, the phase *maintaining innovation* is meant to examine the same factors evolving from the previous phase, *igniting innovation*, in how they sustained innovation until the end of the design process.

The final phase in this model is *implementation*. Usually the role of a design team ends before this phase by handing in the construction documents of a project. However, the team may offer a supervisory service to make sure that everything is implemented as planned.

3. CASE STUDY

The case study focuses on the design process of Dubai Metro project. The design was overtaken by a global architecture firm. They successfully provided a design of fully automated rail system composed of 47 stations, along 43 miles of track; underground stations, above ground stations and elevated stations.

The design concept of the metro station was an iconic representation of an aspect from the heritage of Dubai. It is inspired by the heritage of pearl diving in Dubai, a traditional practice that people by the sea side used to make a living from. Looking down to the metro stations from high-rise buildings, the stations and lines imply the look of a string of pearls that is extended along the urban fabric of Dubai.

This concept is also strengthened by the interiors aesthetics which imply the smooth prestigious look inspired from pearls.

The design team did not merely focus on the iconic representation, but also developed a design that responds to Dubai's weather and environmental aspects. The shell design of most elevated depots provides a high insulation from the hot sun radiations. The double shell design provides a smart cooling system that is energy efficient. Moreover, the use of louvers, overhangs, and high performance glazing are oriented to allow controlled natural light into the interior minimizing the solar gains.

The structure of the shell is considered a manifestation in responding to the inhabited function. The shape allowed a long span structure which in turn creates a large open space that is needed for a smooth movement for the metro.

3.1. The Design Process

The client provided a brief to develop an iconic metro station that responds to the Emarati culture especially in Dubai. The team considered this while they started researching prior to the conceptual design phase. Their research investigated Dubai's traditions, Dubai's climate, and previous successful metro stations. They looked through related projects they designed in Hong Kong, Singapore, and UK. Then they started the design process firstly by identifying a clear frame work and roles of different participants. They set up the architectural project team in Singapore to design all stations whilst Birmingham team designs the depots and London team provides three dimensional computational modeling support. Dubai's office focused more on dealing directly with the client and providing support for the global team. Moreover, they hired other sub-consultants for engineering and interior design consultation. Together, they developed a conceptual design that exceeded the client's demand and expectations. In addition to the iconic representation, the concept worked well with the function, and the extreme climate of Dubai. After the client approved for the conceptual phase, the team commenced working on the schematic design phase. During this phase and until the detailed design phase, all project participants used a software program which worked as a hub for all project information and documents. The software helped organizing and maintaining the information flow and team interactions throughout the project's life.

Towards the final stages of design, the team faced some complexities especially with the paneling system of the shell structure. However, the research and development team in London with their expertise in parametric design could figure out a paneling system that suits the project and its requirements. Finally, the team organized everything together to submit the design to the client, who in turn selected the contractors for implementation.

3.2. Discussion
This section will discuss the case study based on the conceptual model introduced earlier.

3.2.1. Preparing For Innovation

The awarded firm maintained a *culture* that is conductive for innovation. They have a strong base for R&D which later had a positive influence in the project outcomes. Moreover, all project teams have access to the company's archive which encompasses a great deal of knowledge and information from previous projects. Usually, archived projects are used as a reference in the beginning of each project the company begins working on. This agrees with the findings from Ahmed (1998) of innovation culture and climate. However, the firm has a clear chain of command that is also enabled during the design process. When it comes to managing people, the firm seems to focus on the design leaders and directors more than other designers from different ranks. Most design ideas are generated from these leaders, and then are supported by junior staff skills which make it rare for ideas to emerge from lower ranks designers. Only

senior designers are allowed to experiment new ideas during design processes. Although this may hinder the opportunity of investing junior staff efforts in the idea generation, it helps in maintaining a healthy flow of ideas and avoids chaos.

According to Caerteling et al (2006) a strong *management for innovation* should be capable of managing attention to evolving client needs, managing ideas to good currency, managing relationships, and leading and supporting project teams. The management in the studied design organization proved its capability in exceeding the clients' needs through several projects. The firm realizes the contextual impact of their design products, an impact that cannot be addressed or anticipated by their clients, and design accordingly. In managing relations, the office environment encourages open interactions and conversation to happen amongst all design teams from different projects regardless their ranks and positions. All employees from different ranks share the same office space which allows exchanging knowledge and ideas, keep healthy relations and remove job hygiene factors including office politics.

3.2.2. Igniting Innovation

Manley (2006) argued that the *client's* demand is a major trigger for innovation. In this project, the client's brief imposed a challenging task asking for an iconic design that implies a metaphor from Dubai's traditions. The client at the early phases of the design concept was involved mostly in project idea initiation and evaluation. The design team did not simply satisfy what the client requested. They went beyond it to explore opportunities of designing the metro stations for most possible efficient function of the stations in Dubai's context. That agrees with the findings from Ulwick (2002) who presented the concept of filtering the client's needs according to the job performed by the end product.

The project did not witness any emergence of *innovation champions*. Instead, the formal design leaders of the project were the champions in exploring the opportunities in this project. The firm delegated this design project to the project director and the design director to commence working on this project, who in turn could develop the opportunities in this project. Bailetti and Guild (1991) defined innovation champions as opportunity explorers.

The design leaders with the organization's management had a major role in developing *relations* with strong sub-consultants who could assist in leading the project to the final innovative solution. Manley (2006) concluded that developing relations with strong partners is a major construct in developing cutting edge solutions. However, their organization of the design team, including the global sub-consultants, resulted in developing a large collaborating team which caused chaos in the design team. With the knowledgeable leadership, they could overcome this chaos and use it to the project's advantage. They specified the role of each collaborating team to form a consensus frame work that works for all.

Knowledge was a strong trigger for innovation in this project as mentioned earlier in the design process. The team could utilize previous company's knowledge in creating the design concept. Moreover, the existing global networking within the team helped in defusing design ideas by exchanging knowledge. Swan et al (1999) indicated the significance of networking in defusing ideas by sharing knowledge.

Technology had a major role here in defusing the design idea. The experimentation with different digital design tools helped in discovering different possibilities of the design concept. Further, they could establish initial visualization of the design concept using CAD technology. Further, the use of a software as a central platform, where all groups can communicate knowledge and project information through, helped in creating a smoother collaboration between the globally operating networks within the design team.

3.2.3. Maintaining Innovation

In this phase the design team *leaders* could maintain the initial concept and drive it to realistic outcomes through handling the client, maintaining interactions with all sub-consultants, managing information, and using technology in optimising the final result.

To begin with, the *client's* role in this project was clearly defined in the agreement between them and the design firm. That helped in avoiding problems emerging from role ambiguity.

As mentioned earlier, the design team was composed of groups operating from different offices around the world. The firm realized that the size of the team and its global dissemination may impose the threat of causing chaotic *interactions* and loss of *information*. For that reason, the team deployed a *technology* tool to maintain interactions by virtual means. They used a software program that provided a medium for communication and information sharing. The software provided a central hub for all project's information and documents created by the different participants within the design team. These information were accessible by all design team members.

Technology was not only used to maintain interactions and information flow, but also to deliver a design that is ready for implementation. The complex form generated during the conceptual phase required the use of technology to optimize it to an achievable result. Using parametric design tools, the advanced modelling group could figure out the structure, the configuration of parts and the panelling system for the exterior shell. The complex form of the metro stations would not be possible for implementation if those tools were not used.

3.2.4. Implementation

The role of the design team ends here with the submission of detailed construction documents for implementation. The project now is finished with all design phases, and implemented accordingly. The client was the leader here in giving their final decision for selecting a contractor. Now, majority of the project is implemented and functioning.

4. CONCLUSION

It can be concluded that innovation in design projects is a result of a systematic process that is built on the foundation of innovation culture & climate, and influenced by several factors during its different phases.

The innovation process begins only when the organization allows a conductive culture and climate for innovation. Through the analyzed case study and the conceptual model, it can be concluded that enhancing employees' knowledge and maintaining healthy relations were the most valuable constructs for innovation culture. Senior leadership and management roles here should provide the necessary support for such culture through enhancing knowledge base, providing a work environment that allows open communication between different employees, and strengthen employees' relations.

The different phases of the innovation process are subject to influence by several factors. In defusing innovation phase, the case study placed more significance for the client, team collaboration, and knowledge roles. The project started with a challenging client's demand which became the quest for the design team to innovate around it. Moreover, his collaboration and discussions with the design team creates a clearer picture for the team and brings more ideas to the team. Team collaboration plays a major role in sharing knowledge, ideas, and skills to come up with a new idea. In maintaining innovation phase, the client interaction, team collaboration, project information flow, and use of technology have major roles. It was evident from the discussed project that they have a significant influence in driving the design idea to its end result.

It should be noted here that leaders have the most significant role in keeping constant tabs on these issues and utilize them to achieve innovation.

ACKNOWLEDGMENTS

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