Understanding The Innovation Process in Design Projects

فهم منهجية الابداع في مشاريع التصميم

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Dissertation submitted in partial fulfilment of
MSc in Project Management

Faculty of business

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July 2011

Abstract

This study is an attempt to investigate the issues that influence innovation in design projects related to the construction industry. Thus, it focused on the early phases of design projects which usually begins by a client's request and ends with detailed drawings or construction documents. During this phase, teams usually work in a systemized process that takes the design concept from one phase to the next one until it solidifies and becomes ready for implementation. In order to achieve an innovative design, project teams should be provided with the right work environment. Hence, the establishment of innovation culture throughout an organization is important to encourage innovation in project teams operating in the organization. After that, when a project begins, other issues emerge to play major roles in triggering innovation in the project team. The study began by exploring these factors in the form of a literature review. Then formed a conceptual model that links these factors with the design process to formalize an understanding of 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 real projects. The findings revealed that the organization culture plays a major role in preparing project teams for innovation. A conductive culture for innovation requires the management support through investing in expanding the company's knowledge base, enhancing employees relations, and maintaining an enthusiastic atmosphere for innovation. After that, the role of the client, knowledge, team's collaboration, and technology take effect on 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. Throughout the design process, project leaders should pay attention to these issues in order to achieve innovation in design projects.

الملخص

تقدّم الاطروحة دراسة مفصلة للعوامل المؤثرة على ابداع فرق العمل في مشاريع التصميم ضمن قطاع البناء والتشيد. لذلك اهتمت الدراسه بالمراحل الاولى من مشاريع التصميم ابتداءا من طلب العميل وانتهاءا بالرسومات التفصيلية ووثائق البناء. يعمل فرق العمل عادة ضمن عملية منهجية حيث تؤخذ الفكرة الأساسية ضمن مراحل متعددة يتوضّح فيها معالمها لتصبح جاهزة للبناء.

قدرة الفريق على الابداع تبدأ بتهيئة الجو المناسب لهم في مكان العمل، و هنا تكمن اهمية بناء اسس قوية لثقافة الابداع في انحاء المنظمة التي يعمل ضمنها فريق التصميم. من هنا ينطلق الابداع عند بدء الفريق بالتصميم متأثّرا بعدّة عوامل تطرأ خلال مراحل التصميم المتعدّدة و تلعب ادوارا في تحفيز الابداع.

بدأت الأطروحة بدراسة مراجع متعدّدة حول العوامل المؤثرة على الابداع لتكوين نموذج مفاهيمي يربط هذه العوامل بمراحل التصميم لفهم مراحل منهجية الابداع في مشاريع التصميم والعوامل المؤثرة عليها. كما تضمّنت الاطروحة ايضا تطبيقا لهذا النموذج على مشاريع تصميم واقعية لتكوين مفهوم افضل.

اظهرت نتائج البحث أهميّة ثقافة المنظّمة في تجهيز فرق العمل للابداع حيث تقوم المنظّمة بتوفير الدعم الاداري عن طريق تنمية معرفة العاملين لديها و توسيع قاعدة المعلومات لهم، و تحسين العلاقات فيما بينهم، و المحافظة على جو حماسي للابداع في مكان العمل. يأتي بعد ذلك دور العميل، و تعاون فرق العمل و معرفتهم، و دور التكنولوجيا الرقمية ليلعبوا ادوارا هامة في تحفيز الابداع والمحافظة عليه. تثار شعلة الابداع بطلب العميل و تفاعله مع فريق العمل في بداية المشروع متبعا بالتفاعل العملي والمعلوماتي بين فرق العمل داخل و خارج المنظّمة الى ان يتم تكوين لبنة الفكرة الاساسية للمشروع. وللمحافظة على استمرارية و تطوّر الابداع في الفكرة المبتكرة لا بد من الحفاظ على علاقات متينة بين أعضاء فريق العمل، وتوظيف التكنولوجيا الرقمية كوسيلة لتشارك معلومات المشروع و لتطوير الرسومات التفصيلية. كما نوّهت النتائج ايضا الدور الاساسي الذي يقوم به قادة المشاريع في تحفيز الابداع والمحافظة على استمراريته خلال مراحل التصميم المختلفة عن طريق توظيف خبراتهم في دفع عجلة الابداع للوصول الى النتيجة المرغوبة.

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Chapter 1: Introduction

This Chapter introduces the topic of innovation and its significance in design practices. Then it presents a background on the topic, the need for the dissertation and its aims and objectives.

1.1. Overview

"Just as energy is the basis of life itself, and ideas the source of innovation, so is innovation the vital spark of all human change, improvement and progress." Ted Levitt

Indeed, where we live, and what we use in our daily basis is a result of innovation. Therefore, Innovation is everywhere .The word innovation encompasses in its meaning the introduction of new ideas. Hence, it is widely used in different business aspects from different industries. Its significance rises when firms from same industries compete to provide the best services or products suitable for the market. "The only source of profit, the only reason to invest in companies in the future is their ability to innovate and their ability to differentiate." Jeffery Immelt, CEO of General Electric (Adams et al, 2006). The famous Google's distinguishing success among its peers in the industry is heavily dependent on its innovation management providing the suitable culture for innovation and encouraging employees from all levels to introduce new ideas. The offices of TBWA/Raad in Dubai exhibits strong belief in creativity and innovation which made them earn the name "the 2010 Dubai Lynx Advertiser of the Year" for their contributions in the advertising and communication industry (Badih, 2010). There are several other examples from different business sectors where innovation was the road to success. Different industries need innovation since it is the main ingredient for success and the architecture industry is one of them.

Architecture is the art and science of designing erecting buildings and other physical structures. The art and science domains branch out to other dimensions that architects tend to consider while designing ,such as physical context, social context, aesthetics, materials, and rules of physics. Those different dimensions of architecture make us realize the flexibility and the vast room available for innovation to exist. Indeed, history provided evidences through the physical architectural manifestations of how innovation drove changes in the industry, since Architecture is one of the oldest professions for mankind and it has been through many changes resulting in the production of different architectural styles and design approaches. For instance , Ancient

Egyptians believes in divine and immortality were the main influence in their architecture encouraging them to design mega pyramids pointed to the sky resembling the divine power of their Pharos. Roman architecture on the other hand, introduced the construction of large dome structures using new structural design techniques and leading the industry to a new revolution, the concrete revolution. Modernism witnessed the use of reinforced concrete and the use of skeletal structure. At each point of time in history, a change in architecture was a response of social conditions and people's needs and believes. However, this response varies accordingly with the development of knowledge and tools for architecture (Stokstad, 2004).

The development in materials, design tools and knowledge played a main role in the design process and its final product. For instance, the introduction of steel and concrete allowed architects to explore the opportunities of designing long span structures and large vaulted spaces. Moreover, it allowed building high rises more possible. It is evident from history that innovation in architecture was influenced by multiple factors. However, they were not the only ingredients for innovation. Other factors within design teams and individuals also had an influence on innovation.

Innovation in architecture is also subject to designers' emotions and believes which are also considered as major factors that affect innovation. History provided evidence of innovative achievements by individual architects and groups who were motivated by their passion and philosophies in architecture. For instance, Antoni Gaudi, pioneer of Catalan style, introduced new methods in design based on his understandings and believes. His passion in architecture was the major driver for his achievements. Unlike other architects at his time, he was inspired by the curvilinear shapes and geometries observed in nature. As a result, the design language he introduced through his work reflected the forms, geometries and structures that he analyzed from nature (FitzGerald, 2005). Another example of innovative architects is the group known as Ant Farm. Ant Farm was a group of radical architects who were visionaries and cultural commentators. The group was founded in 1968 with the determination of working outside traditional architecture by experimenting with new ideas. This determination driven by their believes and combined with their skills led them to successful accomplishments in design (Lwallen & Seid, 2004).

1.2. Background

The Architecture industry has been through many changes and still developing until now. Although the rate of progress is relatively slow compared to other industries, change is mainly attributed to the competition amongst architecture firms. Being that construction is the valuable final product for construction clients and what affects the firm's reputation, leaders in the industry always thrive to achieve the most efficient and innovative solutions in their designs. 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.

Several consultants believe that deploying skilled innovative designers for a project is what makes them achieve innovation. However, innovators are always subject to organizational conditions and environment. Provoking innovation in a project team requires the management support to stimulate innovation in the team. They should identify what encourages innovation and what hinders it at the different phases of the project. Moreover, they should be sensitive towards projects' participants from different disciplines and their behaviors.

Factors influencing project innovation can be divided into two main categories, which are organizational factors and dynamic factors during the design process. Organizational factors include the conditions and environment where project teams operate. On the other hand, dynamic factors are the influential issues within the project team which possibly include communication,

flow of information, and participants' behaviors and emotions. A successful management should know how to use these issues to encourage innovation in a project.

1.3. Problem statement

There are several researches done about innovation examining the factors that influence it in organizations. However, since the attention was mostly focused on the larger picture, which is innovation in organizations, 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.

1.4. Aim of the Dissertation

The dissertation aims to enhance deploying innovation in architecture projects, specifically in project teams during the design phase. This will be achieved by identifying the major factors that influence innovation in projects during the design process.

1.5. Research objectives

1. Investigate the dynamics of innovation in design practices.
2. Identify the convenient organizational conditions for design team innovation.
3. Identify the major influential dynamic factors that may impede or enhance design team innovation during the design process.

1.6. Research questions

Q1. What are the organizational conditions that set up the convenient atmosphere for innovation in design teams?

Q2. What are the major dynamic factors that affect innovation during the design process?

Chapter 2: Literature review

This chapter discusses literature published on the subject of innovation management. It begins by providing different definitions of innovation and annotating its significance in different businesses including the construction industry. Then it discusses constructs of innovation in organizations. After that, comes two major parts where one discusses the organizational conditions that should be available for project teams to innovate, and the other part discusses dynamic factors that affect innovation during the innovation process. At the end of this chapter, the findings are concluded in a conceptual model.

2.1. Innovation definitions and significance

Although most professionals agree that innovation has to do with the introduction of new ideas and new ways of thinking, there is no consensus definition for innovation in different businesses. How innovation is viewed and defined depends on the perspective that it is looked through. According to Barrett & Sexton (2006) "practitioners view innovation as needing to be action-orientated and delivering overall performance improvement". On the other hand, Tang (1998) described innovation as a process, which is complex in its nature due to the several influential factors and different stakeholders' views that affect the process, of applying new ideas to reach a gainful purpose. Similarly, Brennan and Dooley (2005) defined innovation as the ability to break free from usual processes and think beyond limits to generate new ideas or use existing ideas into new concepts to achieve a certain goal. Hargadon & Sutton (2000) had a similar concept of innovation, but added the concept of overlapping new ideas from different industries. They argued that Innovation is to utilize raw knowledge and ideas from a context and apply them through a process in a different context to solve a problem or introduce new ideas. Bettencourt and Ulwick (2008) viewed innovation from the client perspective. Their aim was delivering efficiency in the job performed by the client using the innovative product or idea. They defined innovation as developing new tool, product, or process in order to enable efficiency in the job performed by the client.

Innovation in different industries is considered a significant ingredient for success whether this innovation is in introducing new ideas, processes or ways of thinking. Brennan &

Dooley (2005) identified the need for firms to continuously innovate in a highly dynamic global environment to stay competitive in the face of rapidly changing technology and markets. Among the pressures being faced are those for reduced prices of products and services while maintaining or improving quality, adopting customer-centricism, as well as increasing productivity and at the same time being innovative. For the most part, the paper states, measures put in place by companies tend to address most of the afore-stated concerns, save for the last one, innovation. This is despite the fact that innovation processes can be a catalyst to addressing all the other issues, from harnessing ideas for innovation from customers, to increasing efficiency in operations, to improving product quality and creating new products that are more competitive.

Erbil & Arkinciturk (2010) attributed the need by construction industry firms to be innovative to the increasing competitive nature of the market and the dynamism of the global economy. Firms are finding themselves in need to differentiate from the competition in terms of quality, cost effectiveness, pre- and after-sales, and speed. The thing that enables such differentiation is innovation. Using the Turkish construction industry as a case study, Erbila & Arkinciturk showed not only how construction is tied in with hundreds of other industries, but also how it is seen as static as regards innovation. This static nature is likely the result of the stationery and durable nature of construction industry products, which render the costs of testing new innovations prohibitive and at times impractical, especially given the attendant risk of failure.

Capozzi M.M & Simpson J (2006) introduce Alberto Alessi, who heads a family design firm, which goes by the name Alessi. The firm is renowned for its innovativeness, and is among the first to have adopted Open Innovation strategies. In this article, the authors sought to establish how Alessi sources for good designs and assesses their potential, and why more companies should risk investing in design. Alessi adopts a two-pronged approach to sourcing for designs; it could come up with a concept in-house then float it by its designers to gauge their interest and reactions. Alternatively, any designer who suddenly comes up with an idea they believe is worthwhile can float it by the company for adoption.

Caerteling, Hartmann and Tijhuis (2006) stated the fact that the importance of innovation in construction is raising as it is becoming a key competence in the construction industry. However, they posited that innovation in the construction industry has hitherto focused on the

implementation phase of the innovation process, with less equitable attention being paid to the earlier, equally important phases of design.

2.2 . Innovation constructs

According to Tang (1998), the most important constructs of innovation are *information and communication, knowledge and skills, behavior and integration, project raising and doing, guidance and support,* and *external environment.* Those enablers should be inherent in the organization's culture in order to encourage innovation. At the operational level, "when an electronic company's circuit designers know what the casing designers are doing, they design a better fitting circuit for the casing. Such flows of information allows for experimentation and innovation" (Eppinger, 2001). At the personnel level, behaviors, skills and knowledge , significantly influence innovation culture. Knowledge and skills can be improved through training and learning. However, the behavior of employees is usually influenced by organization's culture. To support innovation, an organization should understand the significance of keeping their employees motivated by eliminating any source threatening their self esteems and enthusiastically lead them to achieve innovation.

Brennan & Dooley (2005) provided evidence of seven groups of strong influential factors on innovation. The seven groupings included *knowledge management, conceptual frameworks, personality, motivation, organizational environment, training and education and learning styles*. *Knowledge management* is to support new knowledge and maintain a sustainable knowledge and information sharing platform. Indeed, Knowledge is considered a major construct for innovation, and there for it needs to be managed to serve its purpose in triggering innovation (Udeaja et al,2006; Tuncer et al,2006; Walker et al, 2006). The idea of developing a *conceptual framework* is to create a universal understanding of problems and solutions in a project team. The *personality* factor includes the behavior of innovative individuals and their intellectual capabilities. *Motivation* indicated that the degree of personnel's satisfaction affects their willingness to innovate. In order to provoke innovation, the *organizational environment* should provide the foundation for innovation. Moreover, the organization should induce an education and training systems considering their employees learning styles in order to develop the necessary skills and knowledge for innovation.

Manley (2006) identified the triggers and barriers to innovation in construction, based on an extensive survey of 400 Australian construction firms. He found that innovation is often driven by *clients' actions and emergent problems* in a project's lifecycle and harnessed by *managing the relationships* amongst the different stakeholders and related businesses. On the same context, Johnsen et al (2006) concluded that the customer- supplier *relations and interaction* is a major factor in shaping innovation.

Barrett P & Sexton (2006) also argued the significant impact of multidisciplinary interactions. They pointed out that an organization should enact a supportive *interaction environment* aiming for innovation. This is achieved through the integration of the organization's business strategy, organizational structure, technology and people with a management model for innovation.

In order to organize these several innovation constructs in relation to design projects, the following sections of the literature will discuss the convenient organizational conditions for innovation and the dynamic constructs for innovation that emerge and evolve during the design process.

2.3. Organizational conditions

This part of the literature discusses the organizational conditions that prepare a suitable environment for innovation. It is divided into three parts which consist of the organizational culture and climate, management, and leadership. The first part explains the ripe culture and climate for innovation. The second part explains the management role in supporting innovation. The third part presents how leadership can affect innovation in organizations. Finally, The part ends with a conclusion.

2.3.1. Organization culture and climate

Ahmed's (1998) principal point is that becoming innovative and creative happens only if the organizational culture allows it. From this position, he explored the factors that make up an encouraging culture for innovation. For a start, innovation is often shunned in practice by the inherent risk, making them averse to making investments in R&D and creating a culture with a risk appetite, where members strive for innovation. Innovation in turn, is holistic in nature, in that it covers the whole value chain, and occurs in three often concurrent phases. The first phase is the idea generation phase, commonly referred to as the fuzzy front end where lots of ideas fail to take off owing to feasibility issues or incompatibility with strategic objectives. The second stage is more methodical, where ideas are taken through a screening process often in the form of some stage-gate system. The aim of this stage is to align the idea with the company's strategy, objectives and resources. Some ideas may also be dropped at this stage. Finally, the product is commercialized in the final stage. An advantageous culture for such a process to thrive should be tailor-made following diagnostic examination of the specific organization's context. In any case, the leadership is critical to create the appropriate climate, which reflects the environment shaped by the organization's practices on daily basis. Employees perceive the organization's climate through four dimensions. First is the evaluation of interpersonal relationships through the exhibited mutual trust and support, inclusion of newcomers, and feeling of worth. Next is the nature of hierarchy imposed by the organization's structure which is perceived through the demonstrated authority and decision-making. Third is the nature of the work whether it is challenging or boring, flexible or rigid. The final dimension is the level of focus on support and rewards (intrinsic vs. extrinsic motivators, compensation and reward factors).

The intensity of this conclusion on its part hinges on two factors. The two factors are the pervasiveness of the norms and conduct, and the "match between the implicit and explicit aspects of culture", which together determine how crystallized the culture becomes. He highlighted innovative companies like 3M and IBM, where a culture of innovation is ingrained in people. However, He warned against the mistake Apple made in the 1980s of investing in R&D but not on developing the right culture.

Schulte et al (2010) found that service firms whose culture tolerates risk-taking and experimentation along with clearly defined innovation process had greater success at innovation,

with corresponding growth rates in revenues and larger percentages of total revenues attributable to new services. To facilitate the collaboration effort with employees, motivational techniques could be used that transcend incentives. That is further supported by Tang (1998) explaining that employees behavior towards innovation is affected by the organization's culture role in supporting and motivating such innovations to exist.

Some factors from the organization's culture have a great influence in motivating individuals to innovate. Halepota (2005) discussed different motivational theories including Maslow's hierarchy of needs and the Herzberg's theory. Abraham H. Maslow, chairman of the department of psychology at Brandies University, claimed that a person's needs are the main motivator that drives a human. He categorized the needs in five levels. The five categories in order are physiological needs, safety needs, social needs, self-esteem needs, and self-actualization needs. According to Halepota (2005), for a person, the physiological or basic needs are provided by the salary, health insurance, and other benefits. Safety needs include job security. Social needs at work are in establishing relationships with colleagues, team work and other activities. The self-esteem needs include positive feedback and opportunities for advancement. Finally, Self-actualization needs include creating challenging tasks that are stimulating. Organization's culture and climate should allow most employees to reach the highest level of self actualization in order to promote self-motivated individuals who strive to work on challenging tasks and come up with new ideas. The Herzberg's theory of motivation extends from the basic theory of Maslow's hierarchy, and defines motivating factors as job enrichments and demotivation as job hygiene. Job enrichment factors include achievement, recognition, responsibility, freedom, and advancement opportunities. On the contrary, hygiene factors indicate work conditions, policies, administrative efficiency, style of supervision, and relationship between employees. Hence, an innovation culture should inherent these values to encourage innovation and avoid all kinds of demotivating factors.

According to Harkink and Tijhuis (2006), the organizational hierarchy and command chain of a company influences its culture for innovation. They drew a comparison between two Dutch construction companies (A and B), which are considered above average innovators, in a bid to uncover how company's structure and philosophy can impact the innovation processes. It began by noting that the Dutch construction industry is 'conservative', meaning that innovation is slow and predictable. Firms aim at efficiency and risk minimization, which when coupled with

the laborious construction process, has resulted in a decline in value added from construction as a proportion of the Dutch GDP over the preceding 25 years. From the study of the two companies, it found that company A was centrally organized, with top-down instructions aimed at ensuring efficiency. Roles were clear cut, and appraisals were strictly on performance of assigned tasks. Company B on the other hand is informally organized, with decentralized authority and overlapping responsibilities between personnel. As a result, mutual trust is the common glue in B, and workers are fully involved in what they are doing. These different approaches, the approaches of company A and B, have led to different development and innovation patterns. For company A, innovation and production processes are mutually exclusive, leading to increased specialized knowledge. In the contrary, company B's approach has created a dynamic and innovation oriented culture company wide. The paper concluded that cultural development at the operations level is critical for the success of innovation, and that the differences in the organizational structures, as reflected in companies A and B, work to restrict communication, which is essential to implementation of new ideas and knowledge.

2.3.2. Management for innovation

It is one of the management roles to provide the support for innovation in its projects. Tang (1998) argued that with the presence of all constructs for innovation in a team or an organization, innovation cannot succeed unless it is supported by the right guidance. The management entity for an organization sets the rules and boundaries, which act as guidance for project teams, through its philosophy, and management style. Hence, a rigid management with inflexible structure and work methodology may hinder innovation in an organization. Moreover, the management should pay attention to all factors that affect innovation in the organization.

Caerteling, Hartmann and Tijhuis (2006) presented analysis of two case studies considering four central problems in innovation management borrowed from Van de Ven (1986);

1. Managing attention: keeping constant tabs on the evolving environment and customer sentiments/demands, particularly from the most demanding customers. This seems to be lacking in construction, as firms tend to simply take on instructions from clients without prodding deeper to understand their desired outcomes.

2. Managing Ideas into Good Currency: has to do with implementing and systemizing ideas. The construction industry is relatively good at this.

3. Managing part-whole relationships: involving multiple personalities, specialists and partners. This is an achilles' heel in construction, as partnerships on projects seem to be 'temporary coalitions of changing partners'.

4. Leadership: Senior management and clients are identified as leaders with clients holding more power to influence projects' outcomes.

Results from the study pointed out the significance of the four factors and how it affected the analyzed projects indicating that leadership and managing relations are the biggest problems in projects.

For innovation, the organization management should show readiness to change and flexibility to adapt the changing market demands, the industry developments, and new ideas developed by internal empowered employees or external entities. For organizations which undergo weakness in innovation, introducing change is vital to achieve innovation. John Kotter's (2007) landmark article in the Harvard Business Review outlined a time-tested model for organizational transformation, in the form of an eight-step process. The first is Creating a Sense of Urgency, where the realities of the market and of competition are examined, usually resulting in discussion over current and impending crises and opportunities. The second step involves the creation of a Powerful Guiding Coalition, which basically requires that a critical mass of change champions be combined into a cohesive team. The third step is the Creation of a Vision since the guiding coalition is required to lead the effort of creating a picture of where the organization would like to be by the time the transformation initiative is done. At this point also, relevant strategies for achieving the vision are formulated. The fourth step involves Communicating the Vision, where every channel of communication is used to preach the message of the new vision to the rest of the workforce. At this stage, it is often necessary to isolate those elements that are unwilling to change and coach them specially, to gain their buy-in. The fifth step requires that the workforce be empowered to act on the vision, and this would take the form of rigorous training, coupled with provision of adequate resources and tools necessary to carry out the transformation. At this stage, risk is encouraged, and systems and structures that compromise the vision are eliminated. The sixth step is the Creation of Short-term Wins, which is critical to

boosting the morale of the entire workforce for the duration of the implementation process. It includes recognition and rewards for workers who play a part in achieving those wins. The seventh step is to "Consolidate Improvements and Generate Still More Change", which basically leverages the goodwill created by the successes thus far to change more systems and processes that do not agree with the vision. Finally, Institutionalizing new Approaches, the eighth step, puts in place systems that cement in place the new behaviors generated from the transformation process, as well as a sound plan for the development of future leaders and for their succession.

Prosci (2008) offered an Ashland Inc., FORTUNE 500 diversified chemical company providing innovative products, case study in change management, which is critical for organizations looking to develop an innovative culture. Ashland was experiencing deep inefficiencies in its operations and declining revenues as of 2002. A number of spin-offs of its subsidiaries had gone wrong, and an ERP implementation program at one of its lines of business had resulted in near disaster. By then, senior management knew that the company had to either change or perish. The case study offered insight into the turn-around that has seen the company become efficient and innovative. The case study identified a number of factors that proved critical for the success of the turn-around. The first is the buy-in from the top leadership, especially the CEO and/or chairman/president of the company. It explained how introduction of change management had been attempted gradually, but how the same had struggled for lack of top sponsorship. Fortunes changed when the president appointed a unit head to lead the change management initiatives, and personally took up the people side of it, even attending relevant classes, thus conveying the message that no one was exempt. Another contributing factor was the identification of champions across the organization, who would lead the efforts at the local level. The essence of the initiative was in the extensive training which every employee involved in a new or an on-going project was mandated to attend. By ensuring that only employees involved in projects attended, it guaranteed that whatever was learned was implemented practically, so that change management and project management were integrated into one. The significance of this case study is that while many articles simply state that the organizational culture is central to its ability to innovate, this article gives a step-by-step breakdown of such a change in culture occurred in a real organization. What is remarkable is how perfectly the steps concur with Kotter's eight-step organizational change model, bearing testimony to the theory's practicability.

2.3.3. Leadership

Another factor that affects innovation is leadership. Mumford and Licuanan (2004) found out that leadership influences the collaboration and interactions of team members along with the innovation process. However, leadership itself is affected by some conditions which may in fact lessen the leader's effectiveness towards innovation. These factors include followers' creativity, work process clarity, leader's authority, job complexity and organization's climate and structure. On the other hand, a leader should obtain the expertise and the ability to think creatively so that his/her evaluation of followers' ideas contributes positively to the final concept. Leaders play a major role in motivating employees through leading by example or motivating by contingent reward system. At this point, the leader's personality becomes critical in developing tactics to stimulate innovation from the team.

The most common types of leadership in organizations are transformational and transactional leaderships. Although the two styles are different in terms of what leaders and followers offer to each other, they are highly related (Judge and Piccolo, 2004).

Transactional leadership leans more towards leading by reward and punishment. This requires a strong character that can enforce work standards and reward followers according to their performance. On the other hand, transformational leaders' approach is usually to lead by example and influencing others to take initiatives by inspiring end empowering their followers. Empowering staff means to respect them, treat them equally, mentor them to think analytically, inspire them to perform, communicate the organization's vision & project goals, and be emotionally sensitive towards their needs (Jogulu & Wood, 2007). A study conducted by Chen (2004) revealed that transformational leadership is positively related to job satisfaction and performance. Furthermore, Sarros, Gary and Densten (2002) found that transformational leadership is a more encouraging in leading people and organizations than transactional leadership.

Kuo (2004) concluded that each style has a unique impact on teams. Leading by fair contingent reward system have a positive impact on team performance and effectiveness. However, he also concluded that transformational leadership has more positive influence on teams' performance.

Many practicing organizational behavior experts argued that an effective leader is the one who utilizes both leadership styles to reach the organization's goals (Jogulu & Wood, 2007). The

ability of leaders to influence their teams relies on their social power. The foundation of power a leader poses and influence tactics a leader uses are built upon six bases: "information, reward, coercion, legitimacy, expertise, and reference" (Lyons, 2007). Lyons further explained how leaders' actions and intentions to influence can be perceived and interpreted by employees. Hence, a leader should develop sensitivity to these issues and know how to make use of different tactics depending on the available circumstances when projecting his/her intentions to employees. This is further supported by Found & Harvey (2007) who argued that a leader should encourage fluid network relations and interactions to imply and promote a flatter hierarchy.

2.4. Design process and innovation

This part of the literature discusses factors that have an influence on innovation during the innovation process. It begins by explaining how the design process shares similarities with the innovation process. Later it explains factors affecting innovation during the dynamics of innovation process. The discussed factors include role of the client, innovation champions, relations & interactions, knowledge & information, and the role of technology.

2.4.1. The design process

Alberto Alessi, a head of house-ware design factory, explained the innovative design process in his firm by comparing his firm with a car company. He elaborated that when a car company wants to design a new car, the design process begins with the market research to understand the consumers' needs. Collectively, they investigate the current existing designs to identify their successful aspects. Subsequently, all identified successful elements of the investigated designs are put together to formulate the recipe for a new design, which then is further developed by the car designers to come up with the final design. (Capozzi & Simpson, 2009)

This process of creating a design idea shows a lot of similarities to the innovation process proposed by Hargadon and Sutton (2000). The first step, after establishing the need and vaguely deciding what is wanted by the end of the process, is gathering old ideas from different places. These ideas are then researched through experiments and obtained knowledge. The third step is

for the team to think of a new function of the old ideas and develop a scheme to be finally tested for commercial value.

The engineering design process in general also shares similarities with the innovation process. The process usually starts with establishing a need, which is usually identified by the client's request or market demand. This demand is then rigorously analyzed and researched to develop the complementary conceptual framework for the conceptual design phase. In the conceptual design phase, the team collaborates and starts generating different ideas until they formalize the design concept. After that is the stage of embodiment design where the concept begins to solidify and show features which later are fixed in the detailed design phase. In the detailed design phase, the team adds their final touches and revise the final design before implementation. Howard, Culley and Dekoninck (2008) realized this similarity between these two processes. Indeed, they provided an in depth study comparing the engineering design process with the creative process from cognitive psychology.

2.4.2. Handling the clients

Evidence from different sources of the literature argued that innovation is usually driven by clients' demands and actions, being that the client is the one who usually requests for the specific service or product. Moreover, customer's interaction is considered a major influence on innovation. (Cheung & To, 2010; Johnsen et al, 2006; Manley, 2006; Szajnfarber et al, 2010)

Schulte et al (2010) researched 102 innovation managers in the services industry in Germany, with emphasis on the potential for involvement of employees and customers in the innovation cycle, and what this could mean for organizations and researchers. They reiterated the importance of customers as sources of information for innovation, but then posited that with collaborative innovation approaches, the need for traditional R&D systems fades. In their interviews and surveys of the managers, the authors found that the most valued elements of the collaborative process were the 'idea evaluation' and 'service concept and investment decision' phases. Ironically, in services, these are the phases with the least customer input, largely owing to concerns over confidentiality and the attendant costs of customer involvement in the process.

Enkel, Kausch and Gassman (2005) offered methods for how these and other risks of integrating customers into the innovation process can be managed. The first risk identified is the

type of customer integrated in the innovation process. This measures the trustworthiness of a customer, where a customer can be trusted in not disclosing or sharing the company's ideas and work methodology with other competitors, neither claims the ownership of ideas generated by the organization. Hence, careful selection of a customer is important to avoid the risk of "loss of know how". Secondly, customer's personality plays a major role in the innovation process. A customer should understand the cultural norms of the organization especially the micro culture of the project team where she/he is involved in. Thirdly, to avoid any conflicts and demotivating factors imposed by the customer in the innovation process, customer's role should be identified clearly and integrated with the appropriate method. Moreover, the team should identify the phases where customer's contribution is valuable. Finally, the organization should maintain a solid relationship with these selected customers whose inputs are constructive to the organization's innovation.

Ulwick (2002) also focused on the input of customers into the innovation process, but sought to introduce a paradigm shift to the usual approach. Oftentimes, the article stated that companies go out during market research to ask the customer what she/he wants, and the customer would usually respond by describing the product she/he envisions. The R&D team then gets to work to produce the product the customer had described. Most of the time, when the product hits the market, the reception is poor disappointing the organization. Ulwick proposed that rather than seeking a description of the product the customer wants, they should instead seek to establish what outcomes they are trying to achieve. In other words, find out what result or improvement in results they wish for. With the desired outcome clear on the R&D team's mind, it can then apply its expertise to finding an appropriate solution. In applying this outcome approach, Ulwick proposed a 5-step process. First is to create interviews designed to draw responses on outcomes rather than solutions. The second step is to apply a mediator during the interview/survey process to distinguish between outcomes and solutions, thus maintaining the integrity of the survey. The third step requires that the outcomes generated be organized in a coherent manner and prioritized accordingly as the fourth step. Finally, the outcomes can now be used to initiate the innovation process.

Bettencourt & Ulwick (2008) posited that most businesses fail to look at the basic source of direction for efforts at innovation, which is what the customer is trying to get done. Just like clerks, surgeons and janitors purchase the tools of their trade to achieve an end, so does every

other customer of anything else. Therefore, instead of trying to examine the client's current processes and innovating to fit into them, the article proposed that businesses should examine what the customer is trying to get done and innovate accordingly. In exploring this, the authors proposed a generic eight-step process through which every customer goes in trying to get things done. The first is 'define', where the objective is clarified and resources are identified and selected. Second is 'locate', where the inputs necessary for the job are acquired and placed within reach. The third step involves 'Preparation', where the inputs are made ready for the job. This is followed by 'confirmation', which is basically ensuring that all the steps thus far are adequate to the client's job. This is followed by 'execution', which is accompanied by 'monitoring', the sixth step. 'Modification' may be necessary during execution before the process is 'concluded', as a final step. The relevance of this article is that it changes the paradigm through which business innovate, from what the customer thinks she/he needs to what the customer is trying to achieve. In complex operations, such a shift may not be obvious, and potential areas of innovation can be numerous.

2.4.3. Innovation Champion

Howell and Boies (2004) pointed out the great significance of innovation champions in generating and sustaining new ideas. They argued that the birth and life of an idea depends heavily on those individuals who strongly believe in the generated idea and have the knowledge and skills to lead it to fruitful results. Moreover, a champion's character plays a major role in keeping the idea alive by bringing attention of others to the idea, inspiring them, and promoting the opportunity of its gainful results. The results from the study revealed that generating, supporting, and leading new ideas to a variety of organizational outcomes were related to the emergence of champions.

Later, Howell et al (2005), in a primary research effort, developed metrics for the measurement of champion behavior. In this case, champions are those individuals who "informally emerge" in an organization and make significant contributions to innovation by actively promoting its progress through to fruition. The study identified 102 items that were mentioned by respondents to a survey as those inherent in a champion. From this list, 29 were selected as core attributes, which were then whittled down to 14 behaviours. These were tested

through analysis of 47 product innovations across 13 companies, and 47 champions were nominated.

Three overarching factors were found to be most important which were the high level of enthusiasm and confidence in the viability of an innovation, the ability to persist under adversity, and the ability to form a team composed of the right people. Champions are critical in countering the prevailing political, cultural and social barriers to innovation, often turning some of them into advantages. Without a champion, ideas are bound to remain dormant.

Bailetti and Guild (1991) viewed champions of innovation as the opportunity providers or explorers. In other words, champions are the people who work on formulating opportunities for new innovative products through different processes. Traditionally, marketing and product managers look for new opportunities and formulate them to introduce new ideas which are translated into products later on. In this traditional approach, designers take this opportunity with the properties identified by the previous parties and work on designing and detailing the product accordingly. However, Bailetti and Guild argued that product designers have major influence in shaping opportunities for new products and ideas. Hence, designers should be considered as opportunity finders where their early participation in the formulation of opportunities has an impact on the final product.

The study concluded that designers' knowledge, multidisciplinary interactions and exposure to selected external innovation champions influence designers' participation in the opportunity formulating process. The complexity of multidisciplinary interactions should be carefully handled eliminating hierarchies to avoid the loss of opportunities and open the floor for designers' participation. The exposure to external champions of innovation is seen beneficial by most designers since they act as a source of knowledge and inspiration. In addition, their interaction with the design team evokes an enthusiastic atmosphere through the exchange of knowledge and interests.

Innovation champions are usually seen as leaders in guiding and leading teams during the development of new ideas and outcomes. Taylor et al (2011) defined champions as emergent leaders who can initiate or lead a new idea to variety of outcomes. They further elaborated on the concept of champion driven leadership. They explained the dynamic nature of this kind of leadership through a conceptual model which consisted of initiation phase, endorsement phase, and implementation phase. In the initiation phase, champions' enthusiasm towards an idea

motivates them to take initiatives and adopt the role of a leader in a project. Thus, champions' participation takes the form of leadership triggering and leading innovation in a project team. During the endorsement phase, champions promote those initiatives to senior formal leaders and convince them to seize these opportunities in order to endorse the initiatives. Finally, champions' participation in the implementation phase is exhibited through the multidisciplinary interactions and the coordination of leadership activities.

Further, the paper illustrated issues that should be considered in order to enable champion driven leadership. Senior staff and formal leaders of an organization should provide the needed support to foster this kind of leadership. And this happens when they provide the adequate environment that encourages emergence of such champions, and high level of collaboration and support. Leadership development programs are also considered as enablers for champion driven leadership. These programs should be delivered to those individuals and teams who are frequently involved in the process of champion driven leadership. Individual leadership development programs assist those individuals in understanding the behavioral patterns of such champions, and in guiding and supporting those champions. On the other hand, team based leadership development programs strengthen the ability of team members to drive the process of leadership collectively.

2.4.4. Managing relations and interactions

Manley (2006) identified the triggers and barriers to innovation in construction, based on an extensive survey of 400 Australian construction firms. It found that innovation is often driven by clients' demands and actions, and the crises that inevitably crop up in projects. To mitigate these problems, the paper proposed that relationships be enhanced. This way, shared knowledge adopts a multiplier effect, as its flow and use is spread among more entities. The most important relationships to be built are those with cutting edge client, with partner businesses and with the employees. Relationships with cutting-edge clients force the firm to go perform beyond 'business-as-usual', inevitably requiring it to innovate. With partner businesses, relationships enable the spread of risk and combination of respective strengths to enable superior solutions to be created. With employees, positive relationships help gauge the effectiveness of training and overcome the softer people issues that act as obstacles to innovation. Others important

relationships are with government agencies, research centers and industry associations, all of which are bound to have knowledge that complements in-house knowledge. Relationships can be informal or formal, where formal ones could take the form of working groups, workshops, partnerships, alliances, joint ventures, outsourced functions, or joint R&D initiatives.

Johnsen et al (2006) examined the viability of the widely-accepted notion that innovation today revolves around customer-supplier relationships. It seeks to establish whether the degree of relationship necessary depends on the industry and specific company, in light of the innovation life cycle. The afore-mentioned notion is supported by the fact that the right suppliers can bring on board special capacities to enable the creation of new products, besides acting as a gate way to other suppliers down the value chain whose contributions can also be critical to the success of innovation. On the reverse, suppliers also get to bring their own innovations to market through their customers, underscoring the importance of the relationship. He highlighted several works that point to the importance of early involvement of suppliers in the new product development process to cutting costs, improving quality and enabling faster time to market. However, the paper is quick to add that theories regarding supplier involvement in innovation largely apply to relatively mature products, and not to brand new innovations. For the latter, suppliers involved are likely to be universities and research centers rather than tangible component suppliers.

From the notion that stakeholders' interaction is a major influence to innovation, Gassman and Enkel (2004) wrote on the topic of Open Innovation (OI) utilizing a model in which the organization 'does' innovation by leveraging resources outside the company's boundaries to take advantage of externally-generated innovations and commercialize internally-generated ones that fall outside the company's strategic scope. The model involved three core processes; the outside-in process, where innovations created outside the firm's boundaries are introduced to complement internal efforts and processes to produce marketable goods/services that give the firm a competitive edge. The example is given of BMW, which introduced the joystick technology developed in the video gaming industry into its new 7 series range of vehicles. The second process is the inside-out process, which takes innovations created in-house but which either cannot be commercialized by the firm or fall outside its strategies, and then licensing out said innovations to other firms that are willing and able to commercialize them. The third process is the coupled process, where R&D is conducted in collaboration with external entities to develop innovations that are mutually beneficially to all parties involved. Partners,

characteristically, include suppliers, clients, universities and independent industry researchers. One major characteristic of the controlled collaborative innovation paradigm is its insistence that the locus of knowledge need to be the same as the locus of innovation, and neither of these has to double up as the locus of commercialization, much as they are free to if it does make business sense. It places great emphasis on the need for an open, collaborative climate, built upon trust between the collaborative parties involved.

Following the same topic on open innovation and creative alliances, Barbham (2008) introduced the emerging OI phenomenon known as Crowd-sourcing. Crowd-sourcing makes use of 'crowds', who are online communities of people with similar interests such as designers, to source for solutions to problems or generate intellectual property that is then commercialized. Many firms such as iStockphoto and Innocentive apply crowd-sourcing as a major or their principal mode of generating intellectual property. The crowd's contribution may be in the form of improvements on basic designs or platforms, or may be brand new creations. Contributors from the crowd whose ideas are implemented get material reward, but have to surrender ownership of their creation to the firm that runs the crowd-sourcing initiative. This commercial aspect is the principal difference between crowd-sourcing and the better known Open source phenomenon, where all contribution is voluntary. The commercial aspect of crowd-sourcing has been rather controversial, owing to the fact that contributors often receive very little in compensation compared to what the businesses they contribute to make from their innovations. Barbham argued that such commercialization is inevitable, since for most products material costs have to be incurred during production. It is expected therefore, that a producer will have to charge a fee for the product. This then would prompt members of the crowd to ask for their share of profits, making the money element inalienable. However, Antikainen et al (2010) argued that monetary rewards are not the best motivator for contributors to open-innovation initiatives. Rather, other intangible factors like the recognition of peers, the urge to learn, experiment and test their skills, the community cooperation, the presence of a unifying goal and availability of support networks count higher as motivating factors.

This inclination toward creating collaborations, or alliances is supported by Cockaday (2004), who posits that while innovation does bring its challenges, mainly owing to its disruptive/ chaotic nature, it is more dangerous not to innovate. Moreover, collaboration between different parties is an important issue when it comes to managing and transferring knowledge.

Swan et al (1999) found out that healthy relationships between project team's members are valuable constructs for building a constructive interaction where information flows easily through networks between the collaborating parties. Maintaining dynamic interaction networks, which include external and internal team members, results in the creation of new knowledge and the development of new ideas. However, these networks cannot be easily maintained since they are influenced by many other factors imposed by the organization.

Friedman (2005) does not address innovation directly, but expounds extensively the phenomena that are cropping up as a result of the forces of globalization, which in turn are having a profound impact on innovation. Of particular interest to this literature review are out-sourcing and off-shoring. Outsourcing involves using entities outside a firm's boundaries to handle non-core functions. Over the past two decades, Western firms have been outsourcing work to developing countries via fiber-optic cables. The phenomenon is mainly fuelled by the availability of cheap labor in the developing world, helping western firms to cut costs. Over time, the nature of the outsourced work has evolved from simple tasks such as voice transcription and data entry, to very sophisticated functions such as the design of airplane wings. The result is a fresh outlook on everything Western, seeing as the education, culture and perspectives of the predominantly Chinese and Indian entities can be radically different. In a manner similar manner to outsourcing, entire factories or business units are being moved to developing countries, among the most famous case being Nike's entire manufacturing arm being based in China. In off-shoring, diffusion of innovations naturally occurs from the western world to the developing, as technology is transferred. In turn, the expertise necessary to operate the diffused technologies is developed over time in the host country, and with it the capacity to research and develop improvements or adjustments to processes and products in order to suit new markets. Overall, globalization has introduced unprecedented dynamism to the innovation process.

2.4.5. Knowledge and information management

Udeaja et al (2006) pointed out that as is inevitable in most projects, problems are bound to arise. To overcome such problems, it is the norm for project managers to dig into past experience or utilize acquired company knowledge to overcome the problems. However, disjointed and ill organized information can hamper the ability of a manager to leverage knowledge from past resources. As a solution, the authors advocated the use of a new web-based tool, CAPRI.NET, which facilitates 'live capture' of knowledge as it is created, by allowing project members to note their learning experiences as they go about the project. Many firms can share the same platform, meaning that they can all draw from each other's experiences. Its ability to be improved upon and be used multiple times over means offers unique value to construction and design industries.

Similar to CAPRI.NET is ArcIMap (Architectural Information Map), which is expounded upon by Tuncer et al (2006). It is specifically for architects and designers, and serves similar purposes to the earlier-mentioned tool. Walker et al (2006) depart from the technological arguments to offer that metaphors are best-placed to enhance understanding in project management, and this can be achieved by implanting metaphors into models and frameworks. This way, problems and solutions are demystified, and can be customized to suit context and culture as necessary.

Swan et al (1999) advocates for interactive innovation by means of community networking in the field of Knowledge Management (KM), as opposed to the current emphasis on IT based, particularly intranet, approach to knowledge management. It begins by noting how over the last twenty years, innovation has supplanted quality and efficiency as the principal source of competitive advantage for firms. In its own promotion of innovation, the paper underlines the importance of networks and networking, an example being the membership of employees in professional organizations being a proven path for diffusion of ideas. This way, knowledge transcends boundaries, as opposed to operating within the firm's confines as is the case with intranets. However, the latter remains important for internal networking, to facilitate the process of convincing others within the organization to buy into the idea and contribute resources necessary to make an innovation process successful. Networks and networking therefore, are important, and may be preferable to structuralist approaches whose emphasis is on

'best practices' that are applicable only to simple examples. Networks are sensitive to organizational contexts, skills and commitments of varied parties.

2.4.6. Technology

Mann & Cathain (2006) explored the systematic innovation method known as the Theory of Inventive Problem Solving (TRIZ), and attempted to apply it to the field of architecture. TRIZ is a counter-intuitive approach to innovation, in that while innovation - especially at the fuzzy front end stage - is associated with creativity and spontaneous ideas, TRIZ has a structured approach to innovation. Its application to Architecture is however limited. TRIZ was built after extensive research into three million patents, arriving at the conclusion that invention in the world can be boiled down to forty Inventive Principles, meaning that all technological evolutionary trends can be predicted. The methodology works in the form of a generic problem solving framework, where problems and attending solutions are given. The task of the problem definer or solver is to match their specific problem with a TRIZ generic problem, which they then match with its TRIZ generic solution. The generic solution now acts as a basis for formulating specific solutions to the original problem. One strength of TRIZ is that it strips away boundaries between industries to define cross-cutting problems and solutions, thereby allowing problem solvers from one industry to leverage solutions generated in another, and architecture is no different. This theory of generic problem solving is now applied using technology in most design projects solving complex structures, integrating management and defusing innovative processes in solving design problems.

Marasini, Dean and Dawood (2006) decried the use of traditional planning tools in the construction industry, not because they are ineffective but because they are less when compared to modern visualization technologies that are scarcely used in the industry. The predominant traditional methods include Gantt charts and Critical Path methods. On the other hand, modern tools include 4-Dimensional (3D+time) tools for simulation and planning, of the sort widely used in the automobile and aerospace industries. These new tools are particularly helpful in bridging gaps in knowledge, awareness and communication, which can be difficult to do with traditional tools.

The role of technology in design projects extends to reach managing information and knowledge in projects. Sebastian (2011) discussed this issue in design projects. The increased complexity and participation of different stakeholders from different disciplines establishes the need for organizing communication and information sharing throughout the project's life cycle. The use of building information modeling (BIM) simplifies this complexity and decreases the cost of communication between different collaborating parties in a project. Using BIM, any update by any discipline is immediately communicated to all other participants involved in a project creating a smoother flow of information for the innovation process. Sebastian (2011) further pointed out that applying BIM successfully depends on five major factors identified as "POWER: product information sharing (P), organizational roles synergy (O), work processes coordination (W), environment for teamwork (E), and reference data consolidation (R)."

There were earlier attempts in using technology to manage knowledge and information in projects. The use of CAPRI.NET and ArcIMap web-based tools allow employees to communicate information and organize a company's knowledge for better access to archived knowledge. Thus, it helps all members within an organization to overcome the problems that arise when looking for project's information in the traditional way. (Udeaja et al, 2006; Tuncer et al, 2006)

Technology also has a significant role as a design generation and optimization tool during the design process. Fox (2011) discussed the technology of generative production systems in design. He explained generative production systems as a computer aided design methodology that follows certain rules and strategies identified by its creator to automatically generate new designs. It works on the basis of "IF a THEN b". Usually the designer sets these rules and strategies based on what he/she wants to achieve in terms of shapes, complex geometries and designs. Hence, such a system relies heavily on the knowledge of who introduced it. When the methodology is introduced, designers feed it with certain inputs that will subsequently follow the programmed rules and strategies to come up with a new complex shapes or designs. This computerized methodology in a way emulates what human designers do in translating information into shapes and geometries. The advantages of these systems is that they require little or no human input during the autonomous computerized process and they can run contentiously for days to generate different geometries. However, it requires more investment to set up and introduce such a system.

Park et al (2004) provided a solid argument using practical scenarios from the architecture industry that technology can be used in generating innovative concepts in architecture. The paper focused more on the parametric design approach for tall buildings design. In this approach, the definition of the architectural form of a building depends on certain parameters and set of relations between those parameters. The manipulation of the overall building form happens through modifying specific parameters which can consequently adjust other building's information such as total built area, total height and total number of floors. In the parametric design, a building form goes through a series of transformations generating different potential geometries and alternative forms which yet are evaluated by architects and engineers. This approach helps designers to uniquely apply their ideas and skills to generate and explore innovative design concepts.

2.5. Findings and conceptual model
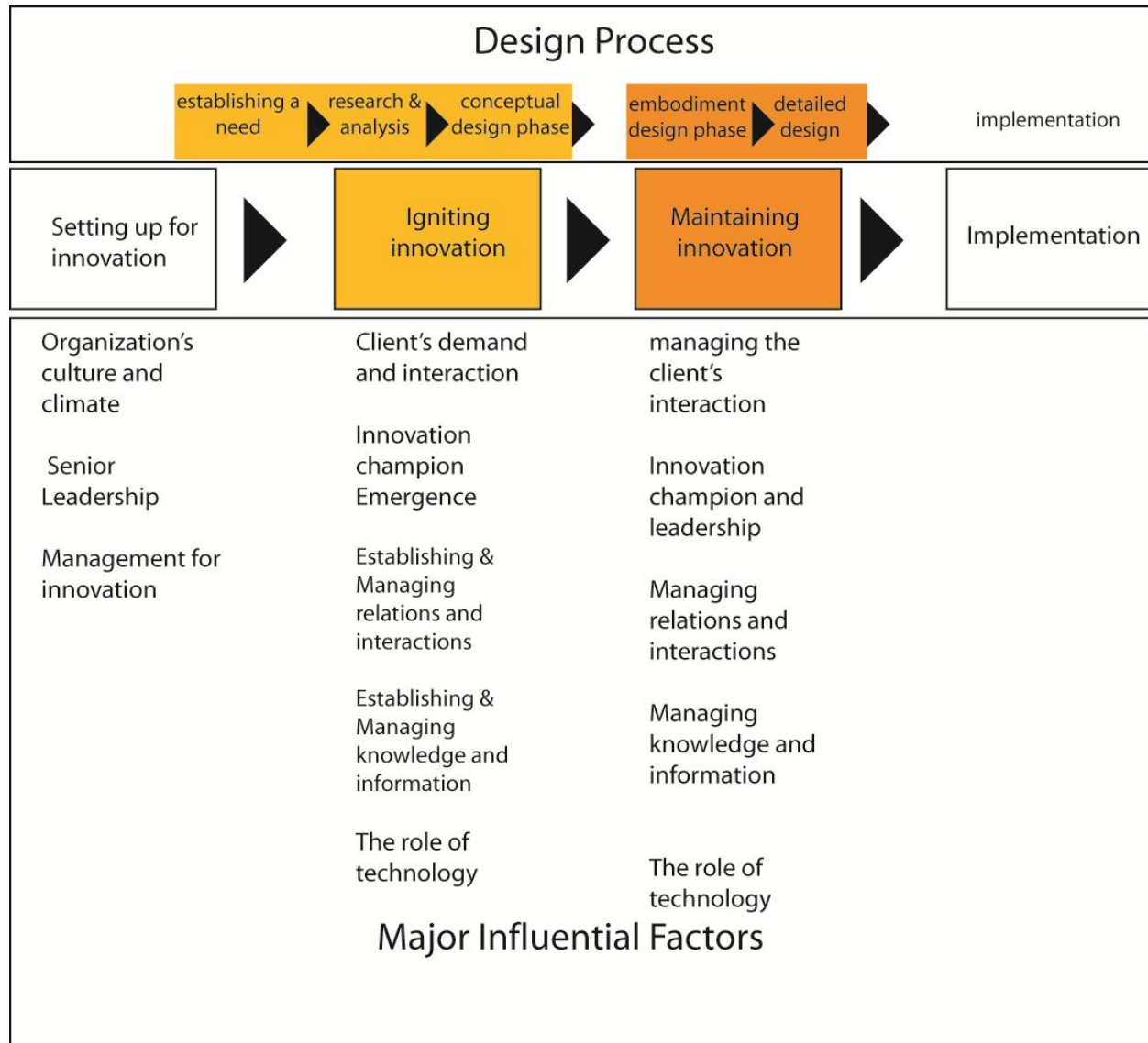
The findings here are organized in a conceptual model that will be used later to analyze the projects presented as case studies. The model explains the innovation process in four major phases. The four phases are 'setting up for innovation', 'igniting innovation', 'maintaining innovation', and 'implementation'. 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.

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. Findings from the literature 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 eliminating job hygiene factors, such as disputes between employees, and promote collaborations in the organization (Tang,1998; Mumford and Licuanan, 2004; Jogulu & Wood, 2007; Lyons, 2007; Found & Harvey, 2007).

Investigating the major factor, management for innovation, the research 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; Prosci, 2008).

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, I sought to find out how the client's demand and interaction were handled in each 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 relation. (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 studies. 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 studies to see how it helped in initiating innovation in this phase. The strength of relations amongst employees allows good information flow, and creates 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. Hence, it is discussed in each case study as a major influential factor in deriving innovation. Here, the paper will examine how the project team used or established knowledge and how they managed and shared them to initiate the design concepts. There are different ways of managing knowledge and information discussed in the literature review chapter. (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.

Chapter 3: Methodology

3.1. Introduction

A qualitative research methodology has been used to conduct this research paper. This chapter explains the methodology used for the dissertation and why it was used in the conceptual framework section. Moreover, It explains in details the sources of data, the way they were collected, how they were analyzed, and what limitations it had.

3.2. Conceptual framework

Investigating innovation in design practices is an important issue due to the fact that innovation in most construction projects begins in the design phase. Moreover, a lot of literature investigating innovation in the construction industry mostly studied organizations, yet not so many investigated innovation in the design process thoroughly focusing on specific projects.

The main idea behind this paper is to identify factors that influence innovation in design projects, and then to test their influence on real projects presented as case studies gained from three architecture consultant firms. Each of these selected projects had a unique concept that made them stand out as innovative design projects.

To create this research paper a qualitative research methodology has been adopted, which allows the researcher to go to the field to gather information, make observations, interact in open ended interviews, and use documents from the projects. Also, this type of research allows the researcher to "focus on organizational processes." (Roberts, 2004). The choice of this methodology is seen more appropriate that it allowed the researcher to interact with the project's teams tolerating observations, informal talks with project participants, access to project documents, and allowing participants to share their opinions about the discussed project's success in innovation. Piekkari and Welch (2006) found that collecting data through interviews is a complex social and sense-making process in which meaning is constructed through interaction between the interviewer and the interviewee.

The research started with a brief introduction about innovation in construction industry to form the research questions and objectives. Then investigated these questions in the form of a literature review to establish a conceptual model which in turn will be used to analyze and apply the findings from the literature on real cases. The conceptual model places the design process against a deduced innovation process where factors were divided against each phase of the innovation process.

3.3. Population Sample

Data for the literature review include only peer reviewed articles. On the other hand, data for the case studies were collected by conducting interviews, observations, investigating project documents, and reviewing publications on the investigated projects and companies' websites.

The paper will discuss three projects from different organizations. The first project, Xiretown by X-Architects, is a masterplan for mixed use development where the team could take the concept of sustainability to a higher level by developing a sustainable urban development with respect to the context of Dubai. The team was very helpful in providing me with the necessary information for the case study. They provided me with written publications about the project and the organization, allowed me to view presentations for the project, and allowed me to stay to observe how the teams work in different projects. Moreover, it was possible to conduct interviews where the interviewee included the design director of the project, and two architects.

The second project, Dubai Metro by Aedas, provided an iconic solution that represents a concept from UAE's heritage. The team could develop a modern representation of the concept which also works in the harsh environment and weather of Dubai. Data for this project also included observations, interviews and publications from design magazines and websites. The interviews were conducted with a design director and two architects.

The third project, a villa design by NAGA architects, had to deal with providing easy accessibility for wheel chairs considering the client's need in providing a comfortable housing for his old parents. The team could achieve a comfortable design that responds to the client's needs. Data for this project included observations of the work environment and people interactions, company's publications, and interviews. Access to project documents was not

allowed. The interview took place with a design director, a senior architect and an interior designer.

3.4. Analysis tool

The research adopts a conceptual model, derived from the literature review, for analyzing the projects. The model 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.

3.5. Instruments for data collection

Collecting data for the case studies required the interaction with the people involved in the investigated projects. Data were collected through observation, investigating project documents and publications, and conducting interviews. Observations included investigating the office settings and environment, the level of interactions, employees relations, and the perceived hierarchy during projects. Informal talks happened with employees while observing the work environment. Moreover, whenever a document from the project was presented, I would engage one of the employees in a discussion when allowed to.

Interviews had a significant weight in conducting the case studies. The interview questions were designed to identify the influence of each factor in the concluded conceptual model of innovation process on the selected projects. The interview questions were as the following:

1. Describe the organization's culture including values and believes, and its potential in supporting innovation in project teams.

   The above question is to address the culture and climate for innovation in the organization housing the discussed project team.

2. Describe the role of management in guiding and supporting new ideas, and its flexibility in responding to industrial changes.

   The question investigates the management role in supporting innovation and in adapting to the industry's progress.

3. How did the project begun? And what was the deployed process to achieve it? And who were the parties involved in each phase?

   This question investigates the initiation of the project's concept and the design process in order to relate it to the used conceptual model.

4. How involved was the client in each phase? and how his/her involvement influenced the overall achievement?

   This question is to address the client's role in defusing and maintaining innovation. Also, it investigates how the client's demand and interaction were handled during the project.

5. Were there any individuals who had major contribution in initiating the project's concept and leading it to the desired outcome? What was the position of each one, and how they influenced the project?

   This question is to address the role of champion of innovation in initiating and leading innovation during the investigated design process.

6. Who were the parties involved in this project team, and how were the relations and interactions managed among them?

   This question is to evaluate how the established relations amongst employees and with external entities had a role in defusing the design concept. Moreover, the answer for this question should address how they were maintained throughout the project's life.

7. What kind of knowledge was used for this project? And how did you manage the project's knowledge and information throughout the design process?
   This question is to address the role of knowledge as a construct for innovation and how it helped in initiating the design concept. Moreover, it addresses how the project's information were disseminated and managed during the project.

8. How technology was deployed in this project? And what significant role it had in initiating the design concept and leading it to the final phase of the design process?
   This question is to explore how technology had a role in initiating and maintaining innovation in the project.

3.6. Limitations

The major limitation of this study is the number of case studies provided. Three case studies is a relatively small number to analyze the proposed innovation process. The many projects provided the better but due to the time constrains, it was not possible to gather more case studies.

Another limitation is that all discussed projects are in Dubai which results in investigating projects only in a small fragment of this global industry. Moreover, access to project documents was not fully allowed in all cases. Dubai metro project only shared documents which were already available in their websites, while all documents were confidential in the villa project.

3.7. Summary

The research uses a qualitative methodology. It began with exploring the factors that have influence on innovation in the form of a literature review. The literature began with identifying constructs of innovation generally, and then focused on identifying organizational factors where teams operate and dynamic factors that affect the innovation process during the design phase. To further formalize these factors to perform analysis on the case studies, a conceptual model was

derived. The conceptual model places the design process against a deduced innovation process where factors were divided against each phase of the innovation process.

The conceptual model begins with a *setting up for innovation* phase. This phase is intended to explore the appropriate conditions that should be available in the organization responsible for the project discussed in each case study. After that is the *igniting innovation* phase where the project concept begins. This phase is intended to explore the influence of dynamic factors in the initiation of the project concept. These factors evolve as they reach the *maintaining innovation* phase. In this phase, the evolution of these factors and their influence on the design concepts is explored on how they sustained or compromised the design concept. The design process ends here maintaining the design idea until detailing the design for implementation. The *implementation* of design has to do more with the actual construction of the design project. However, most of the discussed projects were not implemented yet except for one project.

The paper will discuss three projects from different organizations. The first project is Xiretown by X-Architects, where the team could develop a sustainable mixed use master plan with respect to the context of Dubai. The second project, Dubai Metro by Aedas, provided an iconic solution that represents a concept from UAE's heritage that is also environmentally sustainable. The third project, a villa design by NAGA architects, had to deal with providing a comfortable housing for old people.

Sources of data include companies' websites, project documents, publications, observations and interviews. In each project, three interviewees were involved and others were informally approached. The interview questions were designed to investigate how project participants perceive the influence of the identified factors.

The limitation of this methodology is that it uses only three case studies which are limited to geographic location of UAE. Moreover, some projects did not allow access to its project documents.

Chapter 4: Case Studies

This chapter discusses three design projects from different firms. Each case study begins by describing the project, the organization leading the project, and the deployed design process. After that, the analysis of each project uses the research conceptual model introduced earlier at the end of the literature review section. The chapter closes with a discussion concluding the major observed issues that influenced innovation in the discussed cases.

4.1. Case study 1

Project XERITOWN

Company name: X-Architects

Project Type: Residential Masterplan

Client: Dubai Properties

Sub Consultants: Buro Happold, Smaq, Reflexion, Johannes Grothaus

Location: Dubailand, Dubai, UAE

Program: Apartment Housing, Triplex Apartments, Courtyard Houses, Detached Villas, Community House, Retail, Mosques, Desert Life Museum, Kindergartens &Sports Field/Playground

4.1.1. Project description

The concept of Xeritown project is to create an environmentally sustainable masterplan. Away from the traditional iconic concepts, the focus here was more about creating a sustainable urbanism that responds to the context of the desert and local climate in Dubai. The idea is to let the built environment emerge from the context rather than forcing a structure against it.

The development exercises several passive and active strategies to conserve resources like water, energy, soil, flora and fauna, thus creating a new benchmark for an environmentally conscious and socially vibrant urban setting. As an immediate reaction to the harsh desert sun, the urban footprint has been compressed to occupy only 50% of the site. This creates a compact self-shaded structure defined by narrow pedestrian alleys and small squares, typical of Arabic

towns. The urban tissue is then divided into islands that are orientated and elongated along the North-South direction to reduce solar gain and benefit from the prevailing winds crossing the site. The cool breeze from the sea is channelled between the islands and through the longitudinally carved wind corridors in the urban fabric, while the hot wind from the desert is deviated above the development by the stepped massing. These urban measures combined with the rugged skyline creates air turbulences, on the scale of both low rises and towers, assisting in natural ventilation and a reduction in energy demand for artificial cooling. The resultant urban massing exhibits formal dynamics similar to the dunes in the desert, thus making the development could be interpreted as a consolidation of the desert dunes.

Apart from these passive strategies, the project also applies a multitude of active systems for achieving high ecological quality and energy conservation. These strategies include reducing energy demand by using dimmable LED street lighting, providing District cooling, accommodating photovoltaic panels and roof top turbines to generate low-voltage DC electricity, reducing water demand by low water-use appliances, using recycled grey water for irrigation and less evaporative sub-soil irrigation systems, re-using of excavated soil to create topography, facilitating on-site waste recycling and low maintenance xeriscapes.

To reduce carbon emissions and to encourage a pedestrian oriented development, easy access to public transport is provided by an extensively shaded and well ventilated pedestrian edge. This edge between the urban fabric and the landscape is a focal part of the design. This is the moment in which architecture, infrastructure and landscape come together, coinciding with an intensification of human activity. Here people can walk under a shaded arcade looking at shops, or stroll along a promenade observing the landscape. A shading device composed of photovoltaic panels which provide valuable energy to the site is distributed along this edge.

4.1.2. The organization

X-Architects is an award winning design firm. It was founded in 2003 in Dubai, UAE. Their outstanding performance and driving ambitions made them earn recognitions in several occasions. They won "Mohammed Bin Rashid Award 2009" for young business leaders and won two other awards at the event "middle east architect awards 2010" for the categories "Boutique Architecture Firm of the year" and "Principal of the year". They claim that they focus on

addressing developers aspirations through distinctive and inspirational designs. Indeed, some of the firm's urban design projects earned awards. For example the project XERITOWN won the "Holcim Awards 2008 Africa & Middle East" in the category of sustainable construction, and the "Middle East Architects Awards 2009" in the category of mixed-use projects. The firm now is well established and their name is recognized with out-standing environmental sensitive project concepts.

Being a firm with a deep rooted understanding of the culture and nature of the region, they are conscious of creating a built environment that would be sustainable for future generations. They understand sustainability as an integrative approach to increase the beneficial relationships between human and ecological systems, especially considering the arid desert environment of the region. Their design philosophy is derived from their belief in a balanced approach to sustainability that focuses on embedding contextually relevant passive strategies into their projects rather than solely relying on a patch-work of technological solutions. Their vision is "to evolve into a multi-disciplinary design practice focused on creating a built fabric that is 'Re' Active towards Social, Environmental and Cultural aspects specific to the region."

The office is led by motivated and knowledgeable senior staff with support from internationally trained young professionals from established institutions and design houses from the UAE and abroad who contribute to the firm by their skills and knowledge. X-Architect's designers possess an array of technical abilities in using advanced software to help deliver animated project narratives and to evolve complex built forms. These skills are further backed up by leading consultant teams that assist and encourage the team to push the boundaries of design. Moreover, X-Architects strives to build a strong knowledge base for the organization. They always look for opportunities to participate in design events and seminars. They show great efforts in exposing themselves to educational institutes and champions of innovation related to the industry of architecture, and in participating in researches and lectures. Indeed, they contributed in the book " Al Manakh" which critically talks about the urban and architectural development in the Gulf, especially Dubai, until the year 2007.

The main objective of any design by X-Architects is to provide their clients with atypical practical architecture concepts. They always strive to achieve beyond standard design solutions. Their strategy in tackling projects is based on two fundamental principles: research and collaboration.

The firm has a structure that clarifies the level of authority in the organization. However, this hierarchy cannot be experienced during design processes. The office environment enables interdisciplinary interactions regardless of their ranks and positions. Their belief in that ideas can emerge from any employee in the design process makes them appreciate and further encourage a flat structure during the design process.

X-Architects is a small firm where the management entity is manifested by two established architects. Farid Ismael and Ahmed Al Ali proved their excellence through their projects. They started in the year 2003 with small projects including houses, and then they planned the growth of their firm. Now, they work in more complex large scale projects including urban design and master planning. The management of X-Architects has gone through many changes as they grew in business and still shows an appetite for growth.

The management is also involved in supporting and guiding innovation. They believe that each project should start by rigorous research of its brief and comprehensive analysis of the social and environmental context to deliver an outstanding work. They believe that their project ideas are a result of interacting bodies including clients and sub-consultants. For that reason, they are always concerned of keeping healthy relationships amongst the organization's members and with external entities. Moreover, senior leadership in the organization can be described as enthusiastic and goes more towards empowering staff. Leaders in the organization empower and trust the designers with in project teams to take significant design decisions.

4.1.3. The design process

Like most design projects, Xeritown started with a client's demand. The project's brief proposed by the client did not include many details. It specified that the construction will be a mixed-use development, will take place in an area of 59 hectares in Dubailand, and should provide housing for approximately 7000 people. The client, Dubai Properties, has established a strong relationship with X-Architects through previous projects. In the initiation meeting for the project, the client left all design decisions to the architecture firm, trusting them that they will deliver beyond expectations. Ahmed and Farid, managers and senior leaders of the firm, saw this as an opportunity to exploit their expertise. Realizing the vast opportunity, they organized a project team which included other firms. X-architects worked with SMAQ, an award winning

German design consultant firm, in other projects and saw an opportunity of including them in the design team as co-consultants. Together, they brought on board Buro Happold, engineering and infra structure consultants, Reflexion, lighting consultants, and Johannes Grothaus, the landscape consultants. After that, they started by researching and analyzing the environmental, social, and physical context of the project. Following the analysis, they could provide a preliminary design concept that was responsive to all three analyzed dimensions. During this phase, conceptual design, the firm sought client's participation and feedback by conducting progress meetings. The conceptual design phase resulted in a sustainable design that works against the hot desert wind, accommodate cool breeze coming from the south west, and responds to the sun movement around the site. Ideas from sub-consultants worked to strengthen this major concept on the later phases. For example, the engineering and infra structure consultant strategies aimed to reduce energy demand.

4.1.4. Analysis:

The discussion will use the conceptual model introduced earlier.

a. Preparing for innovation

X-Architects interviewed employees claimed that their *organization culture and climate* encourages innovation. Indeed, the culture seems to have many of the innovation culture attributes discussed by Ahmed (1998). They show a great interest in investing in research and development and expanding the firm's knowledge base. In fact, they have conducted and participated in several researches. Moreover, they already have established relations with different universities in the region and are currently looking toward creating alliances with universities to expand on the research and development. Another attribute is that they maintain healthy relations amongst employees and with external entities. The office environment encourages open communication regardless ranks and positions, and promotes a flat structure during operation allowing ideas to emerge from different sources. Usually, the nature of work and exercises given to the design teams are challenging and stimulates employees' intelligence in solving design problems.

During projects, *leaders* empower the design team to take full responsibility of design decision although they are aware of the risk taken by empowering them. Designers in the firm are always encouraged to experiment with new ideas. This agrees with the findings from Schulte et al (2010) who argued that innovation culture should encourage experimentation and tolerate risks.

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 X-Architects is capable of managing clients' attention and evolving needs. Indeed, they look for the end result rather than simply follow clients' instruction. Moreover, in most of their projects they have a systematic approach to translate project specifications into innovative ideas. Furthermore, they encourage communication, and maintain healthy relations between employees by eliminating any job hygiene factors including office politics which agrees with the issue Halepota (2005) mentioned where job hygiene factors including office politics may act as a demotivating factor. The elimination of office politics in the firm, as claimed by one of the principals of X-Architects, happens through the identification of those individuals who cause it or by clearing out the misunderstanding that happens between the employees. It can be observed in the office environment that discussions of ideas happen freely, formally and informally between different employees from different ranks. To further strengthen the relations amongst employees, the management organizes social activities and events. As for leading project teams, the firm exhibits a systematic guidance in different projects. Senior leaders in the firm suggest project related exercises and resources rather than forcing ideas to a project team. They believe that exercises are what stimulate innovation in a project team, and not the ideas they suggest. However, sometimes they sit with project teams and start suggesting ideas not to force them in a project, but only to participate and discuss variety of opportunities.

Change management is critical for organizations looking to develop an innovative culture (Prosci, 2008). In adapting market conditions, and internal and external organization's needs, the management of X-Architects exhibited flexibility through its continuous changes. The expansion of the firm and their survival during the economic crisis 2008 is a solid proof of their strong adaptive management. They started as two entrepreneurs, and now they have a large work force and developed relations with different design houses in and out of the country. The principal

mentioned in his interview that they could successfully change their management system many times to achieve their goals in this market which is continually changing in its demands and developments.

b. Igniting innovation

It's important to mention that most of interviewee agreed that the *client* had a major role in the success of this project. Beginning with the project brief, the client sought to exploit the design firm's potential through providing an open and short project brief. In fact, one of the project leaders mentioned that the client basically told them: "this is the site, show us what you can do with it" making them realize the vast room for innovation left for the design team to discover in the project, and the level of trust placed on the design team. This strengthened the relationship between the client and the design firm placing a base for mutual trust and support. Moreover, the client is knowledgeable in the field of real estate and construction industry. That resulted in a collaborative effort with the client to achieve the concept outcome. Indeed, Manley (2006) identified that client's demand and actions in cropping up the process to its final results as one of the major triggers for innovation.

The design team considered the *client* as a collaborating entity rather than being a customer. Meetings between the design team and the client happened systematically. The client role during this phase was more towards the idea evaluation. Often times, the client was represented by architects and engineers who have proven knowledge in understanding and evaluating design ideas. Schulte et al (2010) pointed out this significance of collaborative approach bringing to attention that the 'idea evaluation' is one of the most valued elements of the collaborative process with customers.

The *champions of innovation* in this case were selected by the leaders in X-Architects. As mentioned earlier, the design team for this project was composed of X-Architects, SMAQ, Buro Happold, Reflexion, and Johannes Grothaus. All of these selected participants in the design team were considered innovation champion in the services they provide. However, X-Architects and SMAQ had the greatest influence in forming opportunities and leading them to gainful results. Two design principals from those two entities emerged as champions. They exhibited a high level of enthusiasm in inspiring, generating, and promoting the design idea and opportunities.

They suggested the idea of creating an environmentally sustainable masterplan, rather than taking the fashionable direction of iconic design at that time. They saw this project as an opportunity to show their ability in creating a micro-climate that is comfortable for people and energy efficient in the harsh weather of Dubai. This idea was then disseminated to all participants in the design team who further celebrated and supported it. One of the interviewee mentioned that he highly thought if those two principals were not involved in the process, the design team may not see this opportunity and generate this idea. Howell and Boies (2004) explained issues about innovation champions which are similar to the ones found in this project. He proved that the generating, supporting, and leading ideas are related to champions' emergence.

X-Architects has strong *relations* with cutting edge clients, consultants from the construction industry, and educational institutes related to the industry. In this particular project, they could use these relations to the project's advantage. Their strong relation with the client helped them overcome trust issues. Their relations with other professionals from the same industry helped them organize a team with the right people. Relations with educational sectors helped them getting interns and fresh graduates who have fresh new ideas and skills which yet are not tested practically. Moreover, they could discuss design ideas with design professors whom they have close relationship with. In this project, all entities' relations were already established through previous experiences. It can be said that the relations between entities in this project were healthy during this phase of initiating ideas. As a result, their collaborations and interactions resulted in a strong design concept. Swan et al (1999) agreed on a similar finding claiming that healthy relations are valuable constructs for building a constructive team for innovation.

Knowledge here was a strong trigger for innovation. The knowledge of the collaborating firms, especially in sustainable design, provided a strong base for taking initiatives in thinking and guiding the design concept. Sources of knowledge for this project came from the collaboration of these different entities and educational institutes who have established relations with X-Architects. Moreover, the familiarity of X-Architects with the environment of Dubai and their archive of previous projects and researches related to Dubai's context had a significant role in creating a strong knowledge base. Add to that, the process they worked on began with a research phase which contributed heavily in creating the design concept. Knowledge as a

construct for innovation was indicated by several authors in the literature review (Tang,1998; Swan et al, 1999; Brennan & Dooley, 2004). For managing *information*, the team realized the importance of keeping a constant information flow. Hence, all entities in the design team were involved from the beginning of the project. In addition, process updates were communicated continually via the use of emails, and virtual meetings were conducted as necessary amongst the different groups within the design team. In managing information and knowledge of the project, technology had a significant role.

The role of *technology* in igniting innovation was mainly in communicating the design concept using visual digital sketches and models. Moreover, it was used as a mean of virtual communication between the five collaborating firms in the design team. The five firms operated from different countries which made it inevitable to use technology to communicate with each other. Hence, technology here solved a significant issue, communication, which is considered as a major construct of innovation indicated by Tang (1998).

c. Maintaining innovation

During this phase, problems are bound to arise and usually lots of compromises happen to bring the concept to realistic outcomes. However, the design team led by X-Architects managed not only to maintain the generated ideas, but also to strengthen the concept and exceed client's expectations.

The *client* role in this phase was mainly involved in the evaluation of the design. Moreover, their control and suggestions were more linked towards their future plans in implementing the project. For example, oftentimes they suggested reducing some elements and providing alternatives that suits their future forecast for construction. Although the client was very cooperative, the planned budget for construction was not disclosed to the design team. The design principal did not see any risk in not disclosing this datum. Instead, he figured that the client wanted them to focus on the design development by taking the burden of designing according to future planned budget from the design team. It was the client's role to give the design parameters according to their future plans for the investment.

The role of *innovation champions* here was to keep the idea alive and taking the concept to realistic outcomes. They proved their ability to persist under adversity, a trait mentioned

earlier in the literature by Howell (2005). They had a major role in resolving interaction issues, keeping a high level of enthusiasm, and driving the design process to deliverable outcomes. For example, they took the initiative of expanding the design team by deploying the skills within the firms which can take the design to the desired outcomes.

During this phase *relations and interactions* with the client continued to be strong. The client was continually updated with the design development through meetings every two weeks. With this step they could maintain the mutual trust with their client. However, problems came up with in the design team. These problems came up as a result of misunderstandings and communication problems. More communication was required to solve these misunderstandings. The amount of virtual meetings increased to solve these issues which in turn had its impact in flow of *information*.

Technology had a major role here in making the digital models and drawings and in communicating them to other groups within the design team. The use of CAD programs helped them in saving time and overcome some communication problems. Moreover, it helped them in optimizing the design to best possible results.

d. Implementation

The project is finished with all design phases, but it was not implemented yet. The design team is planning to help the client in providing criteria in selecting the right contractor for implementation. Moreover, they also planned to offer a supervisory service to make sure that the design is implemented as specified and proposed.

4.1.5. Conclusion

X-Architects managed to achieve a great success in their project, Xeritown. Located in Dubai, the design team sought to achieve a design that responds to the context of Dubai. With their innovation capacity, they could provide an optimum design solution for the culture, weather, and physical context of Dubai. Indeed, they won awards celebrating their success in creating an innovative design solution for this project.

Their success on this innovation process relied on many factors. Through the analysis, we can say that X-Architects has a strong base for innovation. They exhibited a conductive culture and climate for innovation, supportive leadership, and adaptive management for innovation. In igniting the design idea, the open and brief client demand encouraged the design team to explore variety of opportunities and operate at capacity. The firm chose to collaborate with other consultants, who are considered innovation champions, from the industry which in turn added to their knowledge and skills capacity. This collaboration, along with the guidance and support of innovation champions, resulted in the production of that innovative design solution.

From the study of this project, the most influential factors in igniting innovation were the role of the client, knowledge, and leadership. Moreover, the established relations provided a solid ground for the team's confidence. However, technology did not have a major role in triggering innovation. On the other hand, maintaining innovation was more affected by employees relations and information flow. Strong leadership, with the use of technology could overcome some of the information flow problems. In this phase, leadership, and the use of technology solved most of the emergent problems during the design process.

4.2. Case study 2

Project: Dubai Metro

Company name: Aedas

Project Type: Public transportation

Client: Road and Transport Authority (RTA), Dubai

Sub- consultants:

      Architecture consultants: Rafael Viñoly Architects, Carla Bechelli Architects

      Interior design consultant: KCA International

      Engineering consultants: Capita Symonds (until the end of concept phase), and Atkins (until completion)

      Lighting: Bo Steiber Lighting Design

      Acoustical: Campbell Shillinglaw Lau Ltd.

      Signage: Atelier Pacific Ltd.

Location: Dubai

Program: a fully automated rail system composed of 47 stations along 43 miles of track, underground stations, above ground stations and elevated stations.

> Stations types: At-grade station, elevated station with at-grade concourse, elevated station with elevated concourse, elevated station with third track, Underground station, and Underground transfer station

4.2.1. Project description

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 context 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 respond 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 and overhangs help in reducing the solar gains for the stations. Furthermore, the shell structure contains high performance glazing which is 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 with no columns inside the shell which in turn creates a large open space that is needed for a smooth movement for the metro.

4.2.2. The organization

Aedas was established in 2002 with the partnership of LPT Architects in Hong Kong and Abbey Holford Rowe in the UK. It went through a series of mergers and partnership with other successful professionals. Now, it is a global design firm with 40 offices around the world. They have a global network of professional and passionate designers from different cultural backgrounds. The cultural diversity works for the firm's advantage in dealing with different clients and different contexts globally.

Their vision is: "We are committed to our core values of excellence, integrity, innovation, creativity, enjoyment and diversity. We achieve our goals through our dedication to research and development, sustainability, and continuously developing talented and creative staff working as a global network of experts delivering the highest quality projects for our clients"

Aedas provides its services in architecture, interior design, masterplanning, landscape, urban design and building consultancy in Asia, the Middle East, Europe and the Americas. It is a pure design office that it does not provide services in engineering consultancy. They believe that their focus in design projects will lead them to become one of the best design practices in the world. Indeed, Aedas is considered one of the leading international design firms in the middle-east. Usually engineering consultants are outsourced in most projects designed by Aedas.

 People in Aedas come from different backgrounds to work in a collaborative environment that enhances their knowledge and skills and stimulates creativity and innovation. They believe that people are the source of ideas. Hence, they employ people who are passionate, productive and innovative. They keep a high level of excellence amongst their people through their commitment to research and development. The firm believes that high achieving professional are motivated by "autonomy, ambition, clear expectations, explicit career paths, fair reward and recognition, inclusive culture, minimum bureaucracy, leaders who are professionally credible, a sense of the big picture, stimulating challenging work"

The firm has a structure that clarifies the level of authority in the organization. Also at the operational level of projects is a clear hierarchy. However, the firm always allows interactions between different participants from different levels formally and informally. They respect and consider ideas generated by employees within a project team, regardless their ranks or position.

The firm considers research and development (R&D) as a major influence for their development and innovation in design. Thus, they invest in it to drive initiatives in applying or creating new design methods by computation or parametric tools. The R&D group focuses on three main streams including computational design, advanced modeling, and sustainable design. For example, the team develops a parametric tool that welcomes all design decisions from different team participants, predicts the impact of those decisions on the final design, and suggests some solutions to solve some problems.

4.2.3. 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 stations they have 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 Aedas Birmingham designs the depots and Aedas London provides three dimensional computational modeling support. Dubai's office focused more on dealing directly with the client and providing support for the team. Moreover, for engineering consultation they hired Capita Symonds and for the interior design KCA international, whom were selected by the client. Together, they developed a conceptual design that satisfies the client's demand and add to his 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. Capita Symonds, the engineering consultant, was replaced by Atkins to finish the same job on the other phases until completion. During this phase and until the detailed design phase, all project participants used a software program known as Aconex which worked as a hub for all project information and documents. Aconex helped on organizing and maintaining the information flow and team interaction 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, Aedas 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.

4.2.4. Analysis

The discussion will use the conceptual model introduced earlier.

a. Preparing for innovation

Aedas 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 about 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, Aedas 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. However, other designers can always participate by suggesting ideas to seniors.

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 Aedas proved its capability in exceeding the clients' needs through several projects. The firm realizes the contextual impact of their design product, 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.

b. 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. In addition to providing a metaphor of Dubai's heritage, they set other principals of design including the social and environmental aspects of Dubai. 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.

Innovation champions here were selected rather than emerging from the design team. 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, Robert Troup, and the design director, Boran Agoston 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 identified champions 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 emerged the challenge of chaos in the design team. Cockaday (2004) indicated the emergence of chaotic nature out of diverse teams collaborations. With the strong leadership those champions exhibited supported by their knowledge, 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 the 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 the software called Aconex helped in creating a smoother collaboration between the globally collaborating groups within the design team by providing a central platform where all groups can communicate knowledge and project information through.

c. 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. Secondly, sub-contractors for the project were selected by the client. As a leader, the client here could compose a team of strong designers and engineers and delegated the project's leadership of the project to Aedas.

As mentioned earlier, the design team was composed of groups operating from different offices around the world. Aedas 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 called Aconex which provided a medium for communication and information sharing. Aconex provided a central hub for all project's information and documents created by the different consultants within the design team. These information were accessible by all design team members. This concept of using similar technology in managing information was discussed in the literature (Udeaja et al, 2006; Tuncer, 2006).

Technology was not only used to maintain interactions and information flow, but also to make the design reach a realistic result which is ready for implementation. The complex form generated during the conceptual phase presented itself as a challenge to transform it into a

realistic possible outcome. 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.

d. Implementation

The project 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.

4.2.5. Conclusion

The design team, led by Aedas, could provide an innovative design solution for the metro project. The design did not only satisfy the client's brief, but also satisfied the function of the project in Dubai's context.

Aedas as a firm, showed its readiness for innovation which make it an attractive pick for the client to select for leading the project. Their innovation culture is supported by knowledgeable leaders who have a long experience in design in different parts of the world. They have offices in Fareast, Middle-East, and Europe which in-turn help in expanding the knowledge base in the company by this global collaboration.

The first trigger for innovation identified was the client demand. The client proposed a challenge for the design team to come up with an iconic design inspired by the Emarati culture. The leaders then, who also acted as innovation champions, sought other opportunities in the project. After researches and studies, they developed criteria and a framework for the project, and communicate them to all project groups. Then all parties collaborated in forming the design concept using CAD technology and experimenting with other digital tools. The design leaders awareness of the significance of sharing knowledge and information for defusing ideas made them look for a suitable solution that organize the flow of information between all collaborating parties. A program called Aconex, technological solution, was used to disseminate knowledge amongst the design team globally.

In maintaining the initiated innovation, project leaders and the use of technology had major roles for the concept survival. Leaders at first defined a clear framework for each project participant to avoid chaos and job hygiene factors. Moreover, they were responsible of most decisions including design and project organization decisions. They kept the client satisfied through meetings and implemented the use of Aconex program for smoother interaction and work flow in the project team. On the other hand, the use of technology did not only help in creating a smooth workflow, but also was used in making the design concept ready for implementation. With the use of parametric design tools, the team could configure the complex shell design of the metro stations and optimise it to realistic results.

All factors discussed in the conceptual model had shown their influence in this project. However, some had more influence than others, and some of them influenced other factors. It all started with the client's demand and that had an influence in all other factors. Other than that, collaborations and the use of technology had major roles in defusing innovation in the project team, while leadership and technology had major roles in maintaining innovation and drive it to more realistic results.

4.3. Case study 3

Project: Villa
Company name: NAGA architects
Project Type: private housing
Client: confidential
Location: Dubai

4.3.1. Project description

Unlike the two previous case studies, this one is considered a small size project with far less complexity. It is a design for a villa housing a family and two old parents who use wheel chairs so often. The client described the requirements and specifications that he wanted in the design, and the design team worked on his specifications considering the family member's conditions. The team could successfully achieve a design that went beyond the client's

expectation. The design provided a comfortable space especially for the old parents, and easy accessibility and circulation for the wheelchairs. Moreover, it included a landscaped yard that works in harmony with the designed residential mass, allowing natural ventilation and views to the external designed landscape.

4.3.2. The organization

NAGA Architects is a consultant firm that offers services in urban master planning & design, architectural & interior design, landscape, urban market research & design programming, real estate investment advice, building engineering & value engineering consultancy, and construction management. They believe that their vision, mission and core values create a conductive culture for innovation.

The firm was established in 2000, with two offices in Dubai, UAE, and Boston, USA with an ambitious vision of becoming a well established and respected name with award winning designs that are the first choice of property developers in the Middle East and eventually the world.

Their mission is to build attractive community for urban development projects with their transformational works that influence their surroundings. "Excelling in eight aspects of real estate development: idea inception, idea refinement, detailed feasibility, contract negotiation, formal commitment, construction management, completion & formal opening, and delivery of community development projects in the Middle Eastern region and eventually in the world."

People in NAGA come from diverse educational and cultural backgrounds. The firm always try to attract skilled, knowledgeable, and passionate talented people who can work together to harness innovation in projects and in the organization. All offices are designed in a way that allows open communication between different employees from different ranks.

4.3.3. The design process

The client explained what he wanted in his house design bringing up the issue of his parents comfort who usually use wheelchairs. Dr. Shams Naga, the founder of the firm, was directly dealing with the client. After clarifying the client's need, Dr. Naga, the project director, and a senior architect started collecting references that are related to the client's specifications to show him a variety of choices using pictures from books and old projects done by NAGA Architects and to develop programmatic schemes for the placements of rooms and circulation spaces. They sat with the client who pointed out what elements he liked from the references shown. After identifying the client's preferences, Naga sat with the senior architect to commence working the conceptual phase. Then the senior architect was left to work alone on it with the supervision of the project director. The client was involved during this phase making changes on the concept from time to time. After finishing with the conceptual phase, the senior architect had to communicate what he did to the interior designer, and the MEP engineer. During the schematic design phase, the architect and the interior designer worked at the same time, while the MEP engineer's involvement was minimal. During the next two final phases, design development and detailed design, all participants were heavily involved where each worked on their parts and the client evaluating details. The project is now at this phase of detailed design where the team started working on developing the construction documents.

4.3.4. Analysis
The discussion will use the conceptual model introduced earlier.

a. Preparing for innovation

Studying the organizational *culture and climate*, the firm exhibited strengths and weaknesses in supporting innovation. One major strength is that the firm usually engages its employees in design competitions against external entities. That enhances the knowledge and skills that employees have through exploration, exposure to other innovation champions, and researching at the beginning of each competition. Indeed, Tang (1998) which stated employees skills as a major construct for innovation. However, it seems that this is the only investment they

have regarding research and development. Other than that the company does not have a team that is dedicated only for research and development. Not investing in research and development is considered a drawback for innovation culture as Ahmed (1998) stated the significance of investing in research and development as a major factor that allows innovation in such environment.

Another strength they have is the strong relations that employees have. This pays off during the design process as the work environment allows open interactions between employees. It was observed that employees support each other even when they are not formally involved in a project. An architect would volunteer helping his colleagues by giving extra work references or actually help in design decisions. That agrees with the findings from Ahmed (1998) and Swan et al (1999) who stated that healthy relationships are valuable construct for innovation.

One major drawback that may have an influence in the firm's innovation culture is the observed hierarchy and chain of command. Almost all ideas come from the top as Dr. Naga himself usually sit with the assigned architect and tell him how to design or what to do. Most employees do not perceive that as guidance. Instead, some of them consider it as controlling their innovative abilities. Then the assigned architect will usually lead the project and later engage other assigned designers to the project which in turn adds another layer of limitations for the other designers. Most designers view this as centrality of command which affects innovation in projects. This agrees with the findings from Harkink and Tijhuis (2006) who showed how hierarchy affects innovation culture through a comparison between two companies, where one has a strong chain of command and the other tolerates flatter hierarchy during operation.

Senior leaders in the organization exhibit their strength through the strong knowledge they have in design field. The experience and knowledge they have act as a backbone for defusing, driving and leading innovation in design projects. However, their approach in empowering employees is perceived as strict control by most employees. It seems that they notice this employees' perception, as mentioned by one of the seniors, and they work on fixing it by leaving more room for designers to explore and innovate. Moreover, they realize the importance of keeping healthy relations amongst employees in defusing innovation. Sometimes, they engage their employees in activities informally just to create the feel of having a family in the office. Indeed, this is considered as a motivational technique as discussed by Halepota (2005) in motivational theories. It acts in fulfilling the social needs, and removing job hygiene issues in

the office environment. The significance in utilizing motivational techniques in maintaining innovation culture was also pointed out by Schulte et al (2010).

The *management* utilizes a sustainable growth that helps them overcome crucial market conditions. For instance, they did not practice the downsizing or firing employees during the economic crisis' peak by the end of 2008, which in turn created the feel of job security amongst employees. Indeed, job security is an important factor in satisfying the safety needs discussed by Halepota (2005) in motivational theories.

Taking the same approach Caerteling et al (2006) in analyzing *management* for innovation, the firm's management exhibited their strength in managing attention to clients' needs, systemizing ideas, managing relations, but had some problems with leadership. The firm keeps constant attention to their clients' needs starting with their initial request and evolving needs during their projects as seen in most of the projects in the firm. They have a systemized approach in establishing and maintaining ideas where they start by researching through references and evolve them to ideas that satisfy their client's needs. They further understand the importance of keeping healthy relations amongst employees and with their clients. It was observed how they celebrate team work achievements with their clients being involved throughout all design phases. Moreover, they would usually arrange events out of the work environment to strengthen the relations amongst their employees. However, the leadership exhibited was criticized by most employees where some of them stated that ideas are usually enforced in design teams by their leaders rather than being guided. Also, it seems that senior leaders noticed this issue and try to decrease their involvement to let ideas grow from design teams and work in guiding them.

b. Igniting innovation

The *client* had a significant role throughout the design process especially during the initial stages of the conceptual phase. According to Manley (2006), the client's demands are considered major trigger for innovation. Indeed, his request in this project of providing a design that is comfortable for his parents who use wheelchairs so often proposed the initial problem that directed the design team in creating this design solution. Further, the client was heavily involved during the initial phase where the team provided references from previous projects to him and

developed a programmatic scheme in collaboration with him. The team kept revising their progress in this phase with the client to further satisfy his evolving needs. This resulted in developing a conceptual design that met the client's initial demand, his evolving needs, and developing attributes that went beyond his expectations. This is a good example of what Schulte et al (2010) found out in which collaborative process is most valued element for innovation.

It was not witnessed the emergence of *innovation champion* in this project. However, the selected senior architect had a major role in driving the design idea to its end satisfactory result. This was a result of the imposed hierarchy and chain of command in this project. The founder of the firm actually sat with this senior architect to develop the design idea. As a result, the concept came from the top rather than utilizing the whole team's effort in developing the concept.

Although the firm maintains good *relations* amongst its employees, a problem was witnessed in this project during the conceptual phase. The senior architect was assigned as a sole leader in developing the conceptual design who later engaged the interior designer for further conceptual development. The interior designer made a lot of changes that did not agree with the initial concept. This resulted in a conflict between the designers over whose idea was best. The design director came to solve this problem and could establish a common ground where both designers were satisfied. He explained that what he did was increasing awareness of team's achievement rather than individuals', and the team should work together to strengthen the initial concept. This conflict resulted because there was no clear framework with clearly defined roles at the beginning of the project. Brennan & Dooley (2004) pointed out the significance of developing a conceptual framework to create a universal understanding of problems and solutions in a project team. However, the design director could solve this problem before it magnifies in later stages.

In this project, the team utilized *knowledge* from previous projects and external references to ignite innovation in collaboration with the client. From their organized knowledge of previous projects, the team used elements from their previous projects that satisfied the client's preferences. The firm provides a platform archiving previous projects by the firm. This agrees with what Udeaja et al (2006) pointed out, which was organizing past company's knowledge using technology is important for innovation. Further, their library of knowledge obtained from external sources including design books and innovations by other famous architects came handy to assess further development of the concept. Moreover, the informal

interactions that the work environment allows between all employees from different design teams encouraged knowledge sharing amongst employees resulting in enhancing the overall knowledge base the company obtains. This is similar to the idea of networking to defuse ideas by sharing knowledge discussed by Swan et al (1999).

Technology here was used in developing visual schemes for the conceptual design to assist the communication with the client and amongst the design team members. They used CAD programs to develop the mentioned schemes. This made the client's collaboration easier as he can see and visualize what the team is trying to achieve related to his knowledge.

c. Maintaining innovation

In this phase the design director could maintain the design concept and develop it further along the design process through managing the client's interaction, team members' collaboration, project's information flow, and use of technology.

The design director set milestones in agreement with the *client* where after each one the client was involved to evaluate the progress and provide suggestions for the next one. With this, he could maintain healthy relations with the client by updating him with the progress and integrating his evaluation and evolving needs.

Here, the design director could overcome the challenge of chaotic nature of teams' collaborations discussed by Cockaday (2004) by developing what Brennan & Dooley (2004) discussed as one of the major constructs for innovation, which was the development of a clear conceptual framework with clear roles of each project participant. Starting the design development phase, which falls under maintaining innovation in the conceptual model, the design director conducted a meeting with all members of the design team including the senior architect, interior designer, landscape designer, structural engineer, and the MEP (mechanical, electrical and plumbing) engineers where he clearly explained the role of each participant and the goal they want to achieve. By this, he could establish a framework where all participants knew their roles in order to achieve the project's goals, avoid any problems or conflicts resulting from role ambiguity of each participant, and maintain healthy *relations* amongst the team members.

Project's information in this project were disseminated and shared by face to face conversations and meetings throughout the design process as all team members were operating in

the same office environment. Swan et al (1999) found out that healthy relations are valuable construct to maintain good information flow and constructive team for innovation. Indeed, in this project, information flow was maintained by sustaining healthy relations between the team members from different disciplines as discussed earlier in this case.

CAD *technology* was used in this project as a tool to produce detailed drawings and digital models for the design. It was realized from the discussions with some of the employees that the technology they used did not have a significant change in the design idea, it made the process of development easier as they worked using the same design software, and reduced the time required for development. The program they used generated specifications and schedules while they were developing the design. Usually, schedules for specifications are time consuming and assigned to one employee. However, the team here could focus all their effort on producing the detailed drawings leaving the burden of making schedules and specifications to the program used.

d. Implementation

The project is now at the construction documentation phase where the team have to develop a detailed design with specifications for implementation.

4.3.5. Conclusion

This project is smaller in size compared to the projects presented in the previous case study. In this case the discussed project is a villa for a special client. The influential factors on innovation, which were discussed in the conceptual model, had shown their influence on this project especially the collaboration of the client, leadership and team members' relations.

The client here had a supreme role starting by his demand for the design, and the changes he proposed later during the design process. His demand was the major issue that the design team had to provide a solution for by deploying their knowledge and skills.

Leadership in this project was in the hand of the design director who was the formal leader for this project. He exhibited a fine leadership paying attention to the team's relations and the evolving client's needs. It was witnessed how he solved the conflict between the architect

and the interior designer during the conceptual phase. Also, he initiated a framework for the design team prior to the design development phase to maintain a smooth flow for the innovation process. The framework he set for the team drew clearly the role of each participant in the team and integrated the client's role.

The already established relations amongst employees in the organization had a positive influence in this project. It was witnessed that employees provided useful help to each other. Also, other employees who were not involved in the project provided voluntary help to the team members by sharing knowledge and deploying their skills as needed.

One observed drawback for innovation in this project is the hierarchy which made the project idea come from the top rather than coming from the design team. Also, the hierarchy did not allow the emergence of innovation champion in this project. This may had resulted in the loss of some opportunities or ideas that would emerge from the design team if a flatter hierarchy was promoted. As a result, employees' efforts had a minimal influence in igniting innovation.

Chapter 5: Discussion and Conclusion

5.1. Discussion

Each of the presented cases had a unique concept and approach. Also, in each project, teams had to develop innovative solutions that go beyond satisfying clients' needs and satisfy other contextual issues such as the project's location, culture and weather. In Xeritown project, the client was impressed with the design solution that responded to the harsh climate of Dubai and integrated the dunes landscape of the desert. Case study 2, the Dubai metro project by Aedas, provided a unique design with complex shell form that is integrated with the metro lines implying the concept of a string of pearls extended along Dubai's urban fabric. This gained the client's appreciation as it implied Dubai's prestige and the traditional practice of pearl diving. Also, it integrated this imagery concept with other functional issues of the metro stations. In the third case study, the design team developed a design that excelled the client's expectations. The Client's simple request of a comfy housing was translated into a design that provides easy accessibility, moderates the harsh climate of Dubai, and lessens the consumption of energy.

In all projects discussed, project teams were always exposed to organizational conditions which influence their innovation. Maintaining a convenient culture for innovation in organizations is important for encouraging innovation in their project teams. The observed factors from the case studies indicated that knowledge, leadership, and employees relations play major roles in shaping innovation culture. Enhancing the knowledge base is an important factor for innovation culture and that happens through the investment in research and development as seen in the first two case studies, X-Architects and Aedas, or by engaging employees in design competitions as presented in the case of NAGA architects. Leaders in the discussed cases have experience that helps them in providing the right guidance for their design teams and solve problems which come up during the design process. Employees' relations play a major role in maintaining a conductive culture for innovation as witnessed in all studied cases. It was observed that all discussed organizations realize the importance of this issue and strengthen the relation bonds between employees by engaging them in activities and social events.

Although triggers for innovation at the beginning of any design process vary according to the deployed design approach, the request of the client, knowledge, and team collaboration are major innovation triggers for most design projects. Indeed, these triggers were common in all three discussed projects. First of all, clients presented the problems that design teams had to attend and develop their design solution accordingly. Hence, the primary purpose for innovation in these projects is to provide best suitable solution for the problem proposed by the client. Client's request usually contains a lot of details in its folds which makes the team begin with a research phase to build and establish the necessary knowledge about the functional program and the context of development. After that the team works together combining their skills and knowledge to build the design concept. In addition to that, the first two discussed projects had other triggers for innovation at the early phases of the design process. In the first case study, Xiretown project, established relations with external entities related to the construction brought on board more knowledge and skills, thus had a role in igniting innovation. In the second case study, Dubai metro project, technology had a major role in igniting innovation as it allowed experimentations to discover different design possibilities, and it provided a platform for communication for the design team operating from different parts of the world.

After initiating the design concept, it is important to maintain it until the end of the design process by handling the client's collaboration, maintaining healthy relations, sustaining project's information flow, and utilizing technology. Indeed, the three discussed projects paid attention to these issues. However, leadership had the most significant role in maintaining innovation. Formal project leaders had to attend all these issues by developing a framework with clear roles for each project team's participants as witnessed in all the discussed cases. Moreover, it was witnessed that technology was heavily utilized during this phase in developing the design and maintaining information flow by providing a central platform for project data.

All discussed issues from the research conceptual model were presented in the case studies, except for the issue of innovation champion. The emergence of innovation champion was not clearly witnessed in the discussed projects. Instead, the formal project leaders acted as opportunity finders and design leaders. They generate the concept and empower others to strengthen it.

5.2. Conclusion

Innovation in construction projects during the design phase is firstly influenced by the organization where the design process takes place, and then by the other dynamic factors during the design process. Hence, it is significant for organizations, who want to achieve innovative design projects, to develop and maintain a culture that is conductive for innovation. Maintaining innovation culture in an organization is what allows and encourages innovation in all of its operations including the awarded design projects. Innovation culture is the starting point for innovation in any design project and it should always be supported by the organization's management and senior leadership. After that, the dynamic issues including the role of the client, champion of innovation, knowledge, team collaboration, and technology play major roles in igniting and maintaining innovation in design projects.

A design project team becomes ready for innovation when the company allows a conductive culture and climate for innovation. Through the analyzed case studies and the literature review, 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. This happens through investing in research and development and participation in design competitions to enhance knowledge, providing a work environment that allows open communication between different employees, and engage employees in different activities to strengthen their relations. The significance of these constructs is in the fact that they have great influence on other innovation culture constructs.

During the design process and beginning with the conceptual phase, the research discussed the role of client, knowledge, champion of innovation, team collaboration, and technology in defusing innovation. Each of them played a role in igniting innovation in the discussed design projects, but some had more influence and some did not play any role. The case studies placed more significance for the client, team collaboration, and knowledge roles in defusing innovation. All discussed projects start with a challenging client's demand which becomes 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. However, none of the discussed cases witnessed the emergence of innovation champions. Instead, formal leaders acted as innovation champions in all projects.

The client interaction, team collaboration, project information flow, and use of technology have major roles in maintaining innovation. It was evident from the discussed projects that they have a significant influence in driving the design idea to its end result. The study pointed out that leaders here have the most significant role in managing these issues. In all discussed cases, leaders utilized technology to manage information flow, and optimize the design to reach the desired results.

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Appendix A

XERITOWN Project
Project Type: Sustainable Residential Masterplan
Status: Masterplan Approval by Municipality
Client: Dubai Properties
Budget: Confidential
Design leader: X-Architects
Sub Consultants: Buro Happold, Smaq, Reflexion, Johannes Grothaus
Location: Dubailand, Dubai, UAE
Site: Site Area: 590,000 M2, Bldg. Area: 214,000 M2, Gross Floor Area: 486,000 M2, Bldg. Coverage Ratio: 26 %, Gross Floor Ratio: 83%
Program: Apartment Housing, Triplex Apartments, Courtyard Houses, Detached Villas, Community House, Retail, Mosques, Desert Life Museum, Kindergartens &Sports Field/Playground
Key Deliverables: Master Plan, Technical Reports (List)

Client Brief
"Xeritown" was a proposal to provide a 59 hectares sustainable mixed-use development in one of the fastest growing cities of the world: Dubai. It is located in Dubailand, a new extension of the city towards the inland desert and provides housing for approximately 7000 people.

Design Narrative
"Xeritown" takes the desert and local climate as a context within which the urban form emerges by working with the natural environment instead of against it.

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MBRACING
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ver Ephgrave investigates
ether xeriscaping will
come the standard
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e Middle East

Walk through any five-star hotel complex in Dubai and it is easy to forget that this is a city built on desert. The lush palms, expanses of green grass and manicured borders seem more akin to a city in the tropics than the arid Arabian Peninsula. Although this luxurious style of landscaping appeals to many of Dubai's visitors and residents, it belies the scarcity of rainwater in the region.

Xeritown is a visionary project in the under-development Bawadi district of Dubailand, and one that embraces the country's climate and landscape. The project's name pays homage to the principle of xenscaping - also called zeroscaping - a style of landscaping designed especially for arid climates. Commissioned by UAE developer Injaz and designed by Dubai based X architects, the project covers an area of 590,000 square metres and will provide housing for 7,000 people. According to the architects, the project is in the "final approval stage" and is due to be completed in 2012.

ZERO WATER

Xeriscape purists seek to create a landscape that requires no water for irrigation. If this is not possible, only recycled 'grey' water should be used. Mario Seneviratne, founder and secretary to the board of the Emirates Green Building Council, emphasises the importance of this principle. "Some of the developments and villas in the Jumeira area still use potable water for landscaping - this is atrocious and should be stopped forthwith. In this region, potable water is very, very scarce," he says.

Grey water is created by purifying wastewater - from showers and sinks - via a mechanical or a biological process. A water efficient landscape could earn one point in the LEED green building rating system; a landscape that requires no irrigation, or uses no potable water, will acquire two points. From January 1st, 2009, it will be manda

↑ Xeritown, Dubai

Ahmed Al Ali

"So many foreign landscaping companies are brought in to work here. They use the plants that they are used to. I doubt that many landscape companies actually investigate and see what's freely available here in this country."

However, X-architects is one company that has done its homework on the local flora. The Xeritown project will feature a staggering variety of desert vegetation, including trees, shrubs and annuals. For example, the driest areas of the site will contain willowy trees such as acacia tortillus, the Arabian ghaf tree and the yellow flowering acacia nilotica. Another section of the site will contain aloe vera, a plant that thrives in arid conditions.

Yet the company's search for suitable vegetation is not just limited to the UAE. Executive chairman of X-architects, Ahmed Al Ali, explains: "We don't solely use the indigenous plants – we also use varieties from other countries that can thrive in this environment. During the data collection process, we learned what plants can survive here without much water. Some of the species will require more water initially, but as they grow the required amount will be reduced, in some cases to zero. I think many of the plants are very beautiful."

RESPECTING THE SITE

Al Ali elaborates on his company's philosophy. "Whatever your style – be it historical or contemporary – we believe that an architect has to be sensitive to the site they are building on. Dubai is becoming like any other contemporary Asian city – there is not much difference between here, Hong Kong, Macau or any other city which has grown rapidly. We are careful about the context when we are building; every project is different.

"With Xeritown we felt it was important to respect the desert. We tried to understand the existing landscape before we built – the dunes, the different types of soil, flora and fauna. We also respect the built environment of the UAE. We're trying to bring Arabic architecture into modernity, but in a way that is sensitive to the environment."

Seneviratne agrees with this sentiment. "I believe it is important to preserve the Arabic identity through projects like Xeritown. We are losing our identity by just building steel and glass towers. You could be anywhere," he says.

Embracing the desert landscape will also have a positive effect on the local ecosystem. Al Ali says: "The plants and flowers will attract different types of wildlife to live in the area. We will keep as much of the natural landscape as possible. We are trying to work with the landscape rather than against it."

THE ALLURE OF GREEN

Seneviratne concedes that it is unrealistic to expect every development to fully adopt xeriscaping principles. He says: "It is essential to strike a balance between lush landscaping and arid landscaping. The critical factor is the use of grey water. If you have an abundance of treated grey water, you can go ahead and create a rainforest. But if you don't have much grey water then you should xeriscape. You can use all the water you like, so long as it's not potable water."

There are also ways of creating a lush green environment without using much water. Al Ali explains: "In Xeritown we only use young palm trees – the roots are deep and the trees don't consume as much water as mature palms. There are green areas but only a minimum amount. We use under-soil irrigation to make sure the water is not evaporated."

The project's name pays homage to the principle of xeriscaping – also called zeroscaping – a style of landscaping designed especially for arid climates

new developments in Dubai to earn a minimum ts to become LEED compliant.

ratne explains the additional applications for . "You can also use it in cooling plants, flushing cleaning driveways. So, even if there is not much nt for irrigation, there are still many ways you can water," he says.

TEN FLORA

to Seneviratne, landscapers that adhere to xeris-inciples could gain an extra LEED point on the "innovation". In addition to eradicating the use water, aspiring xeriscapers should only use vege-t survives in arid climates with little or no water.

Jabri, general manager for the Dubai office of ekkei, the Japan-based architecture company alises in sustainable design, believes that the igenous plants is overlooked in many local devel-

"It's a shame that everybody in the UAE uses re are so many other types of local vegetation on't see in the UAE very often; each plant can be beautiful way," he says.

cites the abundance of international consult-market as the reason for this trend. He explains:

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- The client gave the team total freedom to design what they think as an opportunity. During the interview, a senior architect said that the client clearly stated "this is the land. Show us what you can do". Together with the client, they begun exploring opportunities.
- The client representatives have knowledge and experience in the construction industry which made their collaboration more valuable.
- The team was eager in involving the client especially to evaluate the progress in each design phase.
- The client did not disclose any information about the project's budget to the design team. The design team leader mentioned that it did not have any influence on their performance. Instead, the team had more freedom to innovate and did not have to worry about designing according to budget.
- The company maintains healthy relations amongst employees.
- Relations with external entities related to construction. (engineering and architecture schools, engineering and architecture consultants in the region and globally
- Their relations with these entities paid off in this project as it allowed the formation of a solid design team.
- Knowledge in this project came from different sources including the company's researches, previous projects and the participation of other innovators collaborating with X-Architects in this project.
- Technology did not have a major role in defusing innovation in this project. However, it played a major role in maintaining innovation as it was utilized for documentation and developing the design drawings.
- Strongest influential factors in defusing innovation in this project were the client collaboration in exploring design opportunities, the knowledge and experience the company obtains, and the relations with established design companies.

Appendix B

Dubai Metro Project

Client: Roads and Transport Authority, Dubai
Architect: Aedas
Personnel in architect's firm who should receive special credit:
Project Director: Robert Troup, Registered Architect (UK), RIBA
Design Director: Boran Agoston, RAIA, Registered Architect (Bosnia & Herzegovina)
Architect of record: Rafael Viñoly Architects
Associate architect: Carla Bechelli Architects
Interior designer: KCA International
Engineer(s): Atkins
Consultant(s):
Lighting: Bo Steiber Lighting Design
Acoustical: Campbell Shillinglaw Lau Ltd.
Signage: Atelier Pacific Ltd.
General contractor:
Dubai Rail Link (DURL) Consortium which made up of Mitsubishi Heavy Industries,
Mitsubishi Corporation, Obayashi Corporation, Kajima Corporation and Yapı Merkezi
CAD system, project management, or other software used: AutoCAD, Aconex.

Project concept: an elegant shell forms spread in the context of Dubai and linked to each other by the metro lines implying a string of pearls. Also the team had to consider environmental and functional issues designing the stations.

- The client gave a challenging task for the design team which asked for providing an iconic design that represents a cultural aspect from UAE heritage.
- The team kept the client involved throughout the different stages of the design process.
- The company maintains healthy relations amongst employees who operate globally from different parts of the world. (Hong Kong, UK, KSA, UAE) which allows ideas to come from different cultural and contextual backgrounds
- Knowledge in this project came from different sources mostly from the individual designer's experience and the research and development team.
- Technology played a major role for defusing innovation in this project. The team kept experimenting with different design possibilities for the stations using digital programs.
- Strongest influential factors in defusing innovation in this project were the client request of providing an iconic design, team operating globally sharing knowledge and expertise from different parts of the world, and the use of technology as it allowed the exploration of different design opportunities.
- The team used a technology called Aconex (a software for information sharing). This helped in maintaining the speed of information flow where the team shares a central data base and gets updated immediately when a change takes place.
- Technology played a major role in maintaining innovation in this project, as well as the collaboration of the design team. The team dedicated to research and development came up with a solution using parametric design tools to configure the complex shell structure and paneling system.

Appendix C

Villa project in Dubai
Project Type: housing
Stage: construction documents.
Client: confidential
Budget: Confidential
Design leader: NAGA Architects
Location: Dubai
Design Concept: a comfortable, luxuries, and environmentally sustainable housing with easy accessibility for wheelchairs.

- The Client briefly requested a house that should be comfortable especially for his parents. This was the major trigger for innovation in this project as the team had to provide a solution for.
- The client needs were filtered through meetings where the design team (who were only the company's owner, the design director, and the senior architect). Together, with the client they could come up with a preliminary program and design concept.
- Knowledge sources in the company are mostly from books library that the company have and previous projects.
- The company invest in design competitions against other entities in the construction industry. This helps expanding the company's knowledge and keep up with the industry development in theories and practice.
- Employees exhibited strong relations in the work environment. However, there was a clear hierarchy in the organization and during design processes which makes most ideas come from the seniors mostly.
- The owner of the company usually design for the architects who later have to develop the idea further. One of the employees showed his frustration regarding this matter as it does not allow him to explore other opportunities.
- This hierarchy resulted in a problem during the conceptual design phase. A conflict took place between the senior architect and the interior designer. Both were seeking individual achievement rather than supporting each other. However, the design director immediately attended to solve this problem. Indeed, he could put the team back on track.
- The healthy relations amongst employees paid off in this project as members, even from different design teams, would volunteer sometimes sharing his knowledge and skills.
- Most influential factors in this project are the client's demand and employees relations.
- Technology played a significant role for maintaining innovation and driving the design idea to optimum results.