MANAGEMENT OF DYNAMICALLY COMPLEX PROJECTS
(AN APPLICATION OF AGILE TECHNIQUES)

A thesis submitted in partial fulfillment of the

requirements for the degree of

Masters of Science

in

Construction Engineering and Management

by

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This is to certify that the
thesis titled

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This thesis is dedicated to my parents, siblings, grand-parents, colleagues and my respected teachers!

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ABSTRACT

Construction industry in Pakistan consumes almost 80 percent of the national development budget and pays highest tax per million turn over. Construction industry is heterogeneous and enormously complex in nature, so crying need of hour is to focus on development of construction project management. Projects within the construction industry are not managed to change significantly in recent decades. This has resulted in a gap between the managerial vision and the actual execution of construction projects conducted today. Competitive market forces and growing social needs have triggered the demand for rapid delivery of construction projects. As projects become increasingly complicated, delays arise in a more unpredictable manner.

The initial motivation for this research is to explore a systematic flexible framework to deal with delays caused by complex changes in construction and meanwhile enhance the overall project performance. Since agility encompasses multiple meanings and principles, the first task was to provide a clear and specialized explanation, what agility means in the construction. Derived from extensive literature of agile theories, agile project management is an integrated method that allows project success in a complex environment by applying agile approach throughout the project lifecycle effectively. To fulfill the above objective a comparative study of traditional and agile project management practices in construction industry has been closely observed followed by identification of agile project key performance indicators (KPIs) which are then verified by qualitative survey with construction professionals, having ultimate goal of reducing delays and cost overrun.

Finally, an agile project management framework developed which will provide valuable information to clients, consultants and contractors and other stakeholders who desire to improve management techniques in dynamically complex construction projects.

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LIST OF ABBREVIATIONS

APM	Agile Project Management
ACM	Agile Construction Management
BIM	Building Information Modelling
CI	Construction Industry
EVM	Earned Value Management
KPI	Key Performance Indicators
OBS	Organizational Breakdown Structure
PMI	Project Management Institute
PBS	Project Breakdown Structure
PM	Project Management
SPSS	Statistical Package for Social Sciences
TPM	Traditional Project Management
TQM	Total Quality Management
WBS	Work Breakdown Structure

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Chapter 1

INTRODUCTION

1.1 BACKGROUND.

"*Project management is today a current area undergoing intensive development.*"

(Tonnquist, 2006, Preface), (Author's translation)

Discovering the prime method for overseeing, observing and synchronizing the undertakings is a persistent errand (Tonnquist, 2006). Conforming working systems, expressive parts and imagining the task distinction through new easy to understand administration instruments are instances of how this test can be met. Today, project administration frequently upsets the entire association whether it involves a little private association or a greater open corporate.

There are two general techniques that can be utilized to deal with a task (i.e. either an arrangement or procedure methodology) highlighted in customary undertaking administration by Turner (1999) and Boehm (2002). Though this conventional methodology is observed to be valuable for activities with less instabilities, complexities and all around characterized extension (Chin, 2004). The suspicions that dangers and instabilities are unsurprising. (Alleman, 2008) was of late fiercely slated (Atkinson et al, 2006).

The traditional way of handling construction projects is still the same since half a century on which CI relies. Project execution methods have been changed now. The distance between an old and new practices of managing construction projects creates an unease and uncertainty within the industry and its employees. With a specific end goal to examine the probabilities of utilizing an effectively expressed and checked administration approach, which is the point of this proposal, the prime need is to scrutinize the development's conventions industry and take a gander at the future's possibilities.

At the point when the venture is started the expense of task contrarily corresponding to the adjustment in outline, as the undertaking advances the expense of progress expanded and change turn out to be more troublesome (Gould and Joyce, 2009). This

is delineated in Figure 1.1, which demonstrates that cost expands and impact diminishes with time. Changes can become very costly both in time and cost, once the project is in its construction phase.

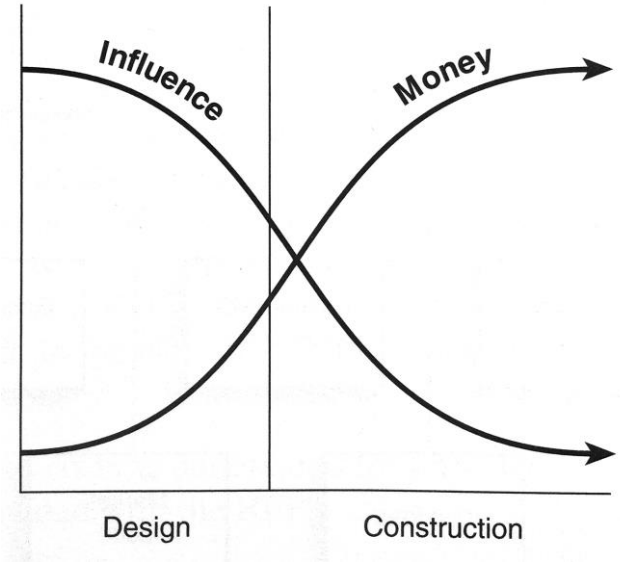


Figure 1.1 While the money spent in a project increases the ability to influence it decreases.

(Gould and Joyce, 2009)

Costly and timely last minute changes that were the prime part of traditional project management has been eliminated by employing agile project management approach that works on iterative process throughout project lifecycle (Schuh, 2005). The above objectives can only be achieved in some projects if organizations are able to adopt agile project management methodologies that are perspective specific and incorporate rigidity and variation within them (Sharifi and Zhang, 2001; Sharifi and Zhang, 2000). Costly supplementary rework and scope changes during the project are the characteristics of traditional project management, while agile project management is unambiguously designed to put up these concealed fluctuations.

1.2 PURPOSE OF STUDY

Uncertainty is an unavoidable part of most ventures, however even the most capable chiefs experience issues taking care of it. They utilize choice turning points to suspect results, hazard administration to avert debacles and successive cycles to verify everybody is gaining the craved ground, yet the undertaking still winds up with an

invade calendar, flooding spending plan and bargained details. Then again most noticeably bad, it just bites the dust.

This means our construction sector services are not maintained at such level where it meet the standards of the local and world construction services. It is hoped that this research can identify and understand the managerial challenges and opportunities confronting the Pakistani construction sector in terms of project complexity and uncertainty, and help investigate ways to mitigate and/or exploit them.

1.3 RESEARCH OBJECTIVES

Objectives set forth for this research work:

1. To compare the traditional and agile project management techniques in construction.
2. To identify construction project KPIs in light of agile project management techniques.
3. To formulate KPIs strategic framework using agile management techniques to improve cost and delay overrun in dynamically complex projects.

1.4 RESEARCH BENEFITS

Pros are that generally familiarize the AM approach to the CI; to study its advantages in association with the construction industry; to precisely discover the ultimate outcome of agile project management in construction projects that what can be gained. Moreover it is also anticipated that this research will help in implementing project management approaches and managing the challenges faced in consulting firms. This will inspire the implementation of agile project management at organizational level. Last but not the least this research will help in both academic and construction industry circles by opening new paths for project management and consulting works.

1.5 LIMITATIONS OF THE STUDY

The proposed research has some restrictions that must be considered before its consideration for any specific situation. The study concentrates on a comprehensive

subject of consulting firm that cannot be deliberated in detail due to the limitation of time and other means. Therefore the pragmatic data was collected from a contracted discernment using a case study.

Opportunities, hindrances that may exist different phases of development undertakings have not been considered. It has additionally been limited to the conventional and the lithe venture administration methodology found in the development business. Some other methodology has not been investigated further.

Lastly, the study did not quintessence on all measures and progressions in the firm whether they are applicable or not. It only concentrates on that which was pertinent to the work and the constraint of our study. In the light of academic work and expert advices recommendations were made.

1.6 SYNOPSIS OF CHAPTERS

The study has been separated into the accompanying expansive sections:

Part 1: Introduction: This area presents the foundation, motivation behind study, research goals and preferences furthermore talk about the study's restriction.

Part 2: Literature Review: Reviews hypothetical foundation of the concentrate, for example, conventional undertaking administration, nimble task administration and counseling.

Part 3: Methodology: This area takes a gander at system connected in the proposition, research setting and the hidden propriety research reasoning.

Part 4: Discussions and Results: This area examines the study and gives results from observational information.

Part 5: Recommendations and Conclusions: This area finishes up the study whilst making proposals for future exploration and on result of the study.

Chapter 2

LITERATURE REVIEW

2.1 BACKGROUND

There are two general methodologies that can be employed to manage a project (i.e. either a plan or process approach) highlighted in traditional project management by Turner (1999) and Boehm (2002). Contrary to the reality on the ground shows that projects are becoming more complex and the business atmosphere is also changing at unprecedented levels making it difficult to predict project behavior (Rodrigues and Bowers, 1996; Nobeoka and Cusumano, 1997; Hauc and Kovač, 2000; Chin, 2004; Shenhar, 2004; Gallo and Gardiner, 2007; Fernandez and Fernandez, 2009; Papke Shields *et al*, 2009;)

One of the developing project management approaches is agile project management, which provides diversified benefits complex projects to different organizations, however others believe it is applicable on all projects whether complex or not (Chin, 2004; Aguanno, 2004; Cicmil *et al*, 2006; Owen *et al*, 2006; Weinstein, 2009;).

Costly and timely last minute changes that were the prime part of traditional project management has been eliminated by employing agile project management approach that works on iterative process throughout project lifecycle (Schuh, 2005). The above objectives can only be achieved in some projects if organizations are able to adopt agile project management methodologies that are perspective specific and incorporate rigidity and variation within them (Sharifi and Zhang, 2001; Sharifi and Zhang 2000). This is thus as a result of in contrast to traditional project delivery methods that depends on costly additional rework, scope and demand changes as project progresses, dexterous undertaking administration is particularly intended to set up these sudden changes through its significance on planned thinking further as prioritization on task learning.

2.2 TRADITIONAL/WATERFALL MANAGEMENT

Several management strategies are used now a days and quite a few of them are old. The brief introduction to one of the traditional management method (TPM) is given

below which is known as Waterfall management, as shown in Figure 2.1. This introduction is given to understanding the standard method during which the development business is managed nowadays.

There are different phases during the course of the project life cycle in TPM (Hass, 2007). Controlled planning and methods are important part of this approach. The events are performed in strategic and organized ways. The project's future is assumed to be predictable in order to perform such extensive planning. When a stage is finished it ought not be reexamined. There are obviously both advantages and disadvantages of this methodology. One of the preferences is that it is systematized and simple to take after. It additionally offers accentuation to the customer's significance prerequisites. On the other side it is exceptionally uncommon that a venture can completely take after the grouping as arranged, following the conditions for the most part change with time furthermore it is troublesome for the customer to indicate in detail all necessities toward the begin.

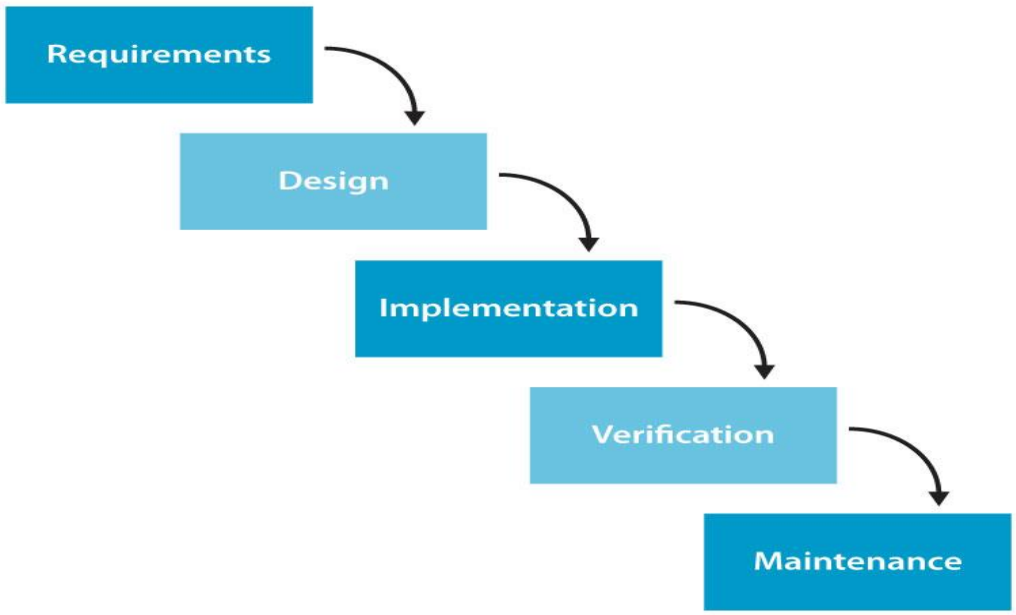


Figure 2.1 An illustration of an example of the Waterfall management approach.

2.3 DEFINITION OF APM

"Agility" is the aptitude to act pro-actively in a dynamic, continuously changing and unpredictable environment (Owen et al. 2006; Orr, 2005) and the aptitude to be naturally adoptable to the changing conditions without having any transformation is called as organizational ability (Tang et al., 2004).

Many scholars attempted to define APM from different aspects. The definitions mainly differ on the basis of the scholar's industrial prejudice and the level at which the term agile is taken (Owen et al., 2006) but they all have some common things. To a certain extent the broad definition from an IT perception is given by Cadle and Yeates (2008:429) who define APM as the *"various systems development approaches that emphasize flexibility, speed and user involvement in development systems*". On the other hand Highsmith (2004:16) forwarded by Conforto and Amaral (2008) give a broad definition of APM as *"a set of values, principles and practices that assist project teams in coming to grips with this challenging environment*". A more comprehensive definition of APM is given by Hass (2007) who defines APM as a highly iterative and incremental process, which demands that developers and project stakeholders get actively involved in *"working together to understand the domain, identify what needs to be built, and priorities functionality*". However, the important thing is that in all conditions, agile situations exhibit internal and/or external uncertainty that requires some unique expertise and a high level of determination to minimize the effect of dynamism (Fitsilis, 2008; Alleman, 2005). This is particularly important if one considers the currently prevailing situation and the mounting effect of the financial crisis on organizations. Chin (2004) gives an interesting equation to define the agile project management environment, which is;

Agile PM Environment = [Uncertainty + Unique Expertise] x Speed

According to Augustine and Woodcock (2008) the main responsibilities of the manager in an agile environment are setting the trend, creating simple and reproductive rules of the system, encouraging constant feedback, adaptation and collaboration. They argue that it enables project teams tangled with agile implementation to efficiently deal with change and look at the organization from a biological system perception (i.e. as a fluid and adaptive system inhabited by intelligent people). To complement this Alleman (2005) emphasize that smaller and manageable teams are an important part of agile

project management. In addition agile project management acknowledges that intelligent control and self-organization are the central beliefs (Conforto and Amaral, 2008). In view of the above, agile project management can be explained as iterative development techniques at systematic review points with importance on more rapidly collaboration among the client, stakeholders and small autonomous development teams in a malleable way that allows the system to evolve around the true project requirements at a certain point in time under a specific appropriate environment to completely minimize the effects of complexity ,unpredictability as well as uncertainties on final project delivery.

2.4 ORIGINS OF APM AND THE COMPLEXITY OF PROJECTS

Provide the market faster desired product / service, in order to meet the demands of customers, flexible, adaptable and ever-changing business needs, drivers and requirements demand project management approach (Macheridis, 2009; Weinstein, 2009; Shenhar, 2004). Failure to traditional project management, approached to meet such requirements in all circumstances that led to the evolution of agile project management (Augustine and Woodcock, 2008).

Agile Project Management (APM) methodologies are increasing becoming popular across different businesses (Macheridis, 2009; Griffiths, 2007; Chin, 2004) and hence there is a need to apprehend their origin, applicability and implications for the other industries such as consulting firms. Its implementation will improve the impossible project manager response and ability forecast construction industry, in order to explore the relevance of the agile concept to industries (Fernandez and Fernandez, 2009; Owen et al, 2006).

Although many scholars agree that APM methodologies emerged from software engineering agile frameworks such as eXtreme Programming (XP) and Scrum in the 1990s (Larman,2004; Boehm, 2006; Cicmil et al, 2006; Fitsilis, 2008; Hoda et al, 2008; Macheridis, 2009), Aguanno (2004) traces their development to the 1980s when the Japanese automobile manufacturers embraced them in their product development. He mentioned that they were lightweight way before the first adoption of agile term known as to exhibit the effect of the project who experienced a high level of change. This stand,

however, is somewhat controversial because Aguanno (2004) combines both lean and agile. According to Augustine and Woodcock (2008) APM principles and practices are hinged on the *"new science"* theory of Complex Adaptive Systems (CAS). This complexity theory is derived from the 'chaos theory'which is defined as the study of how order and patterns arise from apparently disordered systems (Elliot, 2008). Leybourne (2009) suggests that only some elements of CAS are applicable to APM. Therefore it may be necessary to adopt such generalizations with the necessary caution that they deserve.

2.5 THE UNDERLYING APM VALUES

According to Griffith (2007), the popularity of agile methodology in other industries began around 2002, therefore methodology is still evolving. Thus APM is a conclusion of a set of principles and concepts from the software industry (Chin, 2004; Conforto and Amaral, 2008), the information on its application in some industries is still inadequate. In light of this it can be gleaned that for successful APM adoption in other industries it is important to understand its values since they are the basis upon which its principles are derived (Alleman, 2005).Note that the table only shows values as indicated by the authors and not necessarily in the way they are linked.

Table 2.1: Comparison of APM values as stated by various Authors

	Agile Manifesto Larman (2004)	**Alleman (2005)**	**Conforto and Amaral (2008)**
Agile Project Management Values	Individuals and interactions over processes and tools	Feedback (i.e. Continuous feedback is essential for sustenance).	Encourage exploration
	Working software over comprehensive documentation		Deliver customer value
	Customer collaboration over contract negotiation	Humility (i.e. acknowledging contribution from client and team members)	Employ iterative feature delivery
	Responding to change over following a plan	Communication (i.e. Continuous communication among stakeholders is crucial).	Build adaptive teams

	Agile Manifesto Larman (2004)	Alleman (2005)	Conforto and Amaral (2008)
		Simplicity (i.e. using the simplest possible solution to identify the critical success factors). So that all iterations must add some value to the process.	Simplify
		Courage required for decision making during changes	Champion technical excellence

Summarized by authors

Table 2.1 Comparison of APM values as stated by various authors

It can be seen from this table that the APM values are being expanded dependent on the various views of the author. However, it is interesting to note that this development has been largely beneficial for different industries to understand the reasoning behind agile in their own context (Owen et al, 2006). In any case the expanded values still reflect the original agile values and thus they can be taken as the refinement of the agile manifesto over the years.

2.6 TRADITIONAL VERSUS AGILE PROJECT MANAGEMENT

The principles of engineering (e.g construction) and the defense industry played a crucial role in the development of the TPM methods (Augustine and Woodcock, 2008). This resulted in a focus on predictability, deterministic and reductionist approaches, which gave partial solution to the problem of project planning (Weaver, 2007).

The TPM methods had been used for a long time, and its success in certain industry by various scholars (Papke-Shields et al, 2009 Whitty and Maylor 2009 Grundy and Brown, 2004; Kerzner, 2003) highlighted. 2008). However, challenges of projects that have been marked by uncertainty and impulsiveness created (Cicmil et al, 2006; Alleman, 2005). This led to problems because of its rigid nature and the adoption of procedures for monitoring compliance with projects that adversely recorded the motivation, especially in the IT industry in which massive defaults to the project manager (Owen et al, 2006). Forced to bring the increasing pressure to speed quality IT products in a dynamic and rapidly changing global market IT professionals APM to

develop methods (Fitsilis, 2008). So different from TPM, the goal of agile, a small scale, fast delivery high speed (Collyer and Warren, 2009), and there will be more emphasis on communication and not as a process or plan (Macheredis, 2009). Therefore, the two differ in scope. A review of the literature shows that the two approaches differ mainly based on the following assumptions and properties.

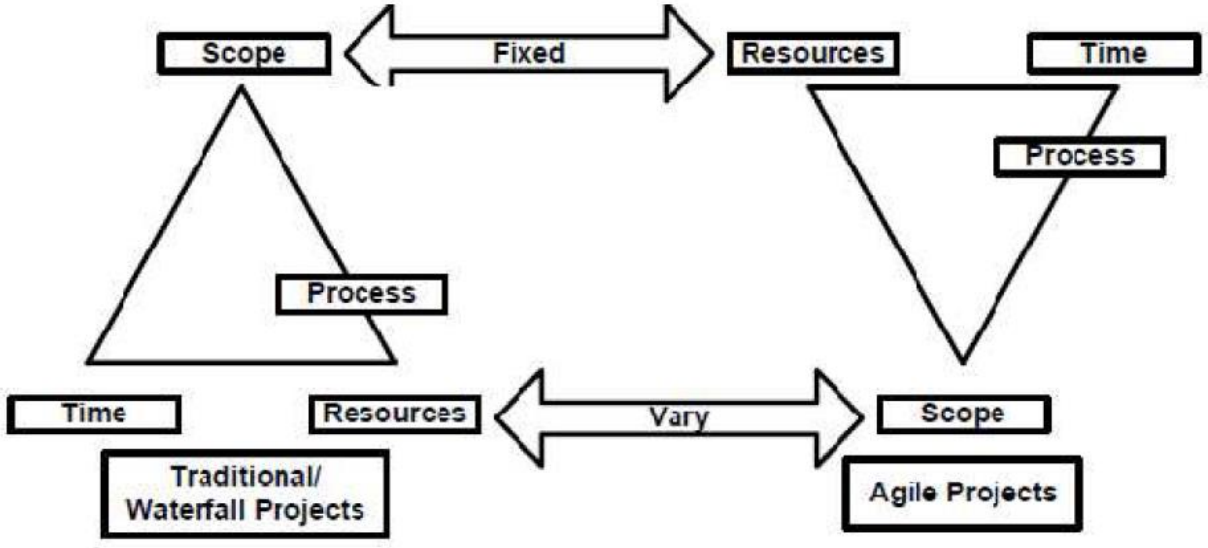
Adapted from Augustine and Woodcock (2008) and Hoda et al (2008)

Traditional Project Management	Agile Project Management
Focus on process and plan	Focus on people
Focus on developing all parts of the scope first .	Focus on the most important part of the scope first and then proceed to the next.
Regulation of changes is based on rigid Procedures.	Regulation of changes depends on flexible and adaptable procedures.
Members work individually within teams i.e. less collaboration.	Team members collaborate in all aspects.
Order establishment is facilitated by hierarchical organizational structures.	Order is established as a result of continuous and voluntary interaction in complex systems
Increased order is a result of increased control.	Self-organization, interaction and simple rules result in increased order.
Organizations must be rigid and static Hierarchies.	Organizations must be flexible and eliminate unnecessary bureaucracy.
Controlling type of management.	Management role is to facilitate and give support.
Employees are interchangeable 'parts' in the organizational 'machine'	Employees are an important part of the organization whose contribution is necessary.
Customer is mainly involved during requirements gathering and delivery phases	Customer is continuously involved throughout the project lifecycle
The reductionist task breakdown and allocation is necessary for solving problems (e.g. Work Breakdown Structure (WBS) and the Project Breakdown Structure (PBS)).	Iterative approaches to selected tasks with continuous feedback from team members and stakeholders result in valuable incremental progress in a short time.
Projects and risks are adequately predictable and it is possible to manage them through detailed and complex advance planning.	It is impossible to control the future because projects and risks are unpredictable due to uncertainties; therefore there is no need for detailed advance planning.

Table 2.2 Comparison between TPM and APM

Both task administration strategies are solid. As indicated by Frye (2009) Agile task administration can clear TPMs rules for undertaking start and conclusion advantage, correspondence administration; Project Integration Management; Project cost administration and danger administration. While TPM can likewise profit by "APM" independent groups; Flexibility and tolerating ceaseless conformity; Keep the need included clients and diminished documentation. In this way, the way to take after is principally subject to circumstances and sort of undertaking.

Figure 2.2 below forwarded (Cockburn, 2003) by Owen et al (2006) shows the conceptual difference between TPM and APM practices, where the famous "iron triangle" is turned on its head. It turns out that, in contrast to conventional project management, determining the scope, emphasizes the view APM functionality of the project environment, relating to the extent to be variable, while project resources (time and people) are fixed. While TPM is for stable conditions, it is also necessary for project managers in unpredictable situations, the dynamic and iterative development considered based on agile methods, where visionary leadership, continuous learning and customer benefit as much within the limits of time and budget (Fernandez and Fernandez, 2009 ;. Owen et al, 2006). This new approach to project management attracts the interest of modern scholars, and it is to be particularly relevant for the consulting industry, particularly in the case of large and complex projects to achieve a



Source: Owen *et al* (2006)

Figure 2.2 Conceptual differences between TPM and APM

number of project managers from different companies, all competing to their different organizational goals.

2.7 TYPES OF PROJECT COMPLEXITIES

2.7.1 Structural Complexity

Structural complexity, the most specified kind of many-sided quality in the writing, is identified with countless and reliant components (Williams, 1999). This is near the first idea of unpredictability as an arrangement of interrelated elements (Simon, 1962), and in addition the Oxford Dictionary meaning of the term ("The state or nature of being multifaceted or confounded; a component included in a convoluted procedure or situation.").

2.7.2 Uncertainty

The conceptualization of vulnerability as overseeing many-sided quality measurement is steady with the hypothesis of unpredictability. The instability influences both present and future conditions of each of the components that make up the previously mentioned framework, additionally how they interface and what the effect of these announcements and connections will be. For directors, it is experienced as a certain opening between the measure of information and data ideally anticipated that would choose, and what is available (Probst and Gomez, 1991). To the extent disperse quality speculation, the defenselessness is related to the major properties of complex systems, improvement (generally the state's precariousness), the non-linearity (basically the flimsiness of joint efforts) and positive data.

The thought of helplessness and their natural relationship with threats in the organization composing after the 1920s present. There are a couple of systems for portraying powerlessness. All things considered organization, it is standard to discuss unsteadiness as to the decision (the probability and the probability of occasion of an event) or as epistemic powerlessness (nonattendance of information, nonappearance of simultaneousness on present and future condition or ambiguity).

2.7.3 Dynamics

Stream implies the headway of undertakings, for instance, changes in points of interest (or changes in targets because of dubiousness - are related to "shakiness" over), the organization gathering, suppliers, or normal setting. These movements can lead the endeavor to anomalous measures of turmoil, redo, or inadequacy, if changes are not all that much conferred or consumed by the gathering and the others included. In component settings, it is moreover relevant to ensure that wander targets continue being conformed to those of key accomplices and new progressions in contention (e.g. NPD). Undertakings change "outside-in" and "back to front"; Team motivation levels can change, family unit technique can create. Grasp the shrouded designs in any occasion some bit of this dynamic can be a good procedure to avoid the "disorder", for case, by purposely control change process.

Deft PM (Highsmith, 2004) has proposed, closer to the convictions of advancement and the ascent of versatile quality researchers, an approach to manage the organization of exercises. The attributes for component diverse quality are altogether not so much made but rather more specific than that for the assistant versatile quality. Inventors tend to be greatly wide in portraying the word stream - for occasion, including all the variability and components (Maylor et al., 2008), the entirety and the impact of changes (Geraldi and Adlbrecht, 2007), or part specific issues, for instance, the level of structure overhaul after a pilot (Xia and Lee, 2005) is required.

2.7.4 Pace

Pace is an imperative sort of many-sided quality as earnestness and criticality of time objectives require distinctive structures and administration responsiveness (Clift and Vandenbosch, 1999; Remington and Pollack, 2007; Shenhar and Dvir, 2007). Williams (1999) offer accentuation to the requirement for synchronized designing to meet tightened venture time periods, which prompts more tightly association between components of the framework and along these lines overstates auxiliary many-sided quality. In later distribution, the same creator goes further and utilizes contentions of many-sided quality hypothesis and discoveries in significant undertakings to accentuation issues identified with a quickened pace in ventures.

Dissimilar to alternate sorts of multifaceted nature, high pace is not a unique build with a few pointers. It basically alludes to the rate at which activities are (or ought to be) conveyed, and has been abridged as "velocity of". Be that as it may, it is still hard to operationalise measures since pace alludes to the rate at which undertakings ought to be conveyed in respect to some sensible or ideal measure (much as the surely understood development administration idea of "over-swarming" is just characterized with respect to some standard or ideal worth).

2.7.5 Socio-Political Complexity

There is an in number stream of examination tasks and hassles that undertakings are done by human performing artists, with possibly clashing hobbies and troublesome identities (Clegg and Courpasson, 2004; Goldratt, 1997; Maylor, 2001). The excellent exchange of multifaceted nature was created by Roth and Senge (1996), a two-by-two network characterized along a given pivot is the fundamental many-sided quality of the issue circumstance which they call "dynamic unpredictability". They advance their definition by saying that "dynamic multifaceted nature describes the degree to which the relationship in the middle of reason and the subsequent impacts far away in time and space"; and along the second pivot they take the many-sided quality of the human and/or gathering impact they call conduct unpredictability "conduct many-sided quality portrays the degree to which the differences in the desires, mental models, and the estimations of those included" (p. 126). Issues of high many-sided quality in conduct as "malevolent"; the multifaceted nature in element high as "underhanded gambling clubs" (Roth and Senge, 1996).

2.8 PROJECT UNCERTAINTIES

2.8.1 Variation

Variation from numerous little impacts and performs a progression of qualities for a specific movement - action X can take 32-34 weeks to the case. Toward the ventures' start portrayed by variety, directors know the request and kind of action and obviously characterized goals. The undertaking arrangement is itemized and stable, however plans and spending plans vary from their normal qualities. A movement calendar brought

about the discriminating way (the train of exercises, that locate the aggregate task term) to move, driving undertaking administrator to screen varieties in all ranges, not just basic exercises. In another improvement, for instance, endless occasions (specialists disorder, climate, postponed incomplete conveyance, unexpected troubles of errands) impact spending plan, calendar and details. Such impacts are too little to arrange and to screen independently, yet the undertaking group had the capacity plan and screen the subsequent changes in expense and time.

2.8.2 Anticipated Uncertainty

Anticipated instabilities are identifiable and comprehended impacts that the administration can't be sure will happen. Not at all like variety, which originates from joined little impacts, anticipated vulnerability is discrete and may require all out danger administration with a few interchange arranges. Pharmaceutical improvement shows anticipated vulnerability. It is intended for distinguishing and overseeing dangers, basically as medication symptoms. A designer of another medication can envision conceivable reactions on the grounds that they have showed up beforehand in connected medications. It then can plot emergency courses of action to change the recommended measurements or confine utilization to specific side effects or very much controlled circumstances. The symptom is the anticipated instability. The emergency course of action may never be utilized, yet it is there if the reaction happens.

2.8.3 Unforeseen Uncertainty

As its name proposes, unexpected instability can't be perceived amid venture booking. There is no Plan B. The administration either is unconscious of the occasion's probability or thinks of it as impossible and doesn't try creating possibilities. "Obscure questions," or "unk-unks," as they are now and then called, settle on individuals uncomfortable in light of the fact that standing choice apparatuses don't address them. Unanticipated vulnerability is not generally brought on by astounding out of nowhere occasions, be that as it may. It additionally can emerge from the unforeseen joint effort of numerous occasions, each of which may, on a fundamental level, be predictable. Unexpected instability happens in any venture that pushes an innovation envelope or enters another or mostly known business sector.

2.8.4 Chaos

Whereas projects substance to unforeseen uncertainty start out with sensibly unwavering assumptions and objectives, projects subject to chaos do not. Even the basic structure of the project plan is uncertain, as is the case when technology is in disruption or when research, not development, is the main aim. Often the project ends up with final results that are completely different from the project's original aim. For example, in 1991, Sun Microsystems conceived of Java as software to drive a controlling device for household appliances. It wasn't until 1995 that Java became hugely successful as a programming language for Web pages. Ironically, a decade after Java's conception, we are finally seeing consumer-appliance applications for it.

2.9 AGILITY IN CONSTRUCTION

The manufacturing industry has experienced dramatic improvements in productivity, while reducing time and costs. However, the construction industry has not seen such positive results as it bears many similarities to manufacturing in the management of complex operations, as well as rapidly changing market dynamics and customer requirements. Opportunities for improvement are in demand. Therefore, research efforts have been taken to this aspect. For example, lean construction, inspired by lean production ideas seems to improve the overall productivity of the construction through the continuous processes of waste disposal. Agility, another theory behind booming in the manufacturing sector is still emerging in construction. In the literature of construction, agility was usually mentioned with leanness, as lean agile paradigms (Naylor et al., 1999).

A concept of "leagile" was discussed in terms of a lean and agile production system for mechanical and electrical construction. Dimension Agile offers flexibility of customer needs and the sales teams need in various stages of construction (Short et al., 2006 Court et al. 2009). In addition, Lu et al. 2011 proposed a model of lean agile production systems for homebuilders where part of agility is used to respond to fluctuations in market demand.

Other studies have evaluated the possibility of bringing agility in managing construction. Owen and Koskela (2006) examined the strength of agile manufacturing before supporting the construction industry could potentially benefit from agile project

management because of the proactive response to volatile changes. Owen et al. (2006) addressed the Agile Project Management (APM) could be provisionally suitable for the construction design phase that contains a greater involvement of customers and their conflicting demands because APM enables adherence to changes for continuous improvement, a particular creative solution for complex changes. In addition, the concept of Agile Construction was recently proposed by Daneshgari (2010), characterized by receptiveness and adaptation to unforeseen changes.

2.10 BENEFITS FROM IMPLEMENTING AGILE TECHNIQUE

2.10.1 Client Contribution

The guideline advantage, with applying Agile, organization in the, setup time of an, improvement endeavor shows up, to be the, client's advantage. Finally, it slips, to the client's joy, and satisfaction with, the completed result so if the client, is relentlessly included, and prepared to make, changes to the thing, while the endeavor is creating, it would lead, to more gainful, endeavors.

The Agile procedure, lets the client think, about the idea, and the objective, and specifically, about the unobtrusive components, and specific responses for the endeavor in the midst of its empowering.

2.10.2 Reduction of Uncertainties in Project

Composed organization, work in cycles that, last from one week, to four weeks. Within these cycles, there are each day, stand-up social affairs, to starting now get, a fast and successful enrollment on the, present day and, the things that, ought to be done, on the next day, produces. Exactly when scrutinizing the respondents, depictions, it is all in all completely like the Agile Strategy. You can set up cycles, for case, 2 weeks and toward the end of each cycle have, evaluated a meeting, an arrangement meeting, at which the headway, is discussed and the late cycle. By then, either another design, meeting to mastermind the, accompanying cycle or two occasions this, be solidified in a lone, meeting of the Evaluation, or Planning held.

2.10.3 Communication

Questioners frequently needed, to pass the correspondence, by the task, director or outline chief. That is on account of, they have to in, all matters emerging, in the undertaking furthermore on the grounds that it, might be inquiries, that can be replied, rapidly by the administrator himself be invigorated.

2.10.4 Program and Product Backlog

Period of the system is the serious time. On the off chance that the projects for the ventures analyzed were consummated or not is difficult to say, but rather when they figure out that the time when the most extraordinary, there are great motivations to trust that they have a considerable measure of exertion into it. Then again, they don't hold in a few tasks to the timetable, in spite of the fact that it creates a point by point program. They say it could have been brought on by the absence of interior assets and poor correspondence. This demonstrates the significance of dispersing data and correspondence, as they had a careful system is not ready to impart the accessibility's significance of assets sooner rather than later.

The hypothesis of Agile Management clarifies the significance of building up the item build-up or program. A buildup that is always upgraded and actualized gradually in the venture can help more exact calendars.

2.10.5 Initial Phases

Toward the starting ,of a venture, the coordinated, methodology is to adding to ,a strong vision for the task, and a very much created, correspondence arrange for ,that incorporates the organized gatherings, such that the, undertaking starts to fabricate a strong establishment.

2.10.6 Constant Improvement

Nimble methodology is, going to get some, an opportunity to get ready for ,the future, do a subsequent later, gain from it and afterward they, will enhance later on. The Agile methodology is beneficial, in a manner that a task begin, with just, a portion of the methodologies systems and after that, amid the venture's advancement, either, begin

with a few of his techniques, modify ,the utilization of existing, routines or can stop some ,of the present strategies. Because of the utilization of cycle were one, in the middle of, evaluated, enhanced and change the procedure that is at present being used, the task empowers the consistent change of effectiveness.

2.10.7 Time management

Agile approach may be of value in the construction industry, is the way it uses time-management, and with time as the most important factor that cannot be changed. Many construction projects today use time management as well, but it is the specific way in which the agile approach uses the ones who can benefit the construction industry. Through skillful planning at different levels with different time frames, it all boils down to small tasks just take a couple of hours to perform. This gives you a tool to evaluate efficiently, as the project progresses, it lags behind when, or if it is better than expected.

2.10.8 Differences

Something that needs to be considered is that the agile approach in a way, quite a lot of the way different projects carried out today. For example, the decision-making process will change if you switch to agile management. Some of the authority under which certain decisions will be transferred from the project manager on the project members. This change may not agree with some of the project manager to lose control of the projects. However, this is only a matter of trust, and it takes some getting used to. Hopefully, the project manager, the company will have the best interest in mind and should therefore do what it takes to improve results.

The employees are motivated by giving a proper level of responsibility. The Agile project management handovers part of the decision making to members of the project team from the project manager and according to literature they are dedicated and motivated for the project. This approach can attract anyone because it shows respect and trust.

2.11 EVALUATION OF KPIs IN CONSTRUCTION

OVERVIEW

APM is proposed as a conceivable administrative thought to manage complex situations in undertakings. One discriminating part of the structure, the KPI, investigates conceivable systems to accomplish deft execution all through task administration. Among all proposed KPIs, this study embraces the five KPIs as recognized by Fei Han (2013) to be more qualified for development ventures. These KPIs were hauled out from both other lithe building controls like coordinated assembling, and existing development related speculations and practice which could have the potential as main impetus to advance dexterity thoughts. These five KPIs are:

“Real time resource monitoring and productivity measurement.”
"Self-autonomous work teams with multi-functional crews.”
“Short-term planning along with concurrent execution of activities.”
“Continuous improvement based on learning organization.”
“Information technology integration.”

BACKGROUND

“APM” is a way to deal with overseeing ventures that permits the task to flourish under persistent and eccentric changes. At the point when contrasted with conventional and incline development administration, lithe administration has three noteworthy qualities:

a. It empowers both proactive and receptive reactions to up and coming changes.
b. It requires profoundly agreeable, level and self-persuaded working structures rather than extremely various leveled and successive structures.

c. It is a redundant and incremental procedure in light of nonstop learning and enhancing instead of a quick and streamlined procedure.

In light of the three's criteria qualities, five key lithe KPI's specified above are proposed for focusing on postponements and expense invade created by dubious changes, and eventually enhancing general project performance.

2.11.1 "Resource Monitoring and Productivity Measurement"

It has been found that astonishing change is one of the basic driver for date-book overpowers to end up transcendent being developed endeavors (Lee et al., 2006). For responsiveness to changes, keeping each day records of the measure of material and work hours have been put satisfies desires sufficiently in shortening a perfect chance to perceive startling changes. Tenacious recording of proficiency, then again, assists ventures with tracking so as to adjust to changes the difference of profitability routinely slanting to track efficiency fluctuation by measurable investigation, proposed by Daneshgari in 2010.

Being developed, resource checking has been executed as a bit of work in the Earned Value Management (EVM), a run of the mill undertaking control framework to give a quantitative assessing of timetable execution. EVM can be upgraded when resource use data is fitted to the Weibull dissemination and after that is dismembered probabilistically close by the threats included (Nassar et al., 2005). Concerning productivity evaluation, Choi and Minchin (2006) measured the difference of a wander's step by step effectiveness and recognized components that unfavorably impacted the regular gainfulness. PC based recreation fusing the impacts of different impedance calculates that may happen amid development is another system to gauge a normal measure of profitability (Choi, 2011). One essential favorable position of the estimation is that it gives administration with precise criticism to venture execution ahead of time, which backings better reaction to unanticipated issues.

2.11.2 "Self-autonomous and Multi-functional Work Teams"

Being deft should be reflected in sorting out the gathering affiliation. Isolating customary chains of significance into level structures can give improvement aggregates a beyond any doubt level of adaptability to settle all alone decisions on endeavor

changes. At the same time, particular workers with multi-handy aptitudes will suit more flexibility for changing work assignments to address endeavors, if important.

This contemplation was gotten from composed gathering in regards to multi-pros systems (MAS) where cross-handy administrators staying for assorted working stations are passed on all through the entire collecting methodology. The best approach to being deft in MAS is that these administrators are expected to run their occupations freely for individual goals, and direction with each other to achieve overall targets gainfully (Lim and Zhang, 2004; Wang et al., 2007). Truly, practically identical contemplations were similarly proposed in investigation related to the improvement store system. Xue et al. (2004) proposed a multi-administrators based structure in which all errand components are assigned a relating masters and fill as a rule for more viable store system coordination. In light of game plan and utility theories, this system showed to reinforce the decision displaying with regards to arranging issues in the midst of creation system operation (Lin and He, 2011).

2.11.3 "Short-term Planning with Concurrent Activity Execution"

Short-between time orchestrating (e.g., steady overview of timetable looking two weeks ahead) is a normal and segregating means for provisional laborers to initiate develops effortlessly. Pappas et al. (2003) battled that poor improvement proficiency is commonly brought on by a nonappearance of advantages at the gathering level. Giving resources properly is an orchestrating issue and short-between time organizing urges without a minute to extra resource supply, in like manner diminishing possible concedes and upgrading gainfulness (Pappas et al., 2003).

What's more, contractual workers live by the calendar. One objective of calendar audit is to seek after simultaneous work by executing however many exercises as would be prudent. Other than accelerating general task conveyance (Bogus et al., 2005), covering consecutive exercises really tries to impart certain adaptability all the while. Since the procedure of conforming the arrangement of exercises should bring administration more profound comprehension of the venture many-sided quality, which is an element that expands the capacity to be adaptable.

2.11.4 Continuous Improvement based on Learning Organization

Ceaseless change is not new in development and is underscored by other administration methodologies like incline development. The distinction lies in how nonstop change is accomplished. As indicated by incline standards, persistent change is obtained by a profoundly streamlined working procedure where change or mixed bag ought to be dodged as a waste (Salem and Zimmer, 2005).

A powerful correspondence component is discriminating in this procedure. One study showed 70% of the deferrals in development were because of absence of opportune and satisfactory correspondence between the gatherings included (Siddiqi & Akinhanmi, 2006). Empowering a learning society is considered as an option approach to enhance correspondence, particularly on a dynamic development jobsite, which adds to snappy choice rolling out and improvement usage (Love et al., 2000).

2.11.5 "Information Technology Integration"

Data innovation has changed the way individuals oversee and perform development venture exercises yet there is still space to completely incorporate them into this administration process. Confronted with always showing signs of change specialized and administration necessities, development experts can swing to programming devices to track and oversee extends productively. Adaptability is another favorable position when data is passed on and looked into through information mixture, web and Building Information Modeling (BIM) in an ongoing.

More potential advantages are increasing so as to be perceived exploration endeavors on it. An idea demonstrating system has been displayed unifying task databases created by all elements for work process and electronic record administration, and at last backing in a communitarian configuration process in development (Van Leeuwen and Fridqvist, 2006). Keeping in mind the end goal to manage the instability of development, recreating "consider the possibility that" situations are more than would normally be appropriate. Marx and König (2011) proposed discrete occasion reproduction in view of BIM that can be utilized to bolster development planning, which hence permits more responsiveness and "substantial" choice making. Preferably, it regards build up a virtual association of development (Jiang et al., 2011), a task based

element association that is upheld by data innovation incorporating the upsides of all undertaking elements to frame center abilities.

2.12 RESEARCH MOTIVATION

The studies above show that the proposed five KPIs are solid with the light-footed abilities. The inspiration of this learning emerges principally from how we can check the proposed dexterous KPIs and the entire thought of deft development administration. With a beginning examination objective of lessening development defers and cost overwhelm, this study conducts quantitative exploration on light-footed thoughts and KPIs from a key point of view to break down and think about their potential application in development (Adjei and Rwakatiwana, 2009).

2.13 RECOMMENDATIONS

To see how the move from today's method for execution of development ventures in the Agile way, an "interpretation" of the Agile methodology for the development business ought to be examined and created. It ought to from one viewpoint are the diverse parts and the parts and obligations and the way how taking care of and leading gatherings will change. The Agile strategy can be valuable in BIM (Building Information Modelling).This subject would be of enthusiasm to examine later on. A point for future examination may accordingly be conceivable on a littler piece of Agile Project Management and what valuable territories it could, if executed in the development business to focus. Another subject may be, to concentrate on related themes, for example, consumer loyalty or effectiveness, and consider whether and how these can be enhanced with the usage of APM.

There is today an agreement shape that supports organization and uses a kind of mentor to continually verify the diverse gatherings adhere to the coordinated effort assertion that was marked at the venture's outset. This agreement structure is utilized more utilized. It is likewise an agreement frame that would supplement the deft approach well and it may in this way have enthusiasm to research further.

Chapter 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

Research methodology demonstrates how the scientists are going to do their study to accomplish and answer research targets (Saunders et al., 2007). The examination was begun with broad writing survey as past studies, exploration papers, books on the subject and few contextual analyses. The strategies for gathering and producing examination information are the poll study and meetings. This exploration is led with an intend to think about for investigating the potential utilization of proposed deft KPIs in development. Schematic design of the exploration approach utilized as a part of this examination is given in Figure 3.1.

The gathered information was dissected utilizing MS exceed expectations and Statistical Package for the Social Sciences (SPSS-18). Tests for typicality and consistency of information were connected. All the chose parameters were investigated independently and a complete rating of execution was measured. The outcomes acquired are closed and a few proposals are made basing on these outcomes.

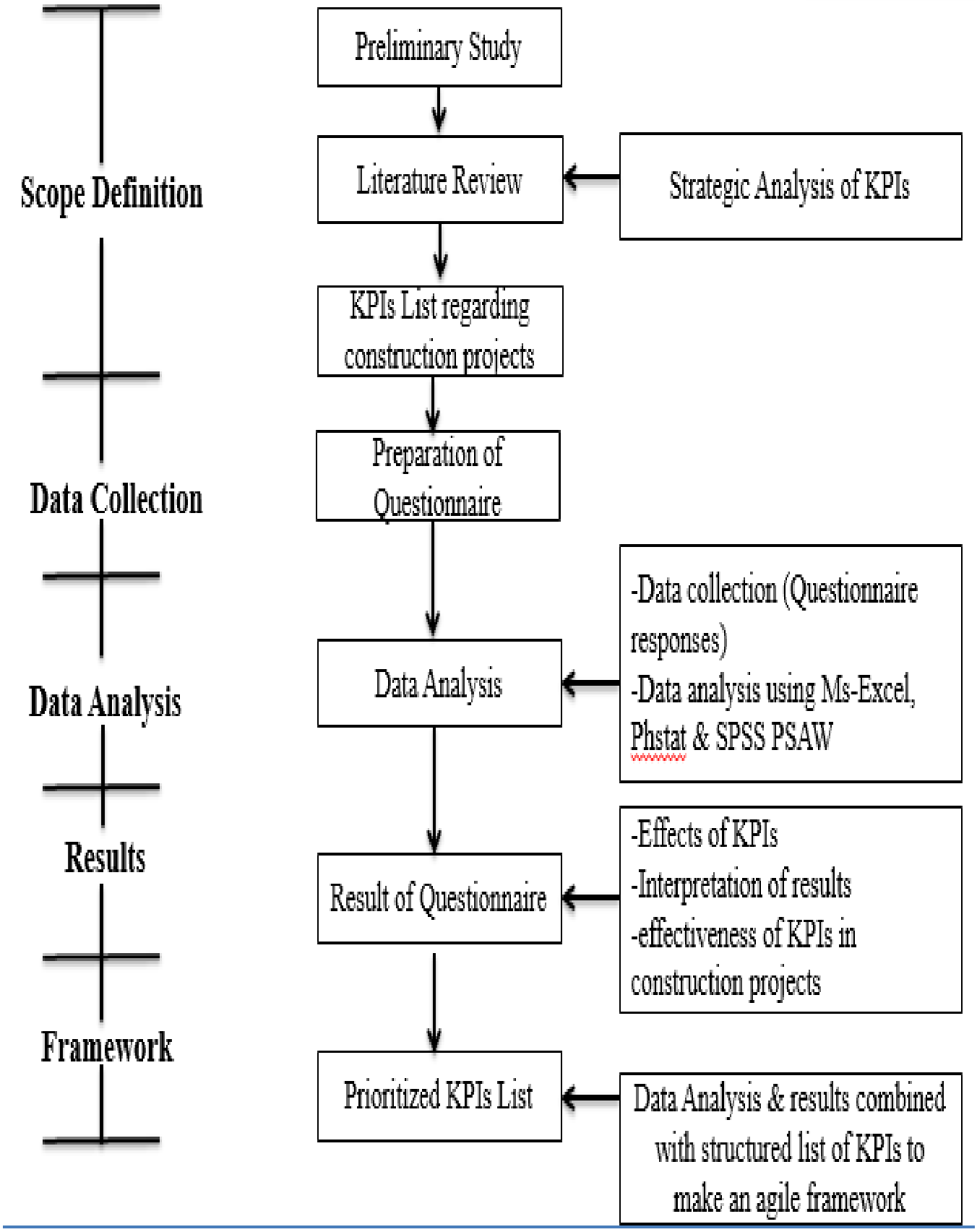


Figure 3.1 Research Methodology

3.2 THE QUESTIONNAIRE

The questionnaire was distributed in hard form as well as it was uploaded through "google Drive" for online filling and submission. Since the online submission through "google drive" is a paper free method, it provides more and speedy responses.

The questionnaire form consisted of two parts. Part I of the questionnaire was designed to make prioritized effect of key performance indicators on project management in construction industry of Pakistan. For this purpose 5 key performance indicators were chosen through extensive literature review and 16 parameters were identified to gauge their internal effects that are explored in part II of questionnaire.

Part II was designed to study the key performance indicators in construction industry of Pakistan. It consisted of five sections. Each section covers factors effecting each KPI.

First section covered general considerations for KPI's in construction industry and their effect based on their priorities. Second section, comprised of 16 questions covered the specific parameters regarding Key performance indicators. The third section consisting of 5 questions explored about some views of construction industry professionals who are implementing agile project management techniques in their projects.

A five-point likert scale, with 1 being very low and 5 being very high, was utilized to judge the performance parameters. All the stakeholders of CI including clients, consultants and contractors/subcontractors are made part of this survey.

The questionnaire was distributed in hard form as well as it was uploaded through "google Drive" for online filling and submission. Since the online submission through "google drive" is a paper free method, it provides more and speedy responses. A total of 104 questionnaires were invited online and 96 were sent to different firms and organizations. Out of these 200 questionnaires sent out, 156 were received. Incomplete questionnaires are excluded, so final analysis is carried out basing on 156 questionnaires.

3.2 SAMPLE SIZE

Calculation of accurate sample size during research survey plays very crucial and vital role accurate and reliable data analysis. It also ensures that surveyed data is true representation of target population keeping statistical power of data in mind (James

Lani, 2010). For a research study the sample size can be calculated through following empirical formula (Jonathan Wilson, 2010):-

$$n = N / [(1+N (e) 2]$$

Where,

n = Sample size

N = Population size

e = Precision level

Sample size that represents the targeted population can also be determined by using the below given equation (Shash and Abdul-Hadi, 1993):

$$\mathbf{n = n' / (1 + n' / N)}$$

Where;

n: sample size from finite population

N: total population

n′: sample size from infinite population, which can be calculated as $n'=S^2/ V^2$

S^2: standard error variance of population elements = P (1-P); maximum at P=0.5

V: standard error of sample population = 0.05 for confidence level 95%

There were 156 valid replies out of 200 showing an overall response rate of 78%. In the construction enterprises, a good response rate is around 30% (Black *et al.*, 2000). Therefore, the response rate in this research is acceptable. To know whether or not this sample size truly represents the population, Table 3.1 is used which exhibits sample sizes required for various population sizes and characteristics at three levels of precision.

Completed sample sizes needed for various population sizes and characteristics at three levels of precision.

	Sample size for the 95% confidence level					
	±10% Sampling Error		±5% Sampling Error		±3% Sampling Error	
Population Size	50/50 split	80/20 split	50/50 split	80/20 split	50/50 split	80/20 split
100	49	38	80	71	92	87
200	65	47	132	111	169	155
400	78	53	196	153	291	253
600	83	56	234	175	384	320
800	86	57	260	188	458	369
1,000	88	58	278	198	517	406
2,000	92	60	322	219	696	509
4,000	94	61	351	232	843	584
6,000	95	61	361	236	906	613
8,000	95	61	367	239	942	629
10,000	95	61	370	240	965	640
20,000	96	61	377	243	1,013	661
40,000	96	61	381	244	1,040	672
100,000	96	61	383	245	1,056	679
1,000,000	96	61	384	246	1,066	683
1,000,000,000	96	61	384	246	1,067	683

True Sample Size Source: (*Dillman, 2000)*

Until 2012, around 30000 building and civil engineering establishments have been registered with PEC. Practically, all these registered organizations would not be active in the CI; however this number can be used as the population size. Confidence level is selected as 95%. It is also assumed that the answers will be homogeneous and will set the p value to 0.5 (means that probability of occurrence is 50%). Using a fifty-fifty split maximizes the question variance, which requires the largest possible sample to control for the differences among the response options. By applying these values in equations (3.1) and/or (3.2), the sample size comes out to be 96 for a sampling error of ±10%. Analysis of the collected data by SPSS, gave maximum sampling error as ±7.8% which is less than ±10% so any sample over 96 is quite acceptable for a sampling error of ±10%. Hence, a sample comprising of 156 respondents is quite reliable for further analysis.

3.3 DATA COLLECTION

The main part of the research study was collection of required data, which was obtained through literature review and filling of questionnaire forms from targeted population.

3.4 RELIABILITY AND VALIDITY OF SURVEY

The unwavering quality and legitimacy of a study discover that the exploration instrument satisfies its expected reason. *"Unwavering quality alludes to the consistency of a measure and to the likelihood of acquiring comparable results if the measure is to be copied"* (Oppenheim, 1992). Unwavering quality can be measured in different ways however most usually utilized technique as a part of examines is inward consistency.

"Legitimacy figures out if the score or question can quantify what it should gauge" (Oppenheim, 1992). To find out the unwavering quality and legitimacy of a survey, scientists utilize various systems. As being what is indicated, some will allude to the examination instrument utilized as a part of past concentrates as of now been demonstrated legitimate and solid.

3.5 TEST FOR NORMALITY

An evaluation of the data normality is a pre-condition for the use of numerous statistical tests. It is performed to know whether data is normally distributed or not, i.e the data parametric or non-parametric in nature. A more thorough test of normality, suitable for data sets of about two thousands (2000) elements or less is presented by the Shapiro-Wilk test. To count as sufficiently normal, the Significance (Sig.) value should be non-significant (i.e. it should be larger than 0.05). For the data set more than 2,000 values, Kolmogorov-Smirnov test, also known as K-S Lilliefors, is more suitable. Hence in this study Shapiro-Wilk test is used to check the normality owing to the limitation of sample size.

3.6 DATA ANALYSIS STRATEGY

To get the reliable and practical outcomes out of received data from respondents across the country, data was segregated. It was distributed in different groups. Data analysis strategy is divided into following steps:

a. Distribution of received questionnaires into respondent category i.e. clients, consultants and contractors/subcontractors.
b. Acceptance/ rejection of questionnaire forms for final data analysis.
c. Entering of complete data into MS Excel and SPSS for its analysis.
d. Checking the normality and reliability of complete data.
e. Prioritization of KPIs.
f. Developing the framework
g. Writing of data reflective notes for conclusions and future recommendations.

3.7 AGILITY FRAMEWORK

To make a system for the administration of coordinated development, an exhaustive survey of the current writing is utilized as a first approach. The writing audit secured the field of administration of the development and additionally spryness in programming improvement and assembling. Since spryness envelops different implications and standards, the first errand was to give a reasonable and particular clarification what it implies deftness in the development and propose a dexterous administration system to take out instability.

Since the light-footed administration idea is as yet rising in development, a theoretical system is regarded fitting as a sort of middle of the road hypothesis that endeavors to associate all parts of exploration hobby. In this manner, diminishing the time may be more like a "critical thinking procedure" beginning from "issue ID" (postponement causes), "improvement arrangements" (hypothetical information/experimental and down to earth) on "assessment of results" and "lessons learned" (acceptance delay lessening systems). In addition, the proposed casing goes about as a guide which gives a consistency by any means "turning points" amid the deferral diminishment forms.

3.8 SUMMARY

This Chapter discusses the detail of formulation of survey questionnaire form and methodology for data analysis. Chapter also briefs in detail regarding the sample size and data collection procedures for data analysis. Finally the chapter tells about the adoption of various steps towards the data analysis strategy. Data is analyzed using MS excel PH stat and SPSS, to have frequency analysis, reliability analysis and parameter analysis.

Chapter 4

DATA COLLECTION AND COLLATION

4.1 INTRODUCTION

Construction industry of Pakistan is surveyed through questionnaire, which was designed to explore the agile project management key performance indicators (KPIs). Data analysis and results chapter contains the detailed analysis and outcomes of the research questionnaire in order of the questions.

4.2 STATISTICAL ANALYSIS

4.2.1 Reliability of the Sample

Cronbach's Coefficient Alpha Method

Internal consistency is most commonly assessed by Cronbach's Coefficient Alpha method, also when Likert scale is used in the study; this method is mostly used to check the reliability of the scale. If the Cronbach's Coefficient Alpha's value is between 0.7 to 0.9 data is acceptable for further analysis, whereas when its value exceeds 0.9 the data is considered as excellent for analysis (Li, 2007). For the present case Caronbach's coefficient alpha is calculated using SPSS which came out 0.705 as shown in Table. This value indicates that data is consistent and reliable, further analysis can be started.

Case Processing Summary

		N	%
Cases	Valid	156	100.0
	Excluded[a]	0	.0
	Total	156	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.705	.728	12

4.2.2 Measurement of Normality of Data

Shapiro Wilk normality test

Shapiro Wilk normality test is directed as appeared in table. The sort of information utilized for the examination study was on ordinal scale and all the more absolutely it depended on the Likert scale estimation including different classes of respondents the nation over in this way. This test is performed to check the typicality of information according to the necessities of test size which is under 2000. This test is performed to know the way of information that is either parametric or non-parametric. Noteworthiness quality found from the test is 0.00 which demonstrates that the information is not regularly circulated, with respect to adequately ordinary information criticalness worth ought to be more noteworthy than 0.05. In this manner, for current information non-parametric systems are utilized for further investigation as information is not ordinarily appropriated.

Tests of Normality

	Shapiro-Wilk		
	Statistic	df	Sig.
How long have you been with your present organization?	.760	156	.000
How long have you been involved in construction development?	.743	156	.000
Qualification	.756	156	.000
Type of Your Organization?	.791	156	.000
Your Company/organization belong to which sector?	.763	156	.000
[Resource Monitoring and Productivity Measurement]	.785	156	.000
[Self-autonomous and Multi-functional work Teams]	.838	156	.000
[Short-term Planning with Concurrent Activity Execution]	.894	156	.000
[Continuous Improvement based on Learning Organization]	.877	156	.000
[Information Technology Integration]	.884	156	.000

Do these 5 KPIs are consistent with agile capabilities?	.751	156	.000
Supply chain coordination system supports the decision-making in case of coordinating issues	.729	156	.000
which technique of planning is more critical	.751	156	.000
Poor construction productivity is commonly caused by a lack of resources at the crew level	.729	156	.000
The delays in construction are due to lack of timely and adequate communication between the parties involved	.729	156	.000
In order to deal with the uncertainty of construction, simulating "what-if" scenario is more than necessary	.729	156	.000

a. Lilliefors Significance Correction

4.3 ANALYSIS OF RESPONSE

The questionnaires were distributed to group of four stakeholders working in project management units with construction professionals and professional consultancy firms in the construction industry of Pakistan and theses firms belongs to different sectors. Tables-4.1 shows the number of respondents and percentage of returned questionnaires whereas Table-4.2 shows the number and percentage of responses from different sectors like private, government and semi governments.

Respondent Profile	**Reponses**	**Percentage**
Client/Owner	17	10.9%
Consultant	60	38.5%
Contractor	37	23.7%
Academic/Researcher	35	22.4%
Other	7	4.5%
Total	156	

Table 4.1 Number of Respondents

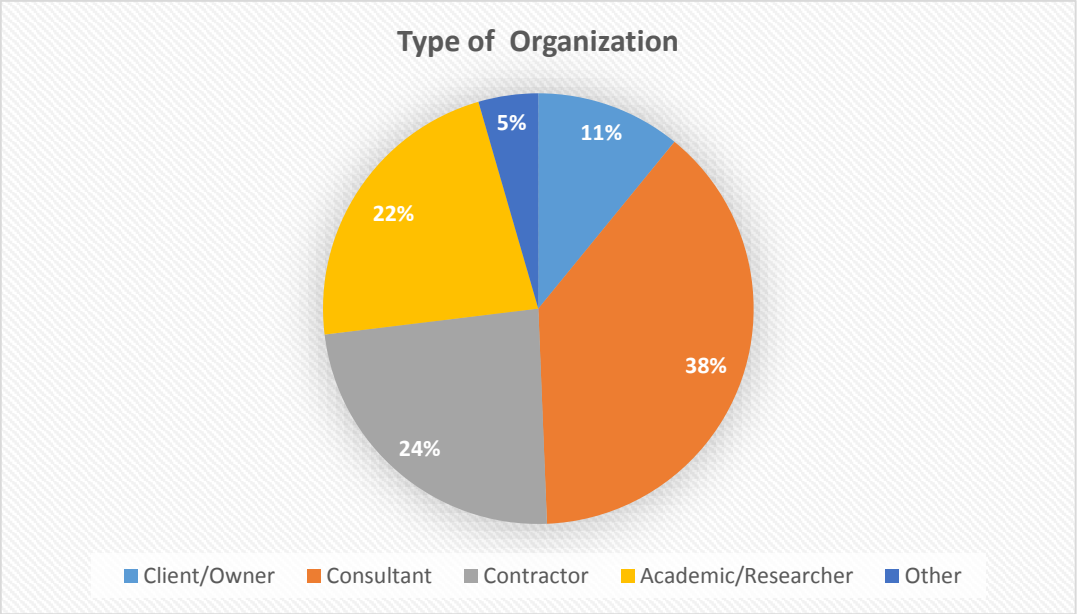


Figure 4.1 Type of Organization

The questionnaire was designed to be answered by respondents who are professionals with experience in the Pakistan's construction industry routinely belongs to consultants, clients/owners, contractor and researcher class of stakeholders. This target was achieved from the statistics presented in Table 4.3. .

Sector of Organization	**Percentage**
Public Sector/Government	30.77%
Private	46.15%
Semi Government	23.08%

Table 4.2 Sectors of Organizations

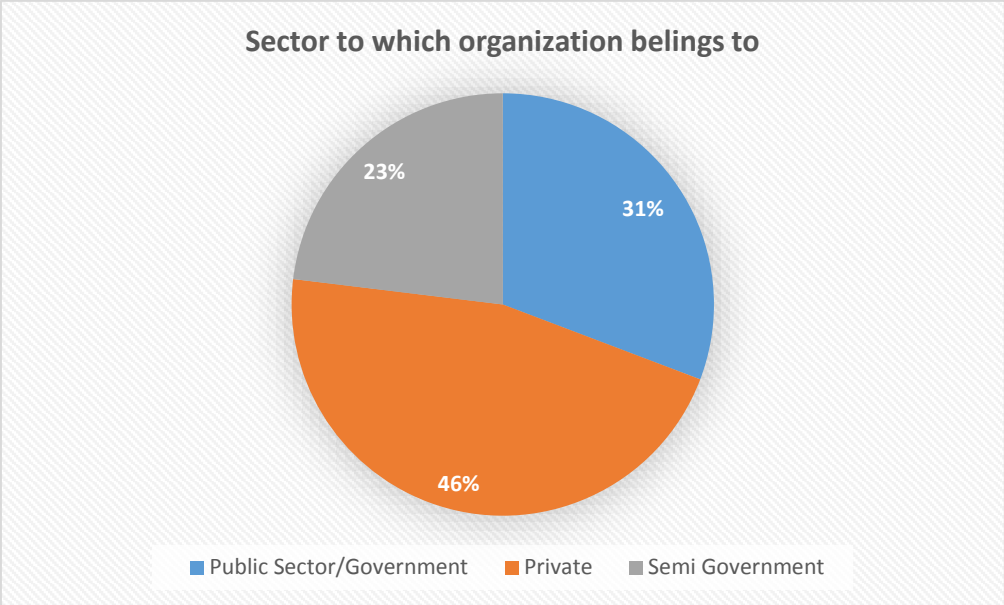


Figure 4.2 Sector of organization

4.4 ANALYSIS AND DISCUSSION OF QUESTIONNAIRE

MS Excel, Minitabs and SPSS-PSAW-18 were the software used for the analysis of collected data. The interpretation of the results is discussed in coming paragraphs.

Experience of the Stakeholders in the Construction Industry

Experience of Respondents	**Percentage of Respondents**	**Cumulative Percentage**
0-5 years	21%	21%
6-10 years	34%	55%
11-15 years	31%	86%
16-20 years	10%	95%
20+ years	5%	100%
Total	100%	-

Table 4.3 Experience of Respondents

From Table 4.2 above, 21 percent of respondents have 0-5 year experience, 34 percent have 6-10 year experience, 31 percent have 11-15 year experience, 10 percent have 16-20 year experience and 5 percent have over 20 year experience in construction industry. The survey shows that the 79 percent of respondents were having experience more than 5 year in construction industry in Pakistan.

This indicate that, most of the questionnaires were answered by people who were construction professionals, experienced and have theoretical and practical knowledge in active project management of construction projects.

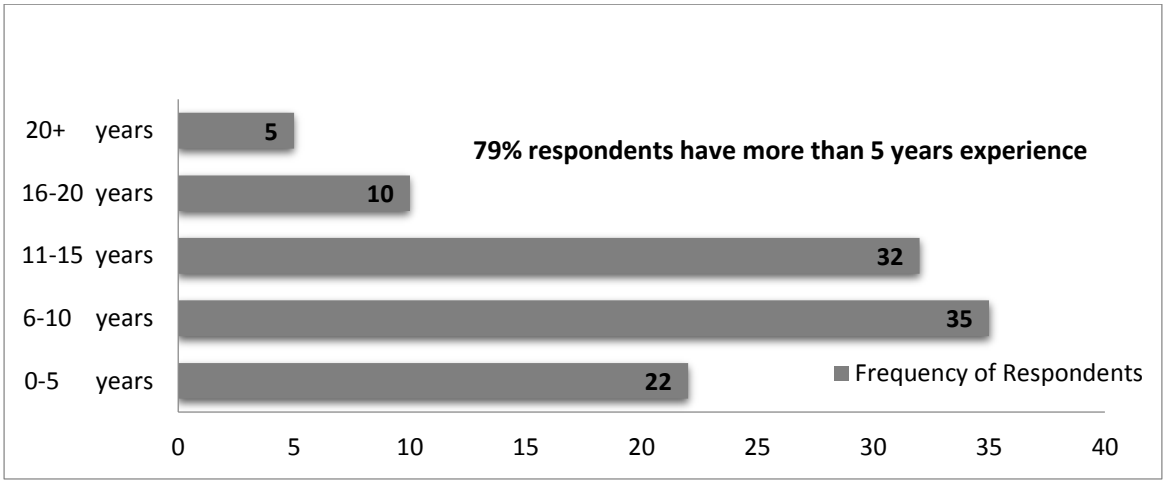


Figure 4.3 Experience Record

4.5 SOLICITATION OF KEY PERFORMANCE INDICATORS IN RECENT CONSTRUCTION INDUSTRY SETUP

It can be seen from the results that Resource Monitoring and Productivity Measurement is most commonly used KPI in projects.

Key Performance Indicators	**Percentage**
[Resource Monitoring and Productivity Measurement]	38%
[Self-autonomous and Multi-functional work Teams]	21%
[Short-term Planning with Concurrent Activity Execution]	17%

[Continuous Improvement based on Learning Organization]	14%
[Information Technology Integration]	10%

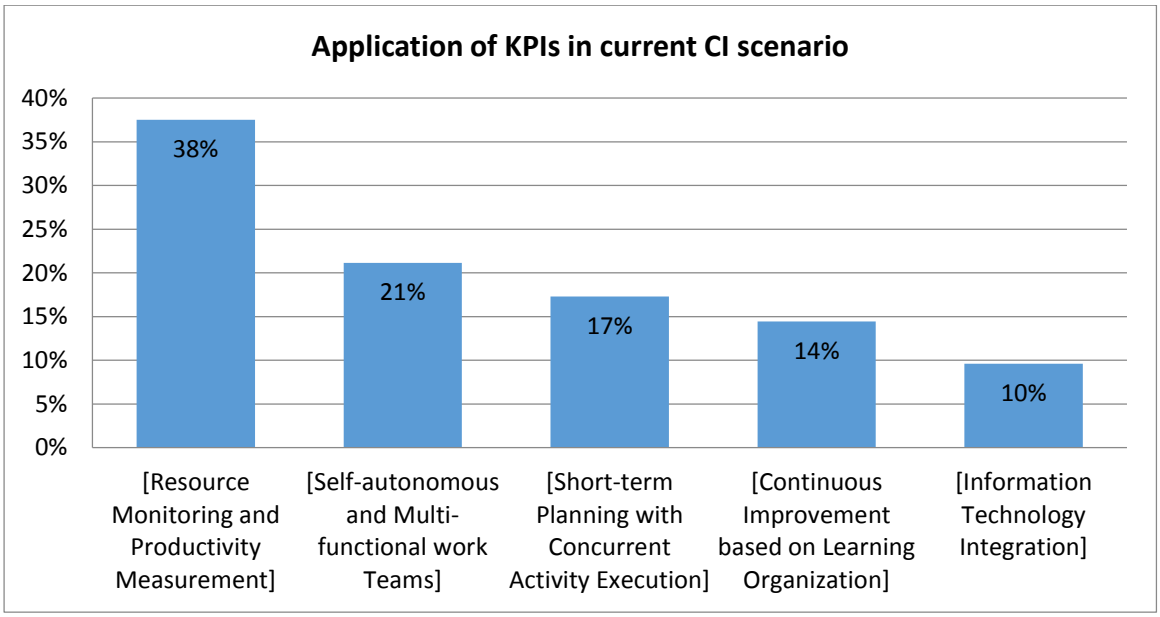


Figure 4.4 Application of KPIs in current CI scenario

Same pattern will be followed for each KPI and there sub questions. Each question will be dealt separately and result will be shown in form of histograms and pie charts.

4.5.1 Consistency of Key performance indicators with Agile Capabilities

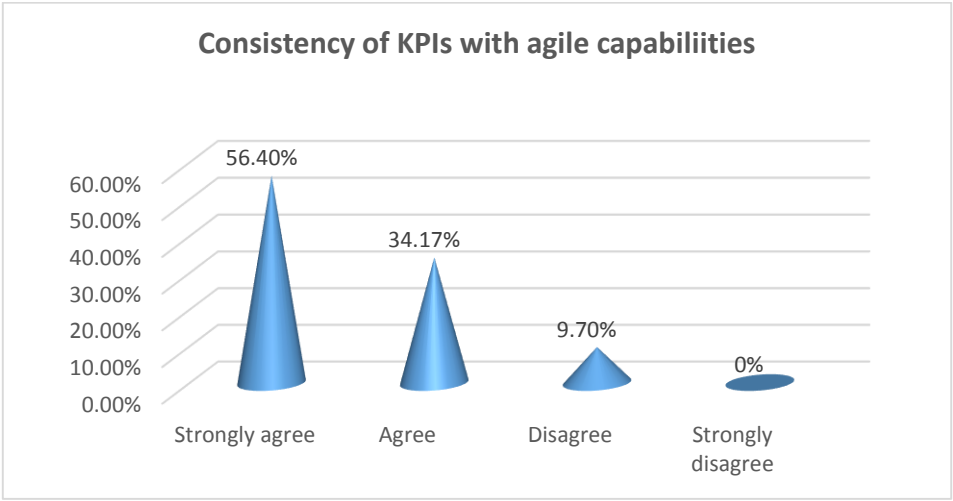


Figure 4.5 Consistency of KPIs with agile capabilities

More than 50% of the respondents have the opinion that these selected key performance indicators are consistent with the agile capabilities of their project.

4.6 ANALYSIS OF FACTORS AFFECTING KEY PERFORMANCE INDICATORS

4.6.1 Resource Monitoring and Productivity Measurement

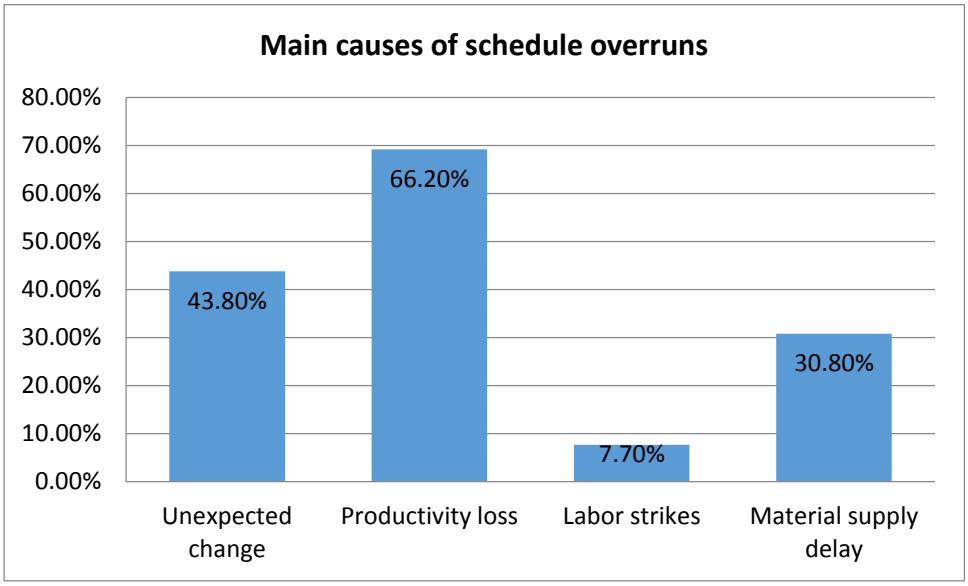


Figure 4.6 Main causes of schedule overruns

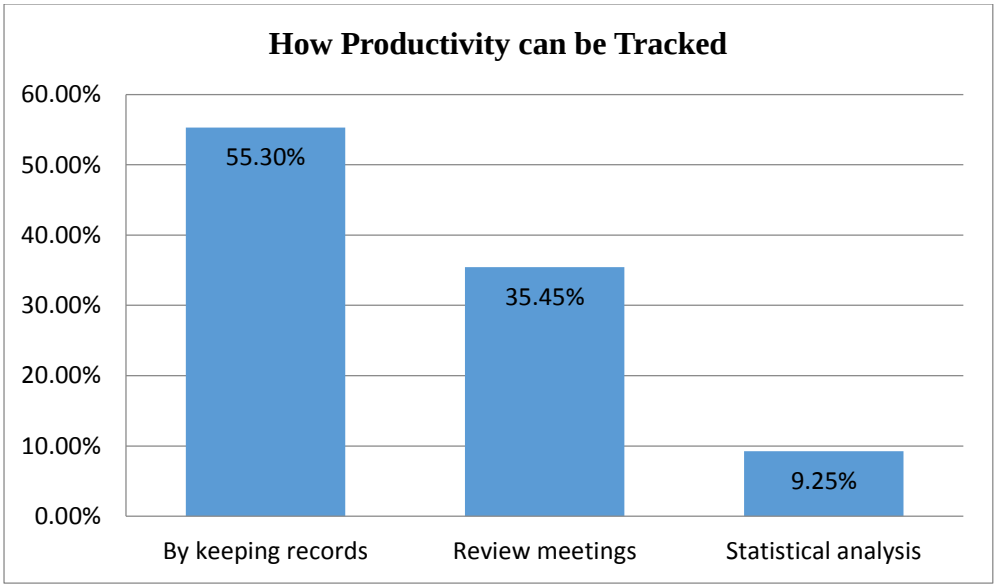


Figure 4.7 How Productivity can be tracked

It has been found that productivity loss and unexpected change are main grounds for schedule plunders (Lee et al., 2006). Keeping daily records of resources of invested works effectively help to detect the productivity loss and unexpected changes which

will effect responsiveness of project performance as shown in Figure 4.6. Incessant recording of productivity helps in tracking the alteration of productivity regularly as shown in Figure-4.7 (Daneshgari, 2010).

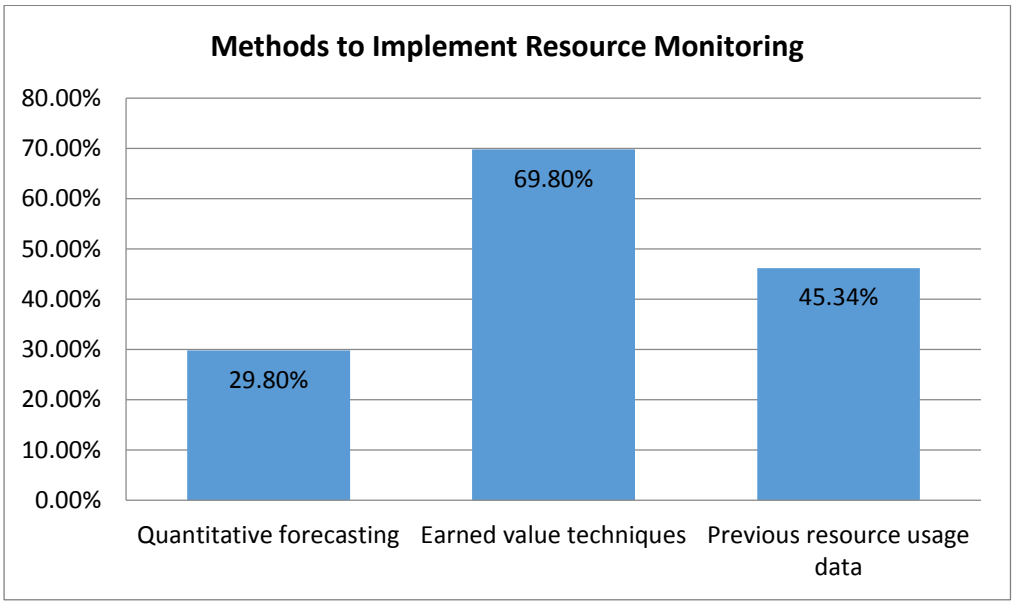


Figure 4.8 Methods to Implement Resource Monitoring

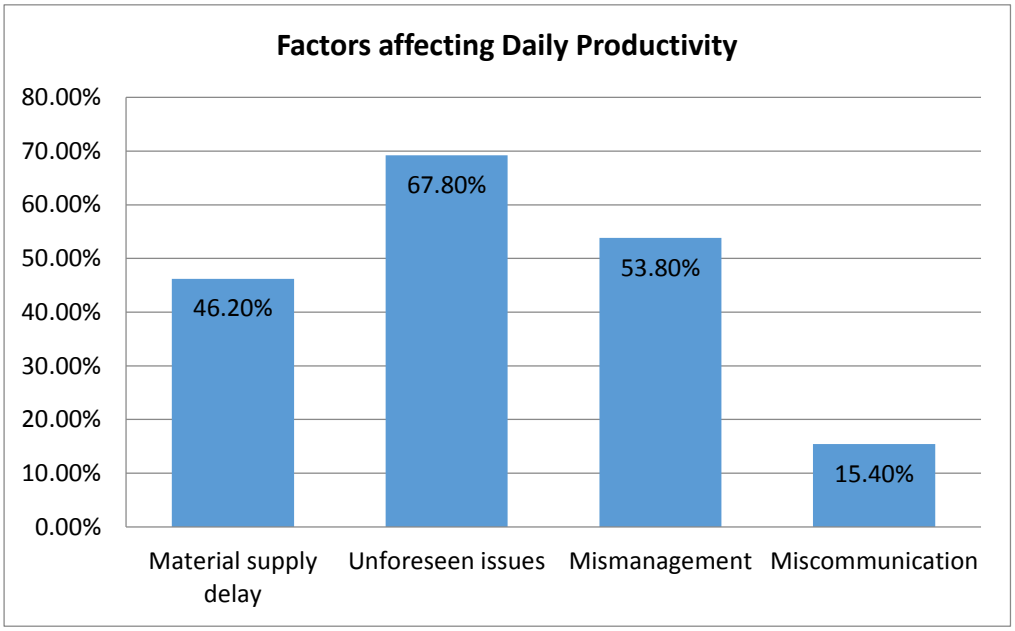


Figure 4.9 Factors affecting Daily Productivity

Resource monitoring has been applied in Earned Value Management (EVM) to provide a quantitative forecasting, of schedule (Nassar et al., 2005), as shown in Figure-4.8

Delay in material supply, unforeseen issues, mismanagement and miscommunication are some factors contribute towards affecting daily productivity on job site. Out of

which the most critical factor is unforeseen issues. These issues should be catered on site so the productivity can't be loosed and schedule overruns can be avoided as shown in Figure-4.9.

4.6.2 Self-autonomous and Multi-functional Work Teams

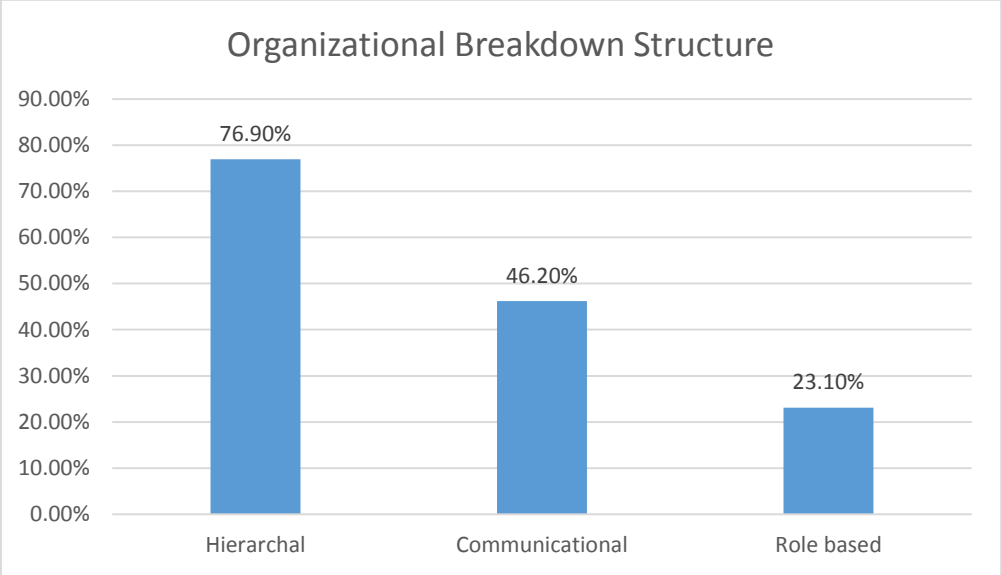


Figure 4.10 Organizational Breakdown Structure

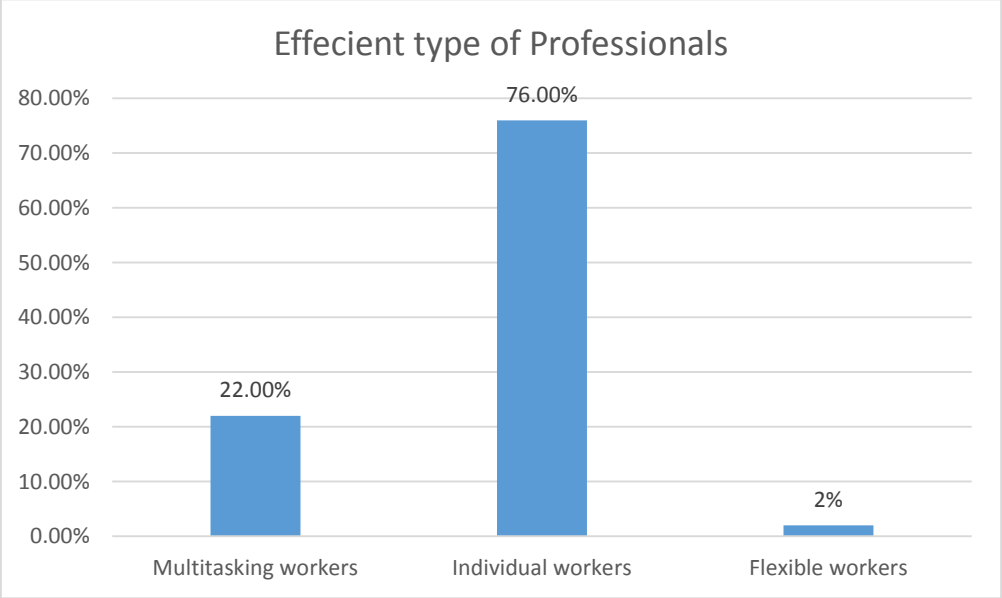


Figure 4.11 Efficient type of Professionals

Being agile should be reflected in organizational breakdown structure. Breaking down traditional hierarchies structures at crew level will provide freedom to the workers ti make their own decisions. The results show that most of the organizations based on hierarchal system. As they give more importance to the system in which members of

an organization or society are ranked according to relative status or authority as shown in Figure-4.10 and Figure-4.11

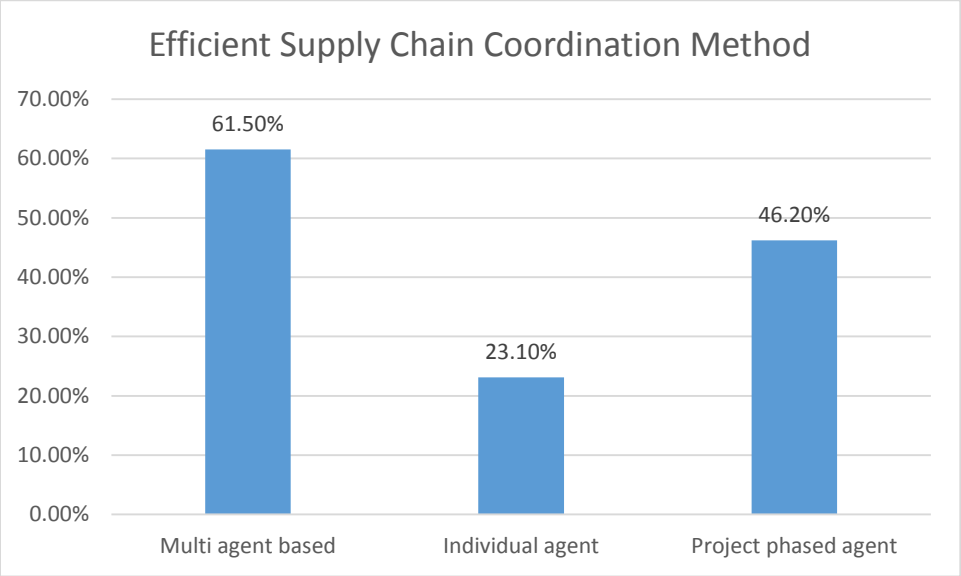


Figure 4.12 Efficient Supply Chain Coordination Method

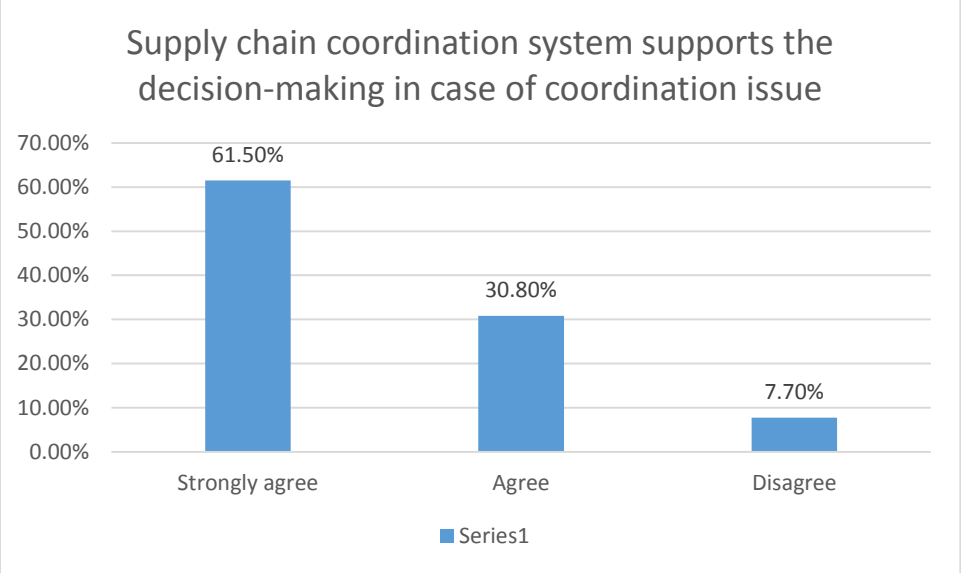


Figure 4.13 Supply chain coordination system supports the decision-making in case of coordination issue

The way to being deft, as these frameworks are intended to keep running for individual objectives professionally and effectively arranged a multi-operators framework in which all task substances are appointed as a comparing specialists and function all in all for more productive store network coordination as appeared in Figur-4.12. If there should arise an occurrence of planning issues with respect to choice making amid store network framework as appeared in Figur-4.13 (Lin and He, 2011).

4.6.3 Short-term Planning with Concurrent Activity Execution

Short interim arranging, encourages "without a moment to spare" asset supply approach, hence decreased conceivable defers and enhanced efficiency (Pappas et al., 2003), as depicted in Figure-4.14 & 4.15

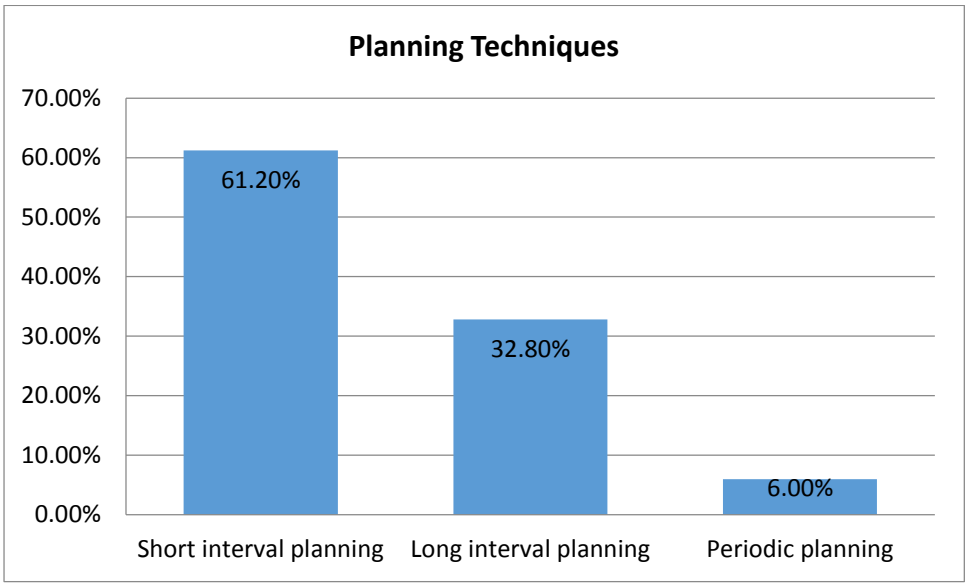


Figure 4.14 Planning Techniques

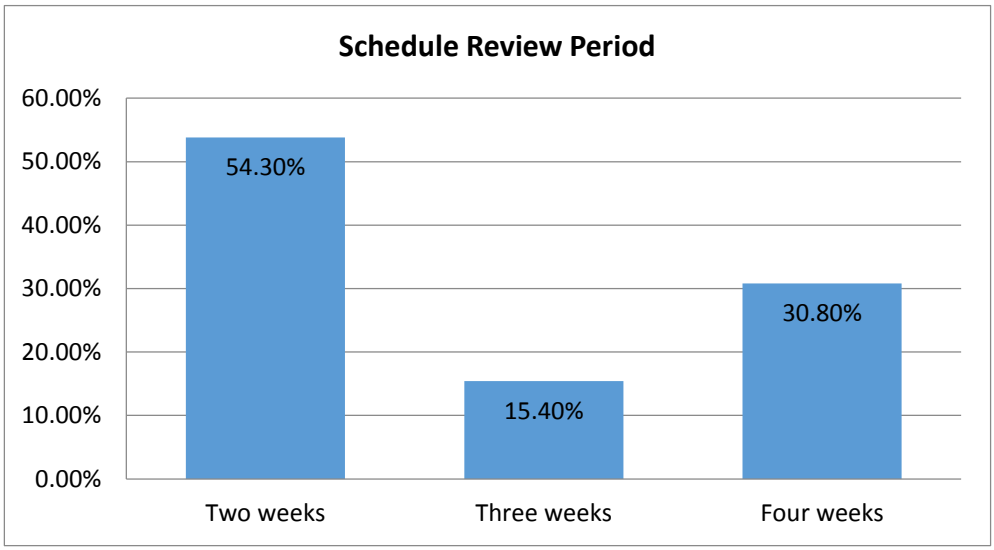


Figure 4.15 Schedule Review Period

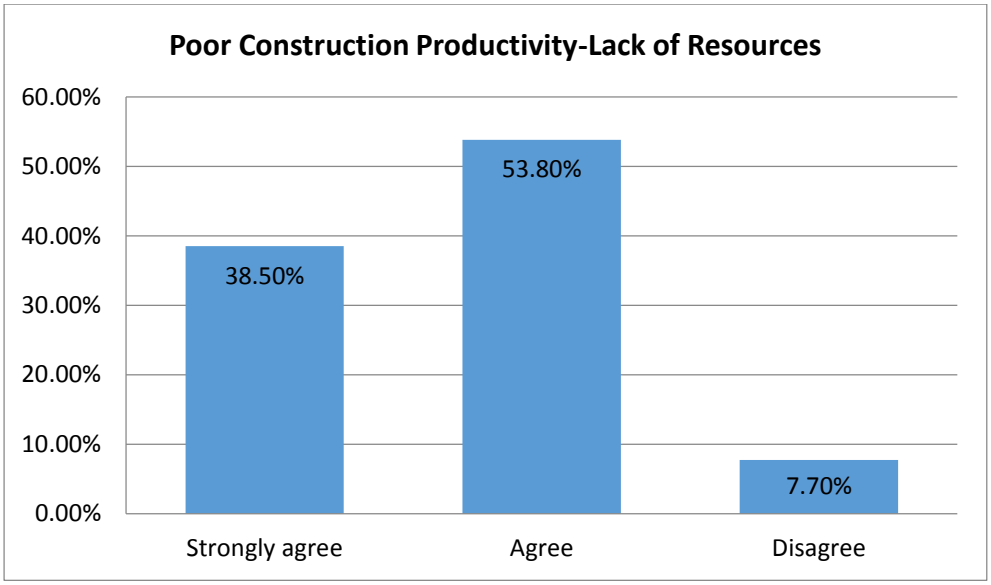


Figure 4.16 Poor Construction Productivity-Lack of Resources

"poor construction productivity" is initiated by a dearth of resources as shown in Figure-4.16

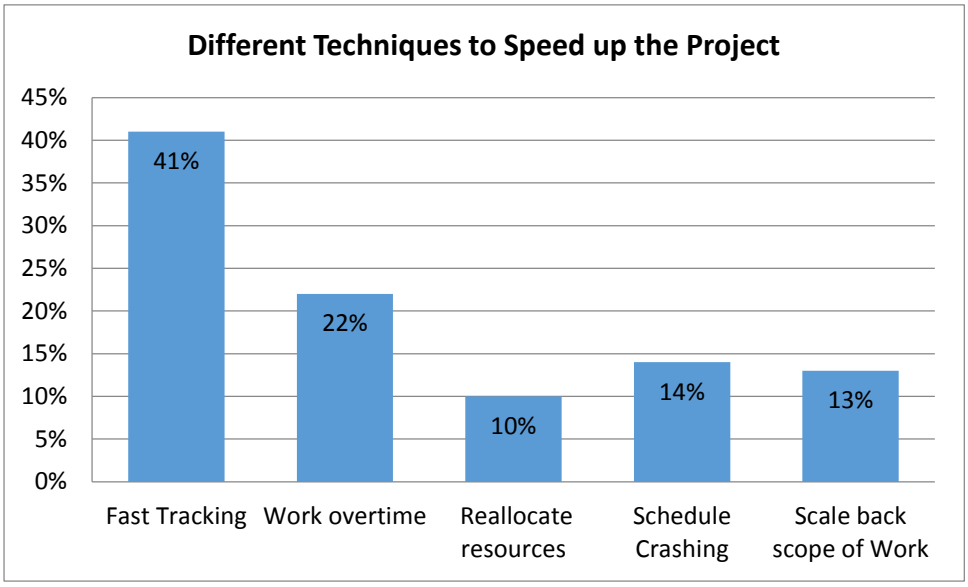


Figure 4.17 Different Techniques to Speed up the Project

Overlapping activities actually tries making the schedule flexible also called as fast tracking. To speed up the project there are many different methods. Different organizations use different techniques. The results show application of different techniques, for speeding up the project. The most commonly used technique for speeding up the project is fast racking and work over time as shown in Figur-4.17.

4.6.4 Continuous Improvement based on Learning Organization

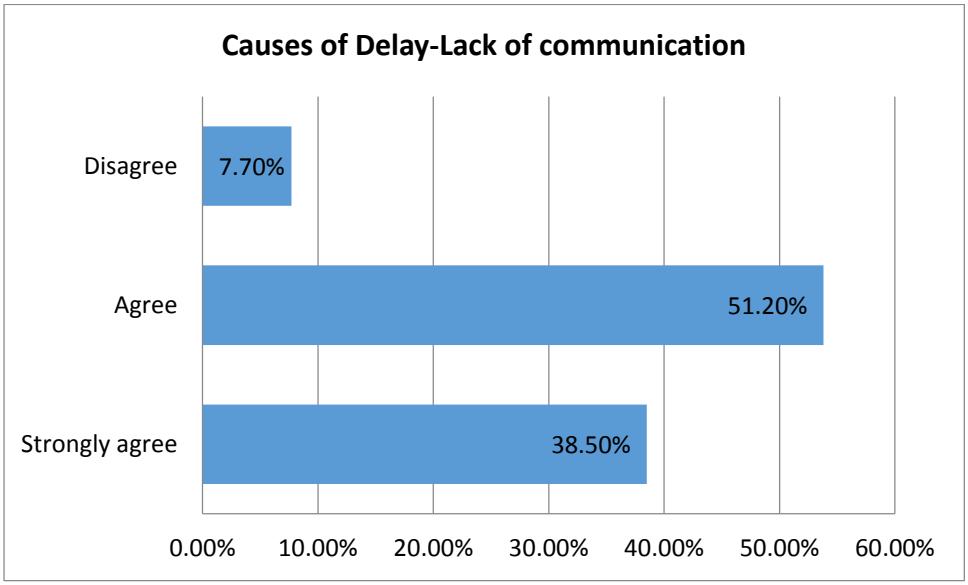


Figure 4.18 Causes of Delay-Lack of communication

Surveyed result also giving same result that lack of communication is one of the main cause of delay in projects as shown in Figure-4.18

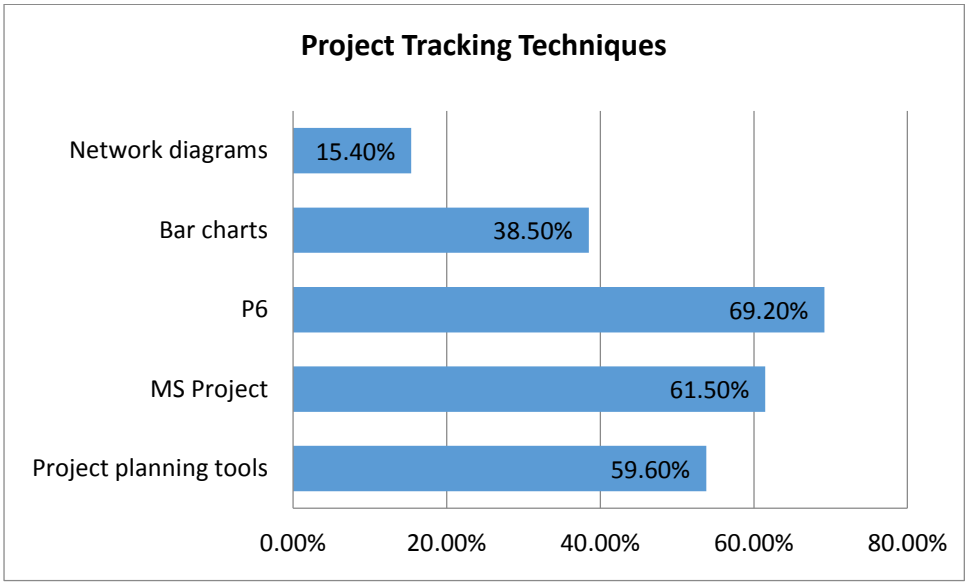


Figure 4.19 Project Tracking Techniques

Results shows that there are a lot of project tracking techniques out of which the most commonly used techniques are Primavera Ms project and project planning tools (Different organizations use different tools) and bar charts. So there is a range of techniques and tools used by construction industry professional for tracking their projects in order to avoid delays as shown in Figure-4.19

4.6.5 Information Technology Integration

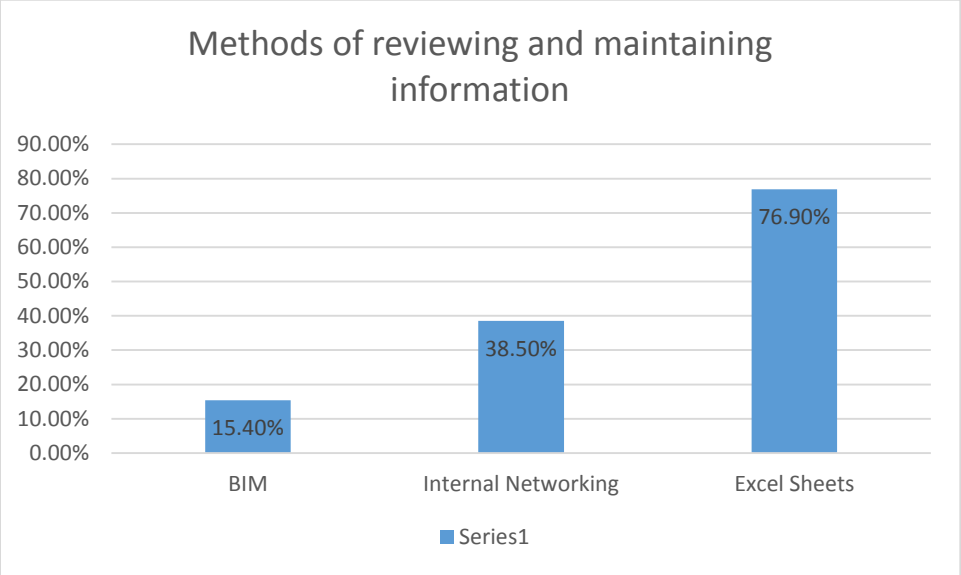


Figure 4.20 Methods of reviewing and maintaining information

Data innovation has changed the way individuals oversee and actualize the venture development exercises, yet there is still space to coordinate them completely into the regulatory procedure. In light of the steadily changing specialized necessities and administration, empowers experts in the building itself to recognize and programming apparatuses to productively oversee ventures. Adaptability is another advantage when data is transmitted and surveyed by pumping information, Internet and Building Information Modeling (BIM) continuously.

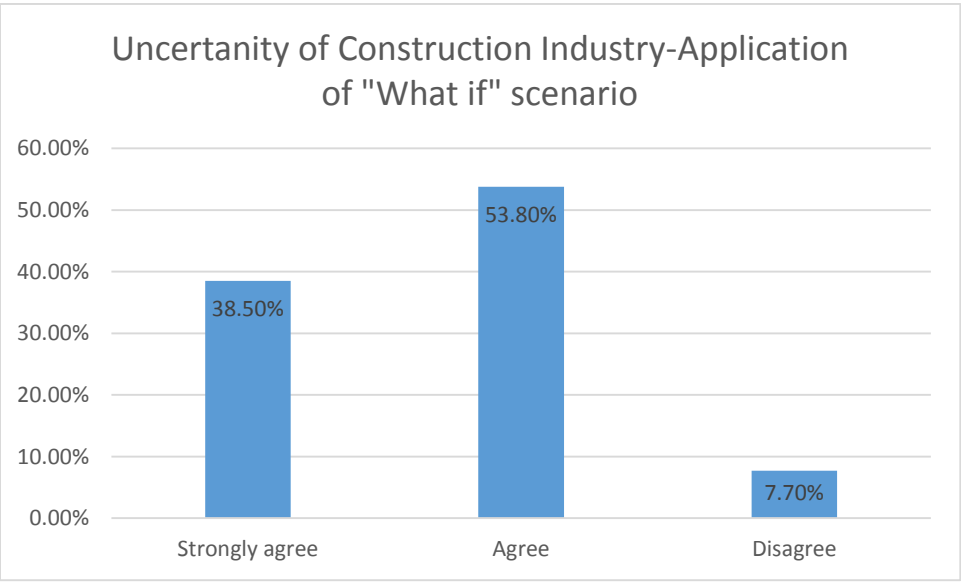


Figure 4.21 Uncertainty of Construction Industry-Application of "What if" scenario

In order to deal with the uncertainty of construction, simulating “what-if” scenarios are more than necessary. Marx and König (2011) proposed discrete event simulation based on BIM that can be used to support construction scheduling, which consequently allows more responsiveness in decision-making as shown in Figure-4.21.

4.7 AGILE PROJECT MANAGEMENT FRAME WORK

Overview of framework:

An agile management framework for construction is proposed in order to deal with construction delays as shown in Figure 2.22. The framework performs following functions.

- First, it represents a prioritized structure of agile project key performance indicators through extensive literature and data analysis which follows the route to pursue agility, means the effect of each KPI on the delay facto of any project.
- Second, the framework suggests relative measurement methods to deal with cost and time over run issue and make the project agile.
- Third, the framework provides a platform to authorize the proposed agile KPIs and ideas, inclusive of all framework components.

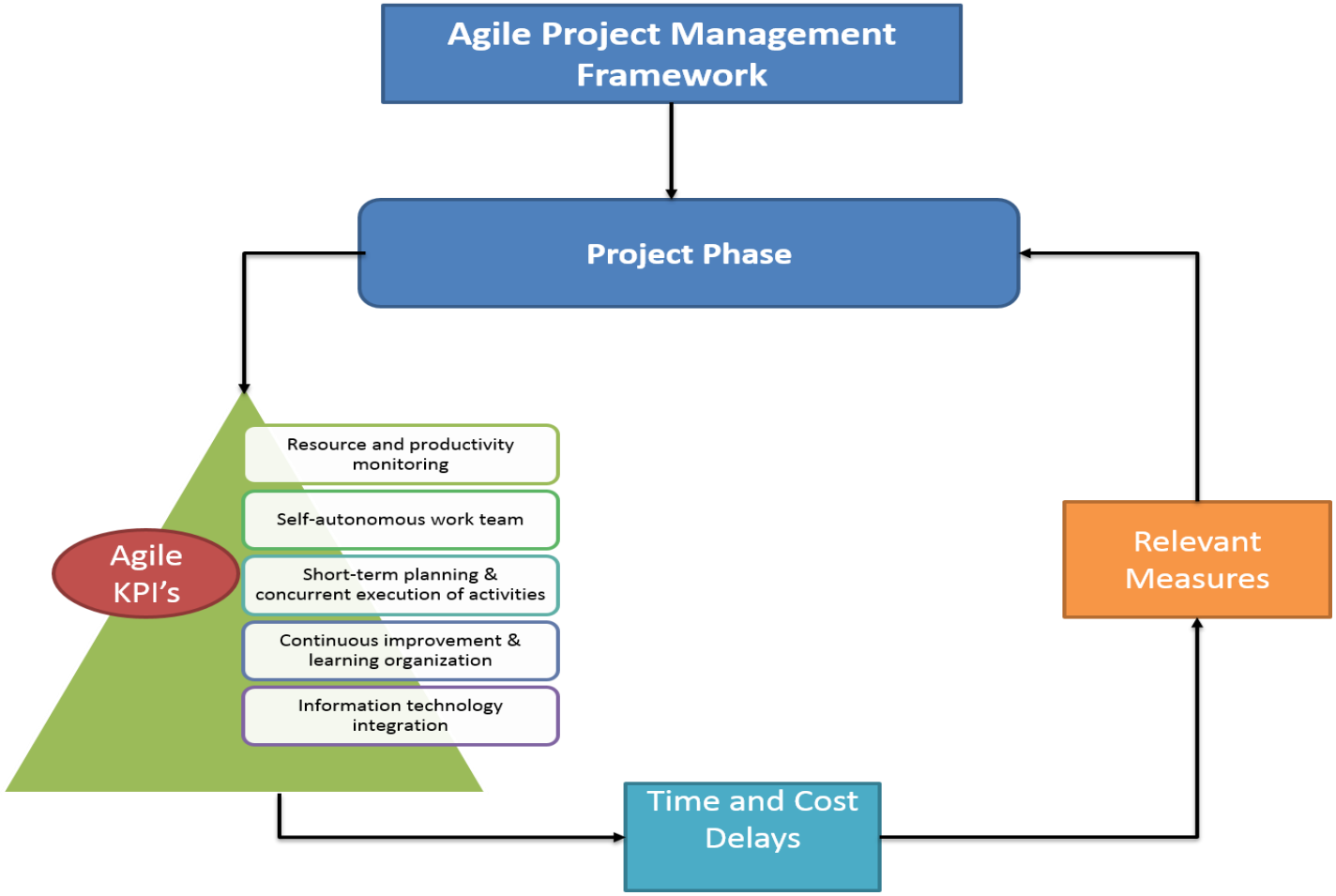


Figure 4.22 Agile Project Management Framework

Component analysis of Framework:

Agile Key Performance indicators:

KPIs literally refer to a series of methods which can bring agile performance during the project delivery process. Numerous agile KPIs have been developed in terms of people (organization), technology, activity execution and enterprise level strategies. Many of them are applicable for construction when each project is considered as a temporary production line. For agile manufacturing, Gehani (1995) addressed "six actions" required for the implementation of agile strategies, including cross-functional team sharing, empowerment for decision making, technology integration, delayed design specification, product succession planning, and enterprise-wide integration of learning. Additionally, more agile methods were proposed, such as self-autonomous and integrated teams, concurrent engineering, partnership in supply chain management, learning organization, and virtual organization, to indicate agility is also desirable as a long-term strategy for enterprises (Li et al. 2003, Devadasan et al. 2005, Vázquez-Bustelo and Avella 2006, Lin et al. 2006).

In construction literature, some studies initiated flexibility-oriented approaches to complex project requirements. In practice, the construction inherently possesses a certain degree of flexibility as owners' requirements or rules and regulations change. Most approaches to flexibility are reactive, such as change orders and as-built plans. Other practice, like short-term planning may work out to deal with increasing job complexity. In addition, some project delivery systems such as fast-track, phased construction, Design-Build and Job Order Contracting are thought to inject certain flexibility to projects with the higher level of management authority.

Last but not least, the development of information technologies such as computer-aid design tools, project management software, Building Information Modeling (BIM) have been changing the way of delivering construction project to be more flexible.

In this study, agile KPIs inspired from the literature of agile manufacturing and flexible construction practices are grouped into five categories and presented. Furthermore agile KPIs could reduce delays directly by adapting to unexpected changes that may result in delays.

Time and Cost Delay Reduction:

Dynamic "changes" become the original incentive of agile management principles. In construction, "changes" in all project phases also exist, and inevitably disturb the as-planned schedules when delays arise. The motivation to accomplish agility in this study focuses on reducing, or at least mitigating time delays. Agility is better suited for dealing with delays caused by complicated reasons. If delays consist of expected delays and unexpected delays, we need to work on them separately. Literature results including identification of delay causes and delay analysis techniques are more appropriate to deal with expected delays based on the empirical data. Agile ideas are proposed to work on both delay scenarios. Especially, the productivity loss and unexpected delay which becomes a "pronoun" for uncertain changes in this study is the primary driver in pursuing agility in construction.

Relevant Measurement Techniques:

Agility, as a fairly new concept in construction could bring challenges in understanding how it handles changes, and protects time schedules from being interrupted by uncertainties. It raises an important question on the effectiveness of being agile. In order to measure agility, it is difficult to find a uniform techniques for agility itself. Instead, performance measurement, as a process of converting effectiveness and efficiency of different dimensions to reasonable symbols to report, has been found appropriate for this task. For the construction industry, the relevant measurement techniques for agility needs to be more specifically associated with delay-reduction, which means the magnitude of delay duration can be reduced for impacted project activities if agility KPIs are used. Agility has been evaluated by qualitative survey, conducted among relevant experts to collect professional opinions on target KPIs.

Capability of Framework:

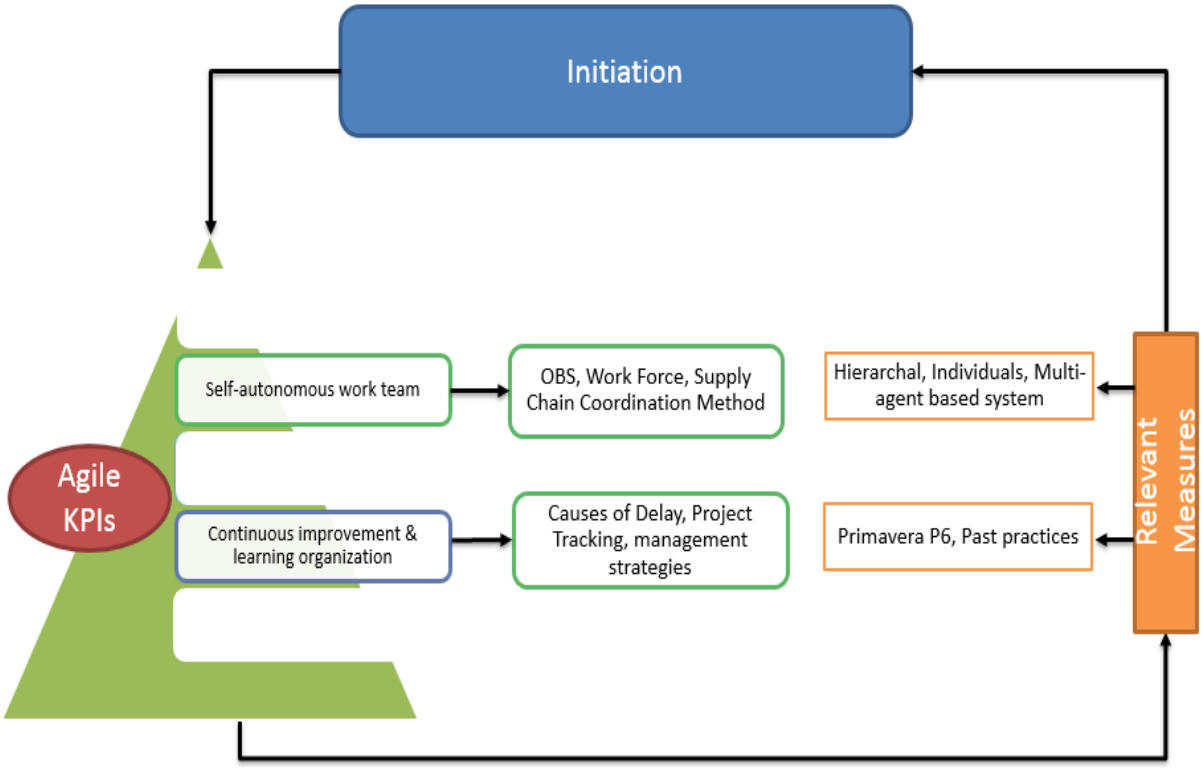
Agility capability generalizes the ultimate attributes to be achieved for being agile. Unlike a simple term interpretation, defining agility is more like a brainstormed process to develop a pool of associated ideas, as applicable.

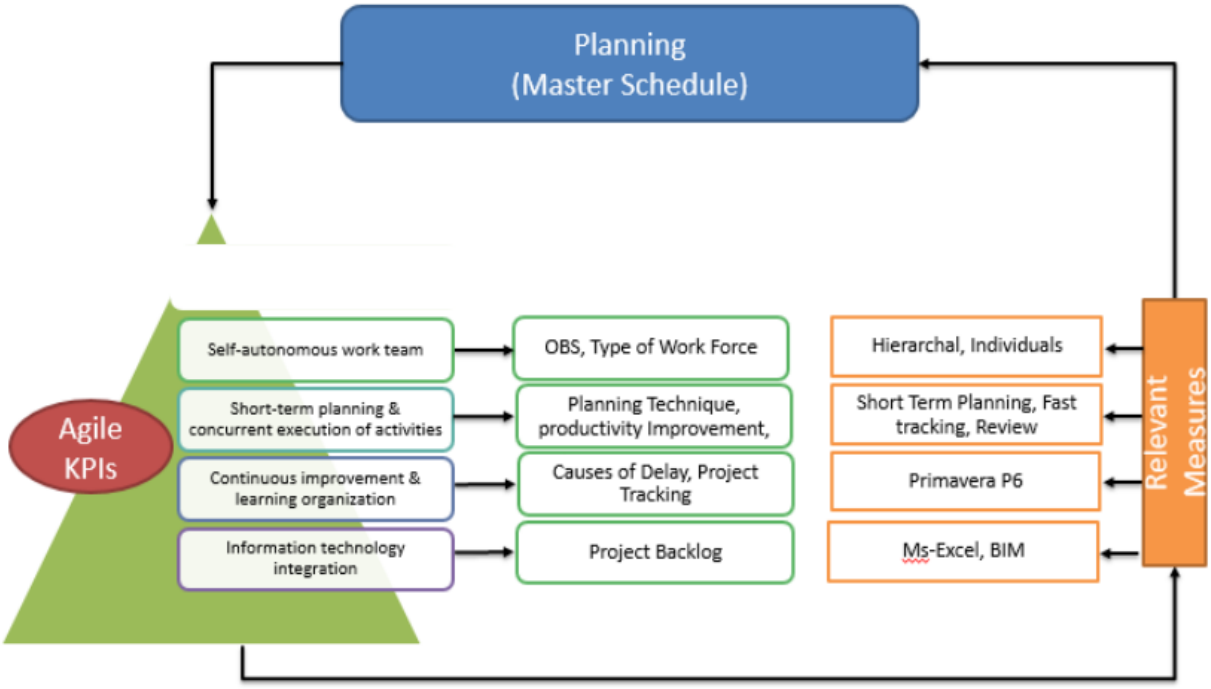
Flexibility is undoubtedly the basic value of agility. Responsiveness and adaptation are selected as other two most typical characteristics in conjunction with flexibility. In running specific project

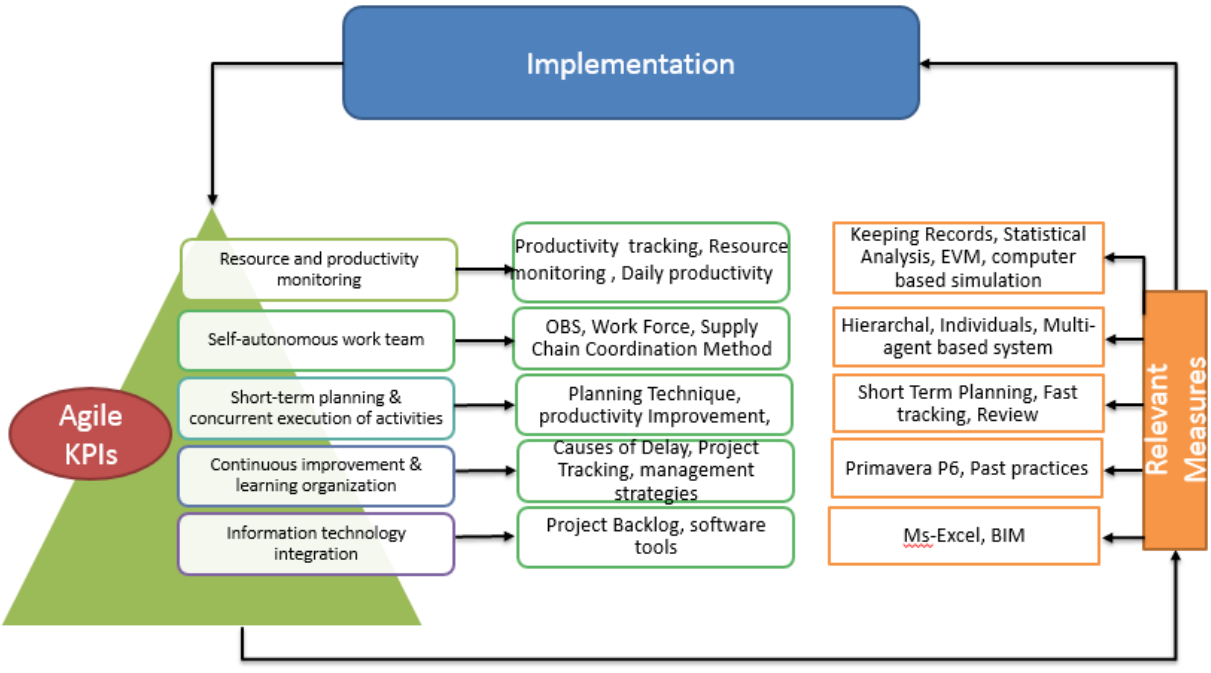
activities, agility highlights both a self-motivated and collaborative working atmosphere. Empowered working teams are formed to run jobs more positively while being less disrupted by over-control or micro-management. Construction projects can benefit from this characteristic. For example, designers are supposed to "welcome" inputs of change from owners and contractors when all participants can obtain a better understanding of design and improve their own work continuously. This can reduce change orders that arise later in construction. As a result, delay events associated with designer's changes could be reduced. If a construction project is labeled as agile construction management, the rest of the agile KPIs such as self-direct, collaboration and partnership etc. should be applicable in other phases of the project delivery process.

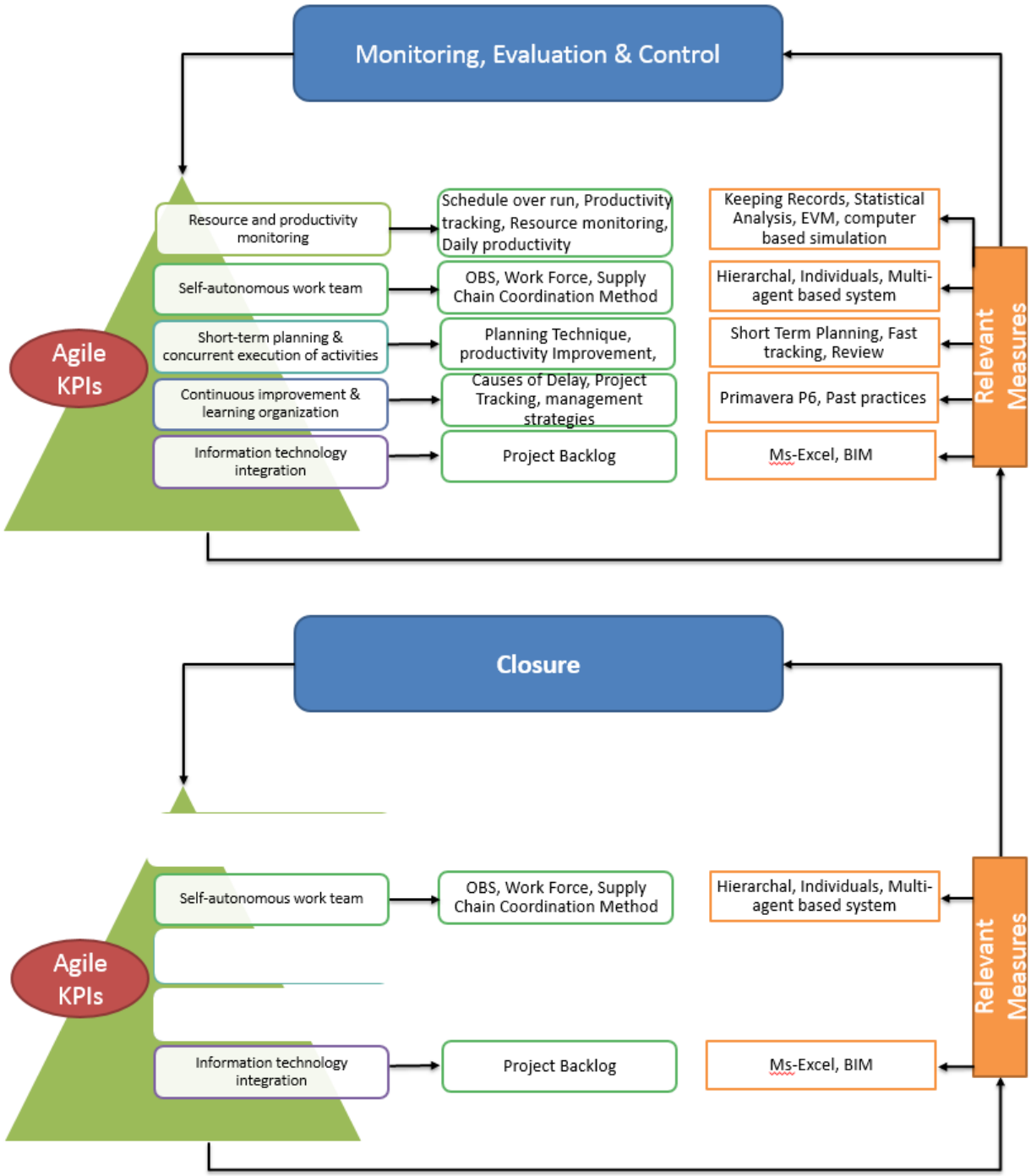
4.7.1 Agile Project Management Frame Work Examples

The following flowcharts shows the implementation of Agile Project Management Framework through examples of each project phase.




Planning
(Master Schedule)
Agile KPIs
Self-autonomous work team
Short-term planning & concurrent execution of activities
Continuous improvement & learning organization
Information technology integration
OBS, Type of Work Force
Planning Technique, productivity Improvement,
Causes of Delay, Project Tracking
Project Backlog
Hierarchal, Individuals
Short Term Planning, Fast tracking, Review
Primavera P6
Ms-Excel, BIM
Relevant Measures


Implementation
Agile KPIs
Resource and productivity monitoring
Self-autonomous work team
Short-term planning & concurrent execution of activities
Continuous improvement & learning organization
Information technology integration
Productivity tracking, Resource monitoring , Daily productivity
OBS, Work Force, Supply Chain Coordination Method
Planning Technique, productivity Improvement,
Causes of Delay, Project Tracking, management strategies
Project Backlog, software tools
Keeping Records, Statistical Analysis, EVM, computer based simulation
Hierarchal, Individuals, Multi-agent based system
Short Term Planning, Fast tracking, Review
Primavera P6, Past practices
Ms-Excel, BIM
Relevant Measures


Monitoring, Evaluation & Control
Agile KPIs
Resource and productivity monitoring
Self-autonomous work team
Short-term planning & concurrent execution of activities
Continuous improvement & learning organization
Information technology integration
Schedule over run, Productivity tracking, Resource monitoring, Daily productivity
OBS, Work Force, Supply Chain Coordination Method
Planning Technique, productivity Improvement,
Causes of Delay, Project Tracking, management strategies
Project Backlog
Keeping Records, Statistical Analysis, EVM, computer based simulation
Hierarchal, Individuals, Multi-agent based system
Short Term Planning, Fast tracking, Review
Primavera P6, Past practices
Ms-Excel, BIM
Relevant Measures
Closure
Agile KPIs
Self-autonomous work team
Information technology integration
OBS, Work Force, Supply Chain Coordination Method
Project Backlog
Hierarchal, Individuals, Multi-agent based system
Ms-Excel, BIM
Relevant Measures

Chapter 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

This research work clearly directed towards analyzing and quantifying the KPIs as well as development of conceptual frame work that works in fluid environment of agile project management and aims at reducing delays and cost overruns. Following conclusions are made.

- The major pros by applying "APM" are the increased client involvement because for development of project team client will continually keep in touch with the project throughout its life cycle.
- It has also been prominent that both project management approaches can be applied on the same project at different times.
- Traditional project management approach mainly focus on the rigid and detailed planning, task and sub tasks distributions and preset stakeholder necessities, while the agile project management conform to soft and human side of projects.
- It has been noted that iterative working approach of small independent teams are vital for agile project management system.
- Iterations in project applications and meetings in case of complex projects are more frequent and used as next step for improvement of projects.
- Traditional project management approach focuses on detailed planning which consumes more time while planning is done progressively, in case of agile project management.

Both project management approaches are good approaches suitable for different situations. It can be summarized that the application of agile project management can lessen the uncertainty and aid in managing the construction project risks. By scheduling well-planned meetings, time management approach and increased client's involvement along with proper team motivation can help, structure and organize the design phase of construction projects.

The achievability of this Agile framework is upheld by the way that recognized key execution pointers exist and are frequently utilized by development specialists. The poll review created statistical data points about dexterity idea, with more potential advantages and down to earth which means. Postponement control is the strength of light-footed structure. The entire task conveyance process from start, arranging, obtainment, usage and shutting utilized "APM" development framework which sets off joining all postponement causes and prompts the utilization of deftness.

The structure proposed clarifies connection of a few nimbleness parts. It has been noticed that center issue in development ventures is "deferral". The framework primarily stresses the most key segments, the five dexterity key execution markers, which are accepted later at calculated level.

5.2 RECOMMENDATIONS

The agile project management system needs more sustenance from the following aspects.

- Detailed and also particular models under every key execution marker ought to be set up for the proper application by development partners so that light-footed structure takes care of the postponement issue
- In this regard trainings should be given to construction professionals in agile philosophy.
- Choose a project, to use as a reference. This should use the agile approach when executing the design phase. It can be called as a pilot-project or a test-project. The project members should mentally embrace the new philosophy completely and apply agile project management techniques on the project.

- The Agile approach can be projected to usage of Building Information Modeling (BIM), which would be of interest for future interest.
- Another remarkable aspect to further investigate is the scope and mindset of the stakeholders in construction industry. Is the industry ready for a change or if there is any change made will it be accepted or rejected?

REFERENCES

Abrahamsson, P., Salo, O., Ronkainen, J., &Warsta, J. (2002). Agile software development methods review and analysis.*VTT Publications*, 478, 3-107.

Ahmed, S.M.,Azhar, S.,Kappagntula, P.,&Gollapudil, D. (2003).Delays in construction: a brief study of the Florida construction industry. *Proceedings of the 39th Annual ASC Conference, Clemson University, Clemson*, SC, 257-66.

Alpert, M., &Raiffa, H. (1969). A progress report on the training of probability assessors.*Judgement under uncertainty: heuristics and biases*. Cambridge University Press, Cambridge, U.K., 294–305.

Apostolakis, G., &Mosleh, A. (1982). Some properties of distributions useful in the study of rare events.*IEEE Trans. on Reliability*, 31(1), 87–94.

Assaf, S.A., & Al-Hejji, S. (2006). Causes of delay in large construction projects.*International Journal of Project Management*, 24 (4), 349-357.

Aguanno, K. (2004) *Managing Agile Projects*, (1st Edition). Ontario: Multi-Media Publications Inc.

Akella, D. (2003) 'Culture Controls within Professional Firms' *Journal of Advances in Management Research*, Vol. 1(1), pp. 56-58.

Alite, B. and Spasibenko, N. (2008) 'Project Suitability for Agile methodologies', *Thesis*, Umea School of Business, Sweden

Alleman, G.B. (2005) 'Agile project management methods for IT projects', in Chapter 23 of *The Story of Managing Projects: An Interdisciplinary Approach*, Carayannis E.G., Kwak, Y.H., and Anbari, F.T., (editors), USA: Greenwood Press, Praeger Publishers, pp. 324-334.

Alleman, G.B. (2008) 'Essay – Can Software Project be Managed using PMBOK–like Processes?' Retrieved on 10th December 2009.

Alvesson, M. & Empson, L. (2006) 'The Construction of Organisational Identity: Comparative Case Study of Consulting Firms', *Working paper*: Lund Institute of Economic Research, 2006/3, Lund.

Alvesson, M. (2002) "Up-or-Out" verses "fun-and-profit": Study of personnel concepts and HR themes in 2 IT/Mgt consulting firms; *Working paper*: Lund Institute of Economic Research, 2002/2, Lund.

Atkinson, R. (1999). 'Project management: cost, time and quality, two best guesses and a phenomenon, it's time to accept other success criteria.' *International Journal of Project Management* Vol. 17(6), pp. 337-342.

Atkinson, R., Crawford, L., and Ward, S (2006) 'Fundamental uncertainties in projects and the scope of project management' *International Journal of Project Management*, Vol. 24(8), pp. 687–698.

Augustine, S., Payne, B., Sencindiver, F., and Woodcock, S. (2005) 'Agile Project Management: Steering from the edges' *Communications of the ACM*, Vol. 48(12), pp. 85-89. Retrieved October, 15th 2009.

Augustine, S., and Woodcock, S. (2008) 'Agile Project Management.' Retrieved on 26th Oct. 2009.

Augustine, S., Payne, B., Sencindiver, F. and Woodcock, S. (2005), "Agile project management: steering from the edges", Communications of the ACM, Vol. 48 No. 12, pp. 85-9.

Austin, S., Newton, A., Steele, J. and Waskett, P. (2002), "Modelling and managing project complexity", International Journal of Project Management, Vol. 20 No. 3, pp. 191-8.

Beck, K., Beedle, M., van Bennekum, A., Cockburn, A., Cunningham, W., Fowler, M., Gernning, J., Highsmith, J., Hunt, A., Jeffries, R., Kern, J., Marick, B., Martin, R., Mellor, S., Schwaber, K., Sutherland, J., & Thomas, D. (2001). *Manifesto for Agile Software Development*. Retrieved from http://AgileManifesto.org.

Biggs, S. E., Banks, T. D., Davey, J. D.,&Freeman, J. E. (2013). Safety leaders' perceptions of safety culture in a large Australasian construction organization. *Safety Science*, v 52, p 3-12.

Bliese, P.(2000). Within-group agreement, non-independence, and reliability: Implications for data aggregation and analysis. *Multilevel theory, research, and methods in organizations*, 349381, 349–381.

Bogus, S.M. Molenaar, K.R.,&Diekmann, J.E. (2005). Concurrent engineering approach to reducing design delivery time.*Journal of Construction Engineering and Management*, 131 (11), 1179-1185.

Bogus, S.M., Molenaar, K.R.,&Diekmann, J.E. (2006).Strategies for overlapping dependent design activities. *Construction Management and Economics*, 24 (8), 829-837.97

Burke, M. J., Finkelstein, L. M., & Dusig, M. S. (1999). On average deviation indices for estimating interrater agreement. *Organizational Research Methods*, 2(1), 49.

Burke, M., & Dunlap, W. (2002). Estimating interrater agreement with the average deviation index: A user's guide. *Organizational Research Methods*, 5(2), 159. Res Methods Div.

Burns, A.,&Burns, R. (2008). *Basic Marketing Research*(Second Ed.). New Jersey: Pearson Education. pp.245.

Bechtold, R. (1999) *Essentials of Software Project Management*. USA: ManagementConcepts Inc.

Berg, B. L. (2004) *Qualitative Research Methods for the Social Sciences*, (5th Edition). USA: Pearson Education Inc.

Blanchard, K. H, Zigarmi, D., and Nelson, R. B. (1993) 'Situational Leadership after 25 Years: A Retrospective' *Journal of Leadership & Organizational Studies* Vol. 1(1), pp. 21-36.

Bloch, B. (1999) 'How they put the "con" in consulting.' *Managerial Auditing Journal*, Vol. 14(3), pp. 115-117.

Boehm, B. (2002) 'Get ready for Agile Methods, with care.' *IEEE Computer*, Vol. 35(1), pp. 64-69.

Boehm, B. (2006). 'A view of 20th and 21st century software engineering' *Proceedings of the 28th international conference on Software Engineering*. Keynote Talks Shanghai China, pp. 12-29.94

Brooks, F.P. (1987) 'No Silver Bullet: Essence and Accidents of Software Engineering.' *IEEE Computer* Vol. 20(4), pp. 10-19.

Bryman, A. (1999). 'The Debate about Quantitative and Qualitative Research' in *Qualitative Research*. Bryman, A., and Burgess, R.G., (editors), London: Sage Publications Ltd, pp. 35-69.

Bryman, A., and Bell, E. (2007) *Business Research Methods* (1st edition), New York: Oxford University Press.

Bryman, A., and Burgess, R.G. (1999) 'Qualitative Research Methodology – A Review' in *Qualitative Research*. Bryman, A., and Burgess, R.G., (editors), London: Sage Publications Ltd, pp. IX-XLVI.

Baccarini, D. (1996), "The concept of project complexity – a review", International Journal of Project Management, Vol. 14 No. 4, pp. 201-4.

Benbya, H. and McKelvey, B. (2006), "Toward a complexity theory of information systems development", Information Technology & People, Vol. 19 No. 1, pp. 12-34.

Brown, S.L. and Eisenhardt, K.M. (1997), "The art of continuous change: linking complexity theory and time-paced evolution in relentlessly shifting organizations", Administrative Science Quarterly, Vol. 42 No. 1, pp. 1-34.

Bryman, A. (1995), Research Methods and Organization Studies, Allen & Unwin Pty, London.

Cadle, J., and Yeates, D. (2008) *Project Management for Information Systems* (5th edition), England: Pearson Education Ltd.

Capra, F. (1997), Das Tao der Phyik: Die Konvergenz von westlicher Wissenschaft und o¨ stilicher Philosophie, 3rd ed., Knaur, Munich.

Cantor, M. (1998) *Object-Oriented Project Management with UML*. USA, New Jersey: John Wiley & Sons Inc.

Carr, W., and Kemmis, S. (1986). *Becoming Critical: Education, knowledge and Action Research*. London: Falmer Press

Cassidy, D. (2005). 'Value-added benefits consulting can save the day' *Handbook of Business Strategy*. Vol. 6(1), pp. 225-229.

Chang, L., and Birkett, B. (2004) 'Managing intellectual capital in a professional service firm: exploring the creativity‐productivity paradox' *Management Accounting Research* Vol. 15(1), pp. 7-31.

Charmaz, K. (2006). *Constructing Grounded Theory: A Practical Guide through Qualitative Analysis*. London: Sage Publications, Inc.

Chatzoglou, P.D., and Macaulay, L.A., (1997) 'The Importance of Human Factors in Planning the Requirements Capture Stage of a Project.' *International Journal of Project Management* Vol. 15(1), pp. 39-53.

Chickillo, G. P., and Kleiner, B. H. (2007) 'Skills and Roles of Consultants: Training Implications' *Journal of European Industrial Training* Vol. 14(1), pp. 26-30.

Chin, G. (2004) *Agile Project Management: how to succeed in the face of changing project requirements*. New York: Amacom Publishers.

Choi, J. (2011). Quantifying the effects of interference for an alternative method of construction productivity estimation.*KSCE Journal of Civil Engineering*, v 15, n 5, p 761-769

Choi, J., & Minchin, R. E. (2006). Work flow management and productivity control for asphalt pavement operations. *Can. J. Civ.Eng.* Vol. 33, No. 8, pp. 1039-1049.

Cicmil, S., Williams, T., Thomas, J., and Hodgson, D. (2006) ‘Rethinking Project Management: Researching the actuality of projects.’ *International Journal of Project Management*, Vol. 24(8), pp. 675‑686.

Cicmil, S. (2003), “Knowledge, interaction and project work: the perspective of complex responsive processes of relating”, paper presented at the 19th EGOS Colloquium, Project Organizations, Embeddedness and Repositories of Knowledge, Copenhagen.

Cicmil, S. and Marshall, D. (2005), “Insights into collaboration at the project level: complexity, social interaction and procurement mechanisms”, Building Research and Information, Vol. 33 No. 6, pp. 523-35.

Cicmil, S., Cooke-Davies, T., Crawford, L. and Richardson, K (2009), Exploring the Complexity of Projects: Implications of Complexity Theory for Project Management Practice, PMI, and Newtown Square, PA.

Cohen, L., Manion, L., and Morrison K. (2000) *Research Methods in Education* (5th edition), London: RoutledgeFalmer.

Collyer, S., and Warren, C.M.J. (2009) ‘Project management approaches for dynamic environments’ *International Journal of Project Management*, Vol. 27(4), pp. 355‑364.

Conforto, E.C., and Amaral, D.C. (2008) ‘Evaluating an Agile Method for Planning and Controlling Innovative Projects,’ *Project Management Journal*, Early View, (Articles online in advance of print), published online: 18 Dec 2008.

Crawford, L., and Pollack, J. (2004) ‘Hard and soft projects: a framework for analysis.’ *International Journal of Project Management*, Vol. 22(8), pp. 645‑653.

Creswell, J.W. (2003). *Research Design: Qualitative, Quantitative and Mixed methods Approaches* (2nd edition). Thousand Oaks, California: Sage Publications, Inc.

Creswell, J. W (2007) *Qualitative Inquiry and Research Design: Choosing Among five Approaches*, (2nd Edition). California: Sage Publications, Inc.

Crossan, F. (2003) ‘Research Philosophy: Towards an understanding.’ *Nurse Research*, Vol. 11(1), pp. 46-55.95

Cui, Y., and Olsson, N.O.E. (2009) ‘Project flexibility in practice: An empirical study of reduction lists in large governmental projects.’ *International Journal of Project Management* Vol. 27(5), pp. 447‑455.

Cockburn, A. (2004). C*rystal Clear: A Human-Powered Methodology for Small Teams*. Addison-Wesley Professional, Reading.

Colombo, A.W., Schoop, R., &Neubert, R. (2006).An agent-based intelligent control platform for industrial holonic manufacturing systems. *IEEE Transactions on Industrial Electronics*, 53 (1), 322-337.

Conboy, K. (2009). Agility from First Principles: Reconstructing the Concept of Agility in Information System Development.*Information Systems Research*, 20 (3), 329-354.

Corbin, J. M., &Strauss, A. L. (2008). *Basics of qualitative research: Techniques and procedures for developing grounded theory*.Sage, Thousand Oaks, CA.

Court, P., Pasquire, C., Gibb,A., & Bower, D. (2006). Design of a lean and agile construction system for a large and complex mechanical and electrical project.*Understanding and Managing the Construction Process: Theory and Practice -14th Annual Conference of the International Group for Lean Construction, IGLC-14*, p 1-14.

Court, P., Pasquire, C.,& Gibb, A. (2009). A lean and agile construction system as a set of countermeasures to improve health, safety and productivity in mechanical and electrical construction. *Lean Construction Journal*,61-76.

Creswell, J.W. (2007). *Qualitative Inquiry & Research Design: Choosing Among Five Approaches*, 2nd ed. Thousand Oaks, CA: SAGE.

Chapman, R. and Hyland, P. (2004), "Complexity and learning behaviors in product innovation", Technovation, Vol. 24 No. 7, pp. 553-61.

Clegg, S. and Courpasson, D. (2004), "Political hybrids: tocquevillean views on project organizations", Journal of Management Studies, Vol. 41 No. 4, pp. 525-47.

Clift, T.B. and Vandenbosch, M.B. (1999), "Project complexity and efforts to reduce product development cycle time", Journal of Business Research, Vol. 45 No. 2, pp. 187-98.

Cooke-Davies, T., Cicmil, S., Crawford, L. and Richardson, K. (2007), "We're not in Kansas anymore, Toto: mapping the strange landscape of complexity theory, and its relationship to project management", Project Management Journal, Vol. 38 No. 2, pp. 50-61.

Crawford, L., Hobbs, B. and Turner, J.R. (2005), Project Categorization Systems, PMI, Newton Square, PA.

Disterer, G. (2002) 'Management of Project management and experiences' *Journal of Knowledge Management*. Vol. 6(5), pp. 512-520.

Dooley, D. (1995) *Social Research Methods* (3rd edition), USA: Prentice-Hall.

Dul, J., and Hak, T. (2008) *Case Study Methodology in Business Research* (1st Edition). UK: Butterworth-Heinemann.

Dunning-Lewis, P. (2004) 'Engagement in Management Research' Lancaster University Management School, *Working Paper*: 2004/039. Retrieved on 18th of November 2009.

Daneshgari, P. (2010). *Agile Construction for the Electrical Contractor*. Jones and Bartlett Publishers, LLC, Sudbury, MA, USA.
Devadasan, S.R., Goshteeswaran, S.,&Gokulachandran, J. (2005). Design for quality in agile manufacturing environment through modified orthogonal array-based experimentation. *Journal of Manufacturing Technology Management*, 16 (6), 576-597.

Dowlatshahi, S., & Cao, Q. (2005). The relationships among virtual enterprise, information technology, and business performance in agile manufacturing: an industry perspective. *European Journal of Operational Research*, 174 (2), 835-60.

Dyer, L.,& Ericksen, J. (2009). Complexity-based Agile Enterprises: Putting Self-Organizing Emergence to Work. *The Sage Handbook of Human Resource Management*, London: Sage: 436-457.

Easterby-Smith, M., Thorpe, R., and Lowe, A. (1991). *Management Research: An Introduction*. London, Sage Publications, Ltd.

Eden, C., Ackermann, F., and Williams, T. (2005) 'The amoebic growth of project costs. *Project Management Journal* Vol. 36(2), pp. 15‐27.

Elliott, S. (2008) *Agile Project Management*, Seminar on Current Trends in Software Industry, University of Helsinki, Finland

Englund, R.L., and Graham, R.J. (1999) 'from experience: Linking projects to strategy' *Journal of Product Innovation Management* Vol. 16(1), pp. 52-64.

Faridi, A.S.,&El-Sayegh, S.M. (2006). Significant factors causing delay in the UAE construction industry.*Construction Management and Economics*, 24 (11), 1167-1176.

Fernandez, D.J., and Fernandez, J. D. (2009). 'Agile Project Management ‐ Agilism versus Traditional Approaches' *Journal of Computer Information Systems*, Winter 2008/2009. Vol. 49(2), pp. 10-17.

Finlay, L. (2008). 'A Dance between the Reduction and Reflexivity: Explicating the "Phenomenological Psychological Attitude."' *Journal of Phenomenological Psychology*, Vol. 39(1), pp. 1-32.

Fitsilis, P. (2008). "Comparing PMBOK and Agile Project Management software development processes," in *Advances in Computer and Information Sciences and Engineering*. Sobh, T. (editor). Netherlands: Springer, pp. 378-383.

Frye, C. (2009) 'Can traditional project management and agile development coexist?' *Software Quality News*, 18 Feb 2009. Retrieved on 15th November 2009.

Gallo, M., and Gardiner, P.D. (2007) 'Triggers for a flexible approach to project management within UK financial services' *International Journal of Project Management* Vol. 25(5), pp. 446-456.

Gardiner, J., and Thorpe, S. (1994) 'Paradigm paradoxes and the processes of educational research: Using the theory of logical types to aid clarity.' Australian Association for Research in Education (AARE) Conference: Newcastle. Retrieved on 20th of November 2009 from: http://www.aare.edu.au/94pap/thors94453.txt

Gareis, R. (2004). 'Management of the Project-oriented Company.' In: Morris, P.W.G., and Pinto, J.K., editors (2004). *The Wiley Guide to Managing Projects*. USA, New Jersey, John Wiley & Sons, Inc., pp123-143.

Gary, C. (1998) 'On being a professional in a Big 6 Firm' *Accounting, Organizations and Society*, Vol. 23(5/6), pp. 569-587

Geraldi, J.G. (2008) 'The balance between order and chaos in multi-project firms: A conceptual model' *International Journal of Project Management* Vol. 26(4), pp 348–356.

Giorgi, A. (1997) 'The Theory, Practice and Evaluation of the Phenomenological Method as a Qualitative Research Procedure' *Journal of Phenomenological Psychology*, Fall, Vol.28(2), pp. 235- 261.96

Gomes, C.F., Yasin, M.M., and Lisboa, J.V. (2008) 'Project Management in the Context of Organisational Change: The Case of the Portuguese Public Sector' *International Journal of Public Sector Management* Vol. 21(6), pp. 573-585.

Graziano, A.M., and Raulin, M.L. (2007) *Research Methods: A Process of Inquiry* (6th edition), USA: Pearson Education, Inc.

Greiner, L. E., and Metzger, R. O. (1983) *Consulting to Management*. USA, New Jersey, Englewood Cliffs: Prentice Hall, Inc.

Griffiths M. (2006) ‘The Five Myths of Leadership’, Quadrus Development, Retrieved on 26th Oct. 2009.

Griffiths, M. (2007) ‘Developments in Agile Project Management’, published as part of 2007 PMI Global Congress Proceedings - Atlanta Georgia

Grundy, T. and Brown, L. (2004) *Strategic Project Management: Creating Breakthrough organisations*, London: Thomson Learning

Gehani, R.R. (1995). Time-based management of technology: A taxonomic integration of tactical strategic roles. *International Journal of Operations and Production Management*, 15 (2), 19-35.

Goldman, S., Nagel, R., Preiss, K., & Dove, R. (1991). *Iacocca Institute: 21st Century Manufacturing Enterprise Strategy: An Industry Led View*. Iacocca Institute, Bethlehem, PA.

Green, S., Kao, C.-C.,&Larsen, G.D. (2010). Contextualist research: iterating between methods while following an empirically grounded approach.*ASCE Journal of Construction Engineering and Management*, Vol. 136 No. 1, pp. 117-26.

Hamzah, N., Khoiry, M.A., Arshad, I., Tawil, N.M.,&Che Ani, A.I. (2011).Causeof construction delay -Theoretical framework.*Procedia Engineering*, 20, 490-495.

Hass, Kathleen B. (2007). The Blending of Traditional and Agile Project Management.*PM World Today -May 2007 (Vol. IX, Issue V).*

Hastak, M.,Gokhale, S.,Goyani, K.,Hong, T., &Safi, B.(2008). Analysis of techniques leading to radical reduction in project cycle time.*Journal ofConstruction Engineering and Management*, 134(12),915-927.

Hatmoko, J. U. D.,&Scott, S. (2010). Simulating the impact of supply chain management practice on the performance of medium-sized building projects.*Construction Management and Economics*, 28 (1), 35-49

Hallgren, M., and Wilson, T.L. (2008) ‘The nature and management of crises in construction projects: Projects-as-practice observations’ *International Journal of Project Management* Vol. 26(8), pp. 830-838.

Hammersley, M. (1999) ‘Deconstructing the Qualitative-Quantitative Divide’ in *Qualitative Research*. Bryman, A., and Burgess, R.G., (editors), London: Sage Publications Ltd, pp. 70-83.

Harrison, W. (2003) 'Is Software Engineering as we know it over the Hill?' *IEEE Software* May/June 2003, Vol. 20(3), pp. 5-7.

Harte H. G. and Dale, B. G (1995) 'Total quality management in professional services: an examination. Part 1' *Managing Service Quality* Vol. 5(4), pp. 38‐43.

Hass, K. B. (2007) 'The Blending of Traditional and Agile Project Management.' *PM World Today*, Vol. 9(5). Retrieved on 30th of August 2009, from: http://www.pmforum.org/library/tips/2007/PDFs/Hass-5-07.pdf

Hauc, A., and Kovač, J. (2000) 'Project management in strategy implementation-experiences in Slovenia' *International Journal of Project Management* Vol. 18(1), pp. 61-67

Haywood-Farmer, J., and Nollet, J. (1994) 'Professional Service Firms and Total Quality Management: A Good Fit?' *International Journal of Service Industry Management* Vol. 5(3), pp. 5-13.

Henry, H.W. (1982) 'A Look at the Strategic Planning Consulting Firms' *Journal of Business Strategy*, Vol. 3(2), pp. 83-86.

Hewson G., (2006) 'Agile Project Management: Much Ado About Agile.' The Agile Vancouver Conference 2006, Retrieved on 5th October 2009.

Highsmith, J. (2008). 'Keeping the Customer in the Product Loop', *The Cutter Edge*, Retrieved on 15th December 2009.

Hoda, R., Noble, J., and Marshall, S. (2008). 'Agile Project Management' *New Zealand Computer Science Research Student Conference*, April 2008, Christchurch, New Zealand, pp. 218-221.

Howcroft, D., Mitev, N., and Wilson, M. (2004) 'What We May Learn from the Social Shaping of Technology Approach' in *Social Theory and Philosophy for Information systems*. Mingers, J., and Willcocks, L., (editors), England: John Wiley & Sons, pp. 329-371.

Hussey, J., and Hussey, R. (1997) *Business Research: A practical guide for undergraduate and postgraduate students* (1st edition). UK: Macmillan Press Ltd.

Hegazy, T.,&Zhang, K. (2005). Daily windows delay analysis. *Journal of Construction and Engineering Management*, 131(5), 505–512.

Heieh, H. F.,&Shannon, E. S. (2005). Three Approaches to Qualitative Content Analysis. Retrieved from http://qhr.sagepub.com/content/15/9/1277.

Howe, Z. C. (1990). The Analysis of Qualitative Data: An Example from the Evaluation of a CommunityReintegration Programme.*Proceedings: Sixth Canadian Congress on Leisure Research*.

IncorTech (2009) ‘Current Practices and Existing Business Systems in Consulting Firms’

Introna, L.D., and Ilharco, F.M. (2004) ‘Phenomenology, Screens, and the World: A Journey with Husserl and Heidegger into Phenomenology.’ in *Social Theory and Philosophy for Information systems*. Mingers, J., and Willcocks, L., (editors), England: John Wiley & Sons, pp. 56-102.

Jiang, L., and Eberlein, A. (2008) *Towards a framework for understanding the relationships between classical software engineering and Agile methodologies*. APOS '08: Proceedings of the 2008 international workshop on Scrutinizing Agile practices or Shoot-out at the agile corral. APM Publishing, pp. 9-14.

Jiang, L., Chen, X., & Zhang, X. (2011). Virtual organization of construction project based on project life cycle.*Communications in Computer and Information Science*, v 209 CCIS, n PART 2, p 47-53.

Jin-Hai, L., Anderson, A.R.,&Harrison, R.T. (2003). The evolution of agile manufacturing. *Business Process Management Journal*, 9 (2), 170-89.

Kakabadse, N. K; Louchart, E. and Kakabadse, A. (2006) ‘Consultant’s role: a qualitative inquiry from the consultant’s perspective’ *Journal of Management Development*, Vol. 25(5), pp. 416-500.

Keegan, S. (2009) ‘PRACTITIONER PERSPECTIVES: “Emergent inquiry” A practitioners reflections on the development of qualitative research’ *Qualitative Market Research*, Vol. 12(2), pp. 234-248.

Kerzner, H. (2003). *Project Management: a Systems Approach to Planning, Scheduling, and Controlling*. (8th edition), USA, New Jersey: John Wiley & Sons, Inc.

Kipping, M., and Engwell, L. (2002). *Management Consulting: Emergence and Dynamics of a Knowledge Industry* UK, Oxford: Oxford University Press.

Kubr, M. (2002) *Management Consulting: A guide to the profession* (4th Edition), Geneva: International Labour Office.

Kyro, P. (1995) 'The Management of Consulting Industry Described by Using the Concept of Profession', *Research Bulletin No. 87: YLIOPISTOPAINO*, Helsinki, Finland

Katayama, H., & Bennet, D. (1999). Agility, adaptability and leanness: A comparisonof concepts and a study of practice. *International Journal of Production Economics*,60, 43-51.

Kharbanda, R.C. (2008). Measurement of Agility in Manufacturing Systems: A Fuzzy Logic Approach.In: *Proceedings of the World Congress on Engineering, 2-4 July2008*, London, U.K.

Kim, B.C.,&Reinschmidt, K.F. (2010). Probabilistic forecasting of project duration using Kalman filter and the earned value method. *Journal of Construction Engineering and Management*, 136 (8), 834-843.

König, M. (2011). Robust construction scheduling using discrete-event simulation.In:*Proceedings of the 2011 ASCE International Workshop on Computing in Civil Engineering*, 446-453.

Kvale, S. (2007). *Doing interviews.* Thousand Oaks, CA: Sage.

Larman, C. (2004). *Agile and Iterative Development: A Manager's Guide*. Agile Software Development Series, edited by Cockburn, A., and Highsmith, J. USA: Pearson Education Inc.

Lee, A.S. (2004) 'Thinking about Social Theory and Philosophy for Information systems' in *Social Theory and Philosophy for Information systems*. Mingers, J., and Willcocks, L., (editors), England: John Wiley & Sons, pp. 1-26.

Lee-Kelley, L., and Loong, K.L. (2003) 'Turner's five-functions of project-based management and situational leadership in IT services projects' *International Journal of Project Management* Vol. 21(8), pp. 583-591.

Leybourne, S.A. (2009) 'Improvisation and agile project management: a comparative consideration' *International Journal of Managing Projects in Business*, Vol. 2(4), pp. 519-535.

Lockett, M., Reyck, B.D., and Sloper, A. (2008) 'Managing Project Portfolios' *Business Strategy Review*. Vol. 19(2), pp. 77-83.

Lord, M.A. (1993) 'Implementing Strategy through Project Management' *Long Range Planning* Vol. 26(1), pp. 76-85.

Lowendahl, B. R. (2000) *Strategic Management of Professional Service Firms*, (2nd Edition). Denmark: Copenhagen Business School Press.

Lowhorn, G.L. (2007) 'Qualitative and Quantitative Research: How to Choose the Best Design, Academic Business World International Conference May 28, 2007 Nashville, Tennessee, USA. Retrieved on 17th of October 2009.

Lundin, R.A., and Soderholm, A. (1995) 'A Theory of the Temporary Organization' *Scandinavian Journal of Management*, Vol. 11(4), pp. 437-55.

LeBreton, J. M., & Senter, J. L. (2008). Answers to 20 questions about interrater reliability and interrater agreement. *Organizational Research Methods*, 11(4), 815.

Lebreton, J. M., Burgess, J. R., Kaiser, R. B., Atchley, E. K., & James, L. R. (2003). The restriction of variance hypothesis and interrater reliability and agreement: Are ratings from multiple sources really dissimilar? *Organizational ResearchMethods*,6(1), 80.

Lee, S.,Peña-Mora, F.,&Park, M. (2005). Quality and change management model for large scale concurrent design and construction projects. *Journal of ConstructionEngineering and Management*, 131 (8), 890-902.

Lee, S., Peña-Mora, F.,&Park, M. (2006). Web-enabled system dynamics model for error and change management on concurrent design and construction projects. *Journal of Computing in Civil Engineering*, 20 (4), 290-300.

Lehtiranta, L. (2011). Relational risk management in construction projects: Modeling the complexity.*Leadership and Management in Engineering*, v 11, n 2, p 141-154.

Li J.H., Alistair R.A., & Richard T. H. (2003). The evolution of agile manufacturing. *Business Process Management Journal*, 9 (2), 170-189.

Lichtenstein, S., Fischhoff, B.,&Phillips, L. D. (1977). Calibration of probabilities: the state of the art to 1980. *Judgement under uncertainty:heuristics and biases*. Cambridge University Press, Cambridge, U.K., 306–334.

Lim, M.K.,&Zhang, D.Z. (2004). An integrated agent-based approach for responsive control of manufacturing resources. *Computers and Industrial Engineering*, 46 (2), 221-232.

Lin, C.T., Chiu, H.,&Tseng, Y.H. (2006). Agility evaluation using fuzzy logic.*International Journal of Production Economics*, 101 (2), 353-368.

Lin, Y., & He, Y. B.(2011). Supply chain coordination of construction management based on multi-agent.*2011 2nd International Conference on Mechanic Automation and Control Engineering, MACE 2011 -Proceedings*, p 2656-2659

Lo, T. Y., Fung, Ivan W. H., & Tung, Karen C. F. (2006). Construction delays in Hong Kong civil engineering projects.*Journal of ConstructionEngineering and Management*, v 132, n 6, p 636-649.

Locke, K. D. (2001). *Grounded theory in management research*.Sage, Thousand Oaks, CA.

Lousberg, L., &Wamelink, H. (2009).Foundation of a practical theory of project management.*Performance improvementin construction management*, B. Atkin, and J. Borgbrant, eds., SPON Press Taylor & Francis, New York, 83–91.

Love, Peter E.D., Li, H., Irani, Z., & Faniran, O. (2000). Total quality management and the learning organization: A dialogue for change in construction.*Construction Management and Economics*, v 18, n 3, p 321-331.

Lu, W. (2010). Improved SWOT approach for conducting strategic planning in the construction industry.*Journal of Construction Engineering and Management*, v 136, n 12, p 1317-1328.

Lu, W., Olofsson, T., & Stehn, L. (2011). A lean-agile model of homebuilders' production systems.*Construction Management and Economics*, v 29, n 1, p 25-35.
Luu, V.T., Kim, S.Y., Tuan, N.V.,&Ogunlana, S.O. (2009) Quantifying schedule risk in construction projects using Bayesian belief networks. *International Journal of Project Management*, 27 (1), 39-50.

Macher, K. (1992). Organisations that learn.*Journal of Quality and Participation*, December, 8-11.

Martin, Y. P.,&Turner, A. B. (1986). Grounded Theory and Organizational Research.*The Journal of Applied Behavioral Science*, vol. 22, no. 2, 141.

Marx, A., & König, M. (2011). Preparation of constraints for construction simulation.*Congress on Computing in Civil Engineering, Proceedings*, p 462-469.

Maxwell, J. A. (2005). *Qualitative Research Design: An Interactive Approach,2nded.*Thousand Oaks, CA: SAGE.

Macheridis, N. (2009). ‘Agility in Entrepreneurial Projects’ *Working Paper Series* 2009/3, Lund Institute of Economic Research: School of Economics and Management, Sweden.

Mansourian, Y. (2008) ‘Exploratory nature of, and uncertainty tolerance in, qualitative research ’, *New Library World*, Vol. 109 (5/6), pp. 273-286

May, T. (1998) *Social Research Methods: Issues, Methods and Process* (2nd edition) Buckingham: Open University Press.

McConnell, S. (1996), *Rapid Development: Taming Wild Software Schedules*. USA, WA: Microsoft Press.

McElroy, W. (1996) 'Implementing Strategic Change through Projects' *International Journal of Project Management* Vol. 14(6), pp. 325-329.

Mingers, J. (2004) 'Re-establishing the Real: Critical Realism and Information Systems' in *Social Theory and Philosophy for Information systems*. Mingers, J., and Willcocks, L., (editors), England: John Wiley & Sons, pp. 372-406.

Moore, K., and Birkinshaw, J. (1997) 'Managing Knowledge in Global Service Firms: Centres of Excellence', *Paper submitted: Institute of International Business, 97/9,* Stockholm.

Muller, R., and Turner, R. (2007) 'Matching the project manager's leadership style to project type.' *International Journal of Project Management*, Vol. 25(1), pp. 21-32.

Munns, A.K., and Bjeirmi, B.F. (1996) 'The role of project management in achieving project success' *International Journal of Project Management* Vol. 14(2), pp. 81-87.

Meng, X.H. (2012). The effect of relationship management on project performance in construction.*International Journal of Project Management*, 30 (2), 188-198.

Mohan, S. B.,&Al-Gahtani, K. S. (2006). Current delay analysis techniques and improvement. *Cost Engineering*, 48(9), 12–21.

Motawa, I.A.,Anumba, C.J.,Lee, S.,&Peña-Mora, F. (2007). An integrated system for change management in construction.*Automation in Construction*, 16 (3), 368-377.

Myers, M. D.,&Avison, D. E. (2002). Overview of qualitative research.*Qualitative research in information systems: A reader*, M. D. Myers and D. E. Avison, eds., Sage, London, 1–5.

Nassar, K.M., Gunnarsson, H.G., & Hegab, M.Y. (2005). Using Weibull analysis for evaluation of cost and schedule performance. *Journal of Construction Engineering and Management*, 131 (12), 1257-1262.

Naylor, J.B., Naim, M.M., & Berry, D. (1999). Leagility: integrating the lean and agile manufacturing paradigms in the total supply chain. *International Journal of ProductionEconomics*, 62(1–2), 107–18.

Nachum, L. (1999) *The Origins of International Competitiveness of Firms: Impact of Location on Ownership in Professional Service Industries*. UK: Edward Elgar Publishing Limited.

Nelson, B., and Economy, P. (2008) *Consulting for Dummies*, (2nd edition) United Kingdom: John Wiley and Sons Ltd, pp 324-335.

Neuman, W.L. (2000). *Social Research Methods: Qualitative and Quantitative Approaches*, (4th edition). USA, MA: Allyn and Bacon.

Nobeoka, K., and Cusumano, M.A. (1997) 'Multiproject Strategy and Sales Growth: The Benefits of Rapid Design Transfer in New Product Development.' *Strategic Management Journal*, Vol. 18(3), pp. 169-186.

Noor, M.A.,Rabiser, R. & Grünbacher, P.(2008). Agile product line planning: A collaborative approach and a case study.*Journal of Systems and Software*, 81(6),868-882.

Nourbakhsh, M., Zin, R. M., Irizarry, J., Zolfagharian, S.,&Gheisari, M. (2012). Mobile application prototype for on-site information management in construction industry.*Engineering, Construction and Architectural Management*, v 19, n 5, p 474-494.
Oakland, J., & Sohal, A. (1996). *Total Quality Management: Text with Cases*, Butterworth Heinemann, Melbourne.

Orr C. (2005) 'Lean Leadership in Construction' *Proceedings IGLC-13*, July 2005, Sydney

Owen, R., Koskela, L.J., Henrich, G., and Codinhoto, R. (2006) 'Is Agile Project Management Applicable To Construction?' In: Sacks, R., and Bertelsen, S. (ed.), *Proceedings 14th Annual Conference of the International Group for Lean Construction*, Ponteficia Universidad Catolica de Chile, Santiago, Chile, pp.51-66.

Odeh, A.M., &Battaineh, H.T.(2001). Causes of construction delay: Traditionalcontracts.*International Journal of Project Management*, 20(1), 67-73.

Oppenheim A. N. (2005). *Questionnaire Design, Interviewing and Attitude Measurement*.continuum, London, New York.

Owen, R. L., &Koskela, L. (2006). "Agile Construction Project Management".*6th International Postgraduate Research Conference in the Built and Human Environment*, 6/7 April 2006 Delft, Netherlands.

Owen, R, Koskela, LJ, Henrich, G.,&Codinhoto, R (2006). Is agile project management applicable to construction?In: *14th Annual Conference of the International Group for Lean Construction*, 25-27 July 2006, Santiago, Chile.

Park, M., & Peña-Mora, F. (2004). Reliability buffering for construction projects. *Journal of Construction Engineering and Management*, 130 (5), 626–637.

Palmer, S., & Felsing, J. (2002). A practical guide to Feature Driven Development.Prentice Hall PTR, Englewood Cliffs.

Palaneeswaran, E., & Kumaraswamy, M. M. (2003). Knowledge mining of information sources for research in construction management.*Journal of Construction Engineering and Management*, v 129, n 2, p 182-191.

Pappas, M. P., Tucker, R. L., & Borcherding, J. D.(2003).Evaluating Innovative Construction Management Methods.*Contruction Research Congress, Winds of Change: Integration and Innovation in Construction, Proceedings of the Congress*, p 221-228.

Patton, Q. M. (2002). *Qualitative Research & Methods.*California,USA: Sage Publications, Inc.

Papke-Shields, K.E., Beise, C., and Quan, J. (2009) ‘Do project managers practice what they preach, and does it matter to project success?’ *International Journal of Project Management*, In Press, Corrected Proof, Available online 6 December 2009.

Perminova, O., Gustafsson, M., and Wikstrom, K. (2008) ‘Defining Uncertainty in Projects－A New Perspective’ *International Journal of Project Management* Vol. 26(1), pp. 73－79.

Perry, C. (1998) ‘Processes of a case study methodology for postgraduate research in marketing’ *European Journal of Marketing* Vol. 32(9), pp. 785-802.

PMI (2004) *A Guide to The Project Management Body of Knowledge (PMBOK Guide)* Third Edition. Pennsylvania: Project Management Institute, INC. pp.5, 8, 377.

Porter, M.E. (1985) *Competitive Advantage*. New York: Free Press.

Probert, S.K. (2004) ‘Adorno: A Critical Theory for IS Research’ in *Social Theory and Philosophy for Information systems*. Mingers, J., and Willcocks, L., (editors), England: John Wiley & Sons, pp. 129-156.

Qumer, A., & Henderson-Sellers, B. (2006). Crystallization of agility back to basics. In: *ICSOFT 2006, vol. (2)*, 121–126.

Ramasesh, R., Kulkarni, S.,&Jayakumar, M. (2001). Agility in manufacturing systems: An exploratory modeling framework and simulation.*Integrated Manufacturing Systems*, 12 (6-7), 534-548.

Rahim, A.R.A., and Baksh, M.S.N. (2003) 'Case Study Method for New Product Development' *Work Study*, Vol. 52(1), pp. 25-36.

Remenyi, D., Williams, B., and Swartz, E. (1998) *Doing Research in Business and Management: An Introduction to Process Method* London: Sage Publications Ltd.

Rodrigues, A., and Bowers, J. (1996) 'The role of system dynamics in project management' *International Journal of Project Management* Vol. 14(4), pp. 213-220

Rubin, A., and Barbie, E. (1997) *Research Methods for Social Work*, (3rd Edition). California: Brooks/Cole Publishing Company.

Russell-Hodge, J. (1995) 'Total project management: The customer-led organisation' *International Journal of Project Management*, Vol. 13(1), pp. 11-17.

Ren, J.,Yusuf, Y. Y., &Burns, N.D. (2000). A prototype of measurement system for agile enterprise. *The Third International Conference of Quality Reliability Maintenance*, 29-30 March, Oxford, UK, pp. 274-252.

Ryu, K., Son, Y.,&Jung, M. (2003).Modeling and specifications of dynamic agents infractal manufacturing systems.*Computers in Industry*, 52 (2), 161-182.

Salem, O., & Zimmer, E. (2005). Review -Application of Lean Manufacturing Principles to Construction. *Lean Construction Journal*, Vol 2 #2.

Sambasivan, M., &Soon, Y.W. (2007). Causes and effects of delays in Malaysian construction industry.*International Journal of Project Management*, 25(5),517-526.

Saladis, F.P., and Kerzner, H. (2009) *Bringing the PMBOK Guide to Life: A Companion for the Practicing Project Manager.* USA, New Jersey: John Wiley & Sons.

Sanchez, L.M., and Nagi, R. (2001). 'A Review of Agile Manufacturing Systems' *International Journal of Production Research,* Vol. 39(16), pp 3561-3600

Sandberg, R. (2003) *Corporate Consulting for Customer Solutions: Bridging Diverging Business Logics,* Stockholm: Stockholm School of Economics.

Sauer, C., and Reich, B.H. (2009) 'Rethinking IT project management: Evidence of a new mindset and its implications' *International Journal of Project Management*. Vol. 27(2), pp. 182-193.

Saunders, N.K., Lewis, P., and Thornhill (1997) *Research Methods for Business Students* UK: Pitman Publishing.

Saunders, M., Lewis, P., and Thornhill, A. (2007) *Research Methods for Business Students*, (4th Edition), England: Pearson Education Limited.

Sauser, B.J., Reilly, R.R., and Shenhar, A.J. (2009) 'Why projects fail? How contingency theory can provide new insights - A comparative analysis of NASA's Mars Climate Orbiter loss.' *International Journal of Project Management*, Vol. 27(7), pp. 665-679.

Schuh, P. (2005) *Integrating Agile Development in the Real World*. USA: Charles River Media, Inc.

Sharifi, H., and Zhang, Z. (2000) 'A Methodology for achieving Agility in Manufacturing Organisations' *International Journal of Operations & Production Management*, Vol. 20(4), pp. 496-512.

Sharifi, H., and Zhang, Z. (2001) 'Agile Manufacturing in Practice - Application of a Methodology' *International Journal of Operations & Production Management*, Vol. 21(5), pp 772-794.

Sharma, D. D. (1991) *International Operations of Professional Firms*, Sweden, Lund: Studentlitteratur.

Shenhar, A.J. (2004). 'Strategic Project Leaderships Toward a strategic approach to project management.' *R&D Management* Vol. 34(5), pp. 569-578.

Shore, J., and Warden, S. (2008) *The Art of Agile Development.* USA, CA: O' Reilly Sebastopol.

Sodhi, J., and Sodhi P (2001) *IT Project Management Handbook*. Vienna, VA: Management Concepts.

Sonnerby, P. (2007) *Contract-Theoretic Analyses of Consultants and Trade Unions*, Dissertation for the Degree of Doctor of Phil, Ph.D. Economics, Stockholm: Stockholm

Steffens, W., Martinsuo, M., and Artto, K. (2007) 'Change decisions in product development projects.' *International Journal of Project Management* Vol. 25(7), pp. 702-713.

Strauss, A.L., and Corbin, J.M. (1998) *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory*. (2nd Edition), USA, CA: Thousand Oaks, Sage Publications, Inc.

Stumpf, S.A. (1999) 'Phases of professional development in consulting' *Career Development International* Vol. 4(7), pp. 392-399.

Stumpf, S.A., Doh, J.P., and Clark, K.D. (2002) 'Professional Service Firms in transition: Challenges and Opportunities for Improving performance' *Organisational Dynamics*. Vol. 31(3), pp. 259-279.

Sandelowski, M. (2000). Focus on Research Method: Combining Qualitative and Quantitative Sampling Data Collection and Analysis Techniques in Mixed-Method Studies. *Research in Nursing & Health*, 23, 246-255.

Sharifi, H.,&Zhang, Z. (1999). Methodology for achieving agility in manufacturing organizations: an introduction. *International Journal of Production Economics*, 62 (1), 7-22.

Sharafi, H., Colquohoun G., Barclay I., & Dann Z. (2001). Agile manufacturing: A management and operational framework. *J. Mech.Engrg*, 21, 857-869.

Siddiqi, K., & Akinhanmi, A. (2006).Managing delayscaused by differing site condition.*AEI 2006: Building Integration Solutions -Proceedings of the 2006 Architectural Engineering National Conference*, v 2006, p 58.

Silverman, D. (2006). *Interpreting Qualitative Data*.third ed. Sage Publications, London.

Stelzmann, E., Kreiner, C., Spork, G., Messnarz, R., & Koenig, F. (2010).Agility meets systems engineering: A catalogue of success factors from industry practice. In: *Proceedings of Systems, Software and Services Process Improvement -17th European Conference, EuroSPI 2010*, 245-256.

Strauss, A. L.,&Corbin, J. M. (1998). *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theor*y,2nd ed. ThousandOaks, CA: SAGE.

Swarup, L., Korkmaz, S., Gultekin, P., & Horman, M. (2010). Exploring the validity of qualitative methods to analyze project delivery of sustainable, high performance buildings.*Proceedings of the 2010 Construction Research Congress*, p 1427-1436.

Tang, D.B., Gu, W.B., Wang, L.,&Zheng, K. (2011). A neuroendocrine-inspired approach for adaptive manufacturing system control.*International Journal of Production Research*, 49 (5), 1255-1268.

Taylor, J. E., Dossick, C. S.,&Garvin, M. J. (2009). Constructing Research with Cast Studies, *Building a Sustainable Future*, 1469-1478.

Tang, T. C., Juhary, A., and Thong, G.C. (2004), 'Knowledge Management in Agile Organizations,' *Sunway College Journal*, Vol.1, pp. 13-20.

Taylor, S.J., and Bogdan, R. (1998) *Introduction to Qualitative Research Methods: A Guidebook and Resource*, (3rd edition). USA: John Wiley & Sons, Inc.

Thomsett, R. (2002) *Radical Project Management*. New Jersey: Prentice Hall, pp.136 - 137

Tomaszewski, P., Berander, P., and Damm, L. (2008) 'From Traditional to Streamline Development – Opportunities and Challenges.' *Software Process Improvement and Practice* Vol. 13(2), pp. 195–212.

Tran, M., and Jay, A. (2004) 'Parmalat: All you need to know about the collapse of the Italian dairy giant.' Retrieved on 30th Oct. 2009.

Trochim, W. M. K. (2006) *The Research Methods Knowledge Base* (3rd edition). Cincinnati, OH: Atomic Dog Publishing. Retrieved on 20th of November 2009.

Turner, J.R. (1999) *The Handbook of Project-Based Management*, (2nd Edition). United Kingdom: McGraw-Hill, pp 4-24.

Tennant, S., & Fernie, S. (2013). Organizational learning in construction supply chains.*Engineering, Construction and Architectural Management*, v 20, n 1, p 83-98.

Tsai, C.S., Chen, C.W.,&Lin, C.T (2008).Align Agile Drivers, Capabilities and Providers Achieve Agility: a Fuzzy-Logic QFD Approach.*Supply Chain, Theory and Application, Book edited by: Vedran Kordic*.

Van Hoek, R.I., Harrison, A.,&Christopher,M. (2001). Measuring agile capabilities in the supply chain. *International Journal of Operations & Production Management*, 21 (1/2), 126-147.

Van Leeuwen, J.P., & Fridqvist, S.(2006). An information model for collaboration in the construction Industry.*Computers in Industry*, v 57, n 8-9, p 809-816.

Vázquez-Bustelo, D., &Avella, L. (2006). Agile manufacturing: Industrial case studies in Spain. *Technovation*, 26 (10), 1147-1161.

Vinodh, S., Devadasan, S.R., Vasudeva R.B.,&Ravichand, K. (2010).Agility index measurement using multi-grade fuzzy approach integrated in a 20 criteria agile model.*International Journal of Production Research*, 48 (23), 7159-7176.

Walker D.H.T., & Shen Y.J. (2002).Project understanding, planning, flexibility of management action and construction time performance: Two Australian case studies.*Construction Management and Economics*, v 20, n 1, p 31-44.

Walker, D. H. T. (2004) 'The Knowledge Advantage (K-Adv): Unleashing Creativity and Innovation,' *Course Notes*, Melbourne.

Waugh, T. (2004), *101 Marketing Strategies for Accounting, Law, Consulting and Professional Service Firms*. New Jersey: John Wiley & Sons, Inc.

Weaver, P. (2007) 'Trends in modern project management: Past, Present and Future; *Mosaic Projects,*' Retrieved on 26th Oct. 2009.

Weinstein, B. (2009) 'Making a case for Agile Project Management' *Ghantthead.com,*

Whitty, S.J., and Maylor, H. (2009) 'And then came Complex Project Management (revised)' *International Journal of Project Management*, Vol. 27(3), pp. 304-310.

Woodside, A.G., and Wilson, A.J. (2003) 'Case Study Research Methods for Theory Building' *Journal of Business and Industrial Marketing*, Vol. 18(6/7), pp. 493-508.

Wuensch, Karl L. (2005). What is a Likert Scale? and HowDo You Pronounce Likert?.*East Carolina University*.

Xue, X., Li, X., Shen, Q., & Wang, Y. (2004). An agent-based framework for supply chain coordination in construction.*Automation in Construction,*v 14, n 3, p 413-430, June 2005, International Conference for Construction Information Technology.

Yang, J. B.,&Kao, C. K. (2009). Review of delay analysis methods: A process-based comparison. *Open Construct. Build. Technol. J.*, 3(1), 81–89.

Yusuf, Y.Y.,Sarhadi, M., &Gunasekaran, A. (1999). Agile manufacturing: the drivers, concepts and attributes.Source:*International Journal of Production Economics,* v 62, n 1, p 33-43.

Yusuf, Y.Y., Ren, J.,&Burns, N.D. (2001). A method for evaluating enterpriseagility—an empirical study. In: *Proceedings of the 16th International Conference on Production Research, 29 July–3 August 2001*, Prague, Czech Republic.

Zack, M. H. (1999), 'Developing a Knowledge Strategy', *California Management Review,* Vol. 41(3), pp. 125-145.

APPENDICES

Appendix 1

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QUESTIONNAIRE