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Implementing Web-based Project Management Systems in the New Zealand Construction Industry.

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r One – Introduction

1.1 Introduction

In November 1999, at CounterEntropy Strategiesô Summit on Software in Chicago, USA, 60 top executives from major engineering and software companies agreed that ñthe Internet will change how engineering software is used by facilitating collaborative efforts involving large numbers of peopleò (as cited by Dossick & Sakagami, 2008, p189). These industry leaders also predicted that ñproject Web sites will proliferate rapidly and that e-commerce will come to dominate all aspects of sales and marketing in architecture, engineering, and the construction industryò (as cited by Dossick & Sakagami, 2008, p189). Ten years on and have these industry forecasts been realised?

Multiple studies have demonstrated the benefits from using information and communication technology (ICT). However, the Architectural Engineering and Construction industry remains slow in adopting ICT, especially when comparing it to advanced manufacturing industries. A frequently cited reason is that the industry, by its very nature, is highly fragmented and complex. The author believes that by understanding the barriers to implementing ICT in the AEC industry, methods can be then identified to overcome those barriers and limitations.

Information and Communication Technology (ICT)

Information and communication technology (ICT) is becoming a significant instrument for businesses and countries in ensuring their growth and competitive advantages are optimized. In the 2008-2009 Global Information Technology Report (GITR), the World Economic Forum Executive Chairman, Klaus Schwab (2009) wrote; ñInformation and communication technology (ICT) is increasingly moving to the core of national competitiveness strategies around the world, thanks

s a critical enabler of growth, development, and

The term ICT encompasses Information Technology (IT) plus areas such as telephony, broadcast media and all types of audio and video processing and transmission. It is used to describe a range of technologies for gathering, storing, retrieving, processing, analysing and transmitting information.

Most developed and many developing countries are embracing the ICT movement as they observe the many benefits it brings, such as; empowering citizens with exceptional access to information and knowledge; offering significant outcomes in terms of providing education and access to markets; and successful means of doing business. New Zealand is no exception and the GITR (2008-2009, P 19) states that New Zealand possesses excellent infrastructure for ICT delivery and an ñICT-friendly political and regulatory environment. The majority of industries appear to be embracing the ICT movement ï is the AEC (Architectural Engineering and Construction) industry?

ICT and the Architectural Engineering & Construction (AEC) Industry

The AEC industry is fragmented due to its multi-disciplinary/multi-organisational nature and the many stakeholders and phases involved in a construction project environment. According to Nitithamong & Skibniewski (2006), this has led to well documented problems with information and communication processing and low productivity in construction projects. Matheu (2005) concurs and states that it has also ñcontributed to the proliferation of adversarial relationships between the parties to a projectò.

The use of Information and Communication Technology (ICT) in the AEC industry is creating new opportunities for collaboration, coordination and information exchange among organisations that form a construction project team (Matheu, 2005, p38). ICT is becoming more evident in the AEC industry and is

ıbat the fragmentation issues referred to above. Its
cient financial control and communications, an increase in the quality of documents and the speed of the work, and simpler and faster access to data and reduced errors in documentation (Matheu, 2005, p1).

The Internet is at the centre of the ICT applications which best facilitates a collaborative working environment in a construction project. It was predicted by Walker and Betts (1997) that the Internet will be the key to change in global construction business in the near future and will impact professions, collaboration, and the construction business structure (as cited in Nitithamong & Skibniewski 2006). Matheu (2005) stated that its use as a communication means can help information transfer occur more quickly and effectively, providing ña unique opportunity for the development of distributed systems that can cross organisation boundaries and provide a unique opportunity for teamwork and workflow automationò. The web also has the ability to overcome incompatibilities of data formats; meaning that project participants using different software applications may eventually be able to share the same information over the Web in real time without any data transformations (as cited in Nitithamong & Skibniewski, 2006).

The use of ICT allows for real time access of information and improves coordination and collaboration between the project participants. Ahuja, Yang, & Shankar (2009) state that when utilised, its benefits include, ñan increase in the quality of documents and speed of work; better financial control and communications, and simpler and faster access to common data as well as a decrease in documentation errors as use of incorrect data can comprise the scheduled completion of a project and lead to wastage of resourcesò.

Web-based Project Management Systems

In recent times the concept of how ICT can manage construction projects has been widely acknowledged by practitioners (Matheu, 2005, p1). This concept is now commonly referred to as a Web-based Project Management System

ectronic project management tool conducted through
ivate network that uses Internet protocols to transmit information. They are designed to store and manage project information. Basically, these systems provide a centralised, commonly accessible means of transmitting and storing project information. Project information is stored in a server and a standard web browser is used as an access point to exchange this information, eliminating geographic and boundary hardware platform differences (Matheu, 2005, p1).

The basic rationale behind WPMSs is that communication and information control in modern design and construction projects are chaotic. Frequently, this leads to lapses in communication, poor understanding, and ultimately, to annoyance, conflict, and cost and programming over-runs (OôBrien, 2000). These systems offer a level of access to project information that exceeds traditional means of communication such as telephone, fax, traditional post, and email, and storage mechanisms such as project binders for hardcopies. WPMSs provide project participants with the same information in a reliable and easily retrievable method, in theory, improving communication and leading to improved projects (OôBrien, 2000).

Many authors believe that WPMSs improve overall coordination, collaboration, and communication on construction projects in a variety of ways which will be discussed in subsequent chapters (Cox, 2007). Cox (2007) comments that, ñNo other technology provides interaction, communication, collaboration, archival data, a project-information continuum, participant reliability, and accountabilityò. Cox (2007) also suggests that WPMS technology is, ñplaced to make the largest impact on construction project delivery since the introduction of the person computerò, which is a bold statement.

1.2 Problem Statement

e technology itself and the considerable and Project Management Systems (WPMSs) present, adoption and implementation of this technology still remains slow within the Architectural Engineering Construction (AEC) industry."

Construction is one of the most information-dependent industries there is, due mainly to its extended fragmentation. Construction projects, by their very nature, are unique, uncertain, and complex, involving several stages during which a large number of human resources of various specialities interact and cooperate, performing diverse project tasks. Thus, the amount of information and documentation generated and exchanged during the construction process is massive, even on small projects (Chassiakos & Sakellaropoulos, 2008). As construction projects become larger and more complex, an efficient way to deal with such intricacy, is through the use of WPMSs.

Although interest in WPMSs is increasing and more AEC organisations and practitioners are becoming more aware of their existence (and to a lesser extent aware their associated benefits), the adoption, uptake, buy-in, and implementation of such tools is still relatively weak. This is demonstrated by Dossick & Sakagamiôs (2008) study entitled ó*Implementing Web-based Project Management Systems in the United States and Japan'*. According to this study, approximately only 17% of all U.S. construction firms used a WPMS in 2004. Of that, 5.7% used in-house or custom-built project collaboration software and 12.2% used commercial, off-the-shelf products. The Dossick & Sakagamiôs (2008) study cited that 42% of large Japanese construction companies (over 1000 employees) used application service providers (ASPs) that offered WPMSs. However, when taking into account all contractors in Japan, less than 10% were using such systems.

Despite the proven progress in the project collaboration technology, the AEC industry has yet to fully embrace these web-based project management software tools. The

ers that contribute to the underutilisation of these
s is what this research is attempting to identify.

1.3 Purpose

The goal of this study is to:

- Identify/verify the barriers that influence the adoption/implementation of Web-based project management systems (WPMSs) on $5+ million construction projects within New Zealand; and
- Identify/verify methods of overcoming those barriers to WPMS implementation.

It must be acknowledged that there are multiple WPMS available in New Zealand and all have various strengths and weaknesses. The purpose of this research is not to review each of these software packages, but to determine what users want from the software; the benefits and limitations that are associated with WPMSs in New Zealand; and what factors would contribute in determining whether or not to implement a WPMS on a $5+ million construction project within New Zealand.

1.4 Significance of Study

Although the current uptake of WPMSs is lower than the anticipated trend, the systems hold great promise and are expected to replace traditional project management methods (as cited in Nitithamong & Skibniewski, 2007).WPMSs are focused around efficient information management, of which a major element is collaborative communication. According to Quashie (2009), a well structured communication system is a key factor in the success of building project management.

arch, the information and data gathered will assist in s of WPMSs and their associated benefits in the AEC industry; inform WPMS vendors of general limitations with the software; and inform the AEC industry how and why to implement WPMS on New Zealand construction projects. This study will be of interest/significance to the AEC industry and their clients.

Government, industry and clients are all seeking to bring about a change in the construction industry, change that will increase value to clients by improving quality, competitiveness and profitability (Matheu, 2005, p29). Traditionally, the emphasis has been on project managers to manage the interface between the project and the clientôs organisation. There is now a shift towards the requirement of managing the flow of information through the whole life cycle of the project with greater emphasis on those activities which actually add value (Matheu, 2005, p29).

Project managers should particularly benefit from this research as ñcommunication consumes about 75-90% of a project managerôs time and informationò and WPMSs are predominately centred around improving the communication flow and control on construction projects (as cited in Alshawi & Ingirige, 2003). Matheu (2005) reiterate this point by stating that, ñthe management of construction projects is about managing the project communication and information flow. And managing project information about managing the documentation generated in a particular projectò.

This study will also highlight how WPMSs have significant potential to add value to the internal performance of an organisation and to the whole life cycle of a project, as well as the client. That is, the potential benefits of successful implementation. Understanding which factors are critical for system success is fundamental for improved WPMS implementation (Nitithamyong & Skibniewski, 2007).

g such systems, setting out the barriers to WPMS methods of overcoming those barriers, this study will also:

- Assist the vendors of Web-based project management software with feedback from their users,
- Encourage construction organisations to prepare for and implement ICT, and
- Provide options for overcoming the barriers to implementing WPMSs for the AEC industry and their clients.

1.5 Research Question

The research questions for this study are:

"What are the key barriers influencing the implementation/adoption of Web-based project management systems in the New Zealand construction industry?"

And;

"What are the recommendations to overcoming these barriers?"

Chapter Two – Background

2.1 Literature Review

Project Management

Modern project management first came into existence in the early 1950s on large defence projects. After World War II, the increasing complexity of projects and a diminishing wartime labour force demanded new organisational structures. The Program Evaluation and Review Technique (PERT) charts and Critical Path Method (CPM) were pioneered allowing managers greater control over heavily engineered and highly complex projects Matheu, 2005).

These techniques spread, initially to larger companies, as business leaders sought new management strategies. However, after viewing the success of these operations, smaller organisations gradually took to adopting the strategies and now a very high majority of construction firm worldwide implement some form of project management (Alshawi & Ingirige, 2003). These days, projects are generally far more complicated involving large capital investments, combining several disciplines, project members who are widely dispersed, tighter schedules, and rigorous quality standards. These factors together with the rapid developments in Information and Communication Technology (ICT) have offered project management practitioners the opportunity to take advantage of newly developed management tools and the latest technology, such as Web-based project management systems (WPMSs) (Alshawi & Ingirige, 2003).

According to Ahuja (et al., 2009) project management requires a system that, ñprovides shared project information, analysis of tools to analyse the information,

e to handle the flow of information, a multi-device rmation and a system that ensures the persistence of the underlying information among the participantsò. ICT tools and systems have the ability to provide these services (Ahuja et al., 2009).

Communication

According to the Royal Institute of British Architects (as cited in Matheu, 2005), ñThe overall role of project managementé .is to harmonise the functions of planning, communicating, monitoring and control in order to meet the projectôs overall objectives as defined by the scope, time, cost, quality and client satisfactionò.

Communication deals with the producing, issuing and transmitting reports/documents, and chairing meetings with key project participants in order to ensure the proposed timing, method and strategy is made available and understood. Matheu (2005) writes that, In essence, collaboration of various participants in a project is measured by how effectively the communication channels were managedò.

Therefore, as conveyed by Matheu (2005), ñThe responsibilities of the Project Management are to plan, coordinate and control the overall projectò. Such duties can be achieved through a good communication and information management tool, such as a Web-based project management system (WPMS).

There is a growing body of literature delineating the advantages/benefits of using WPMSs on construction projects.

Advantages

Although exploring the various advantages of implementing WPMSs is not within the direct scope of this research, the author believes it is important to briefly

such systems in order for the reader to understand nplement a WPMS. It is important to understand the benefits in order to appreciate the purpose of this research - which is to discover what the key barriers are influencing the implementation of WPMSs in the New Zealand construction industry. When the benefits are known and the advantages of such systems are explained, the question then remains, ñwhy is the Architecture, Engineering and Construction (AEC) industry not implementing these systems on *all* large construction projects?

The advantages gained from utilising WPMSs are documented in a growing number of research papers produced over the past decade. **Figure 1** below summarises some of the benefits these systems provide at the project and organisational level.

Figure 1: Tangible, quasi-tangible, and intangible benefits at the project and organisation levels (Becerik and Pollalis, 2006)

	Value – le Benefits EFITS			Savings – Intangible Benefits HARD BENEFITS		
	new income / value	increased income / value	avoided costs	new income / value	increased income / value	avoided costs
Project Level Benefits	•ability to refer back to data •enables international links •better information version control •better forecasting and control	•decreased work flow turnaround •improved quality of the output •better communication; fewer information bottlenecks •greater integration and process automation •improved idea sharing among team members •improved capture of design/construction decisions	•reduced errors and omissions •minimizing project risks •advanced purchase of materials	•improved project delivery; early occupancy		•reduced/saved staff requirement •reduced transaction costs •decreased # of RFIs/Change Orders •reduced storage requirements •reduced litigations and discovery costs
Organizational Level Benefits	•Improved company image •Gained market access •Improved customer relationships •Gained negotiation power •Strategic competitive advantage •Claims mitigation and management •Forecasting •Knowledge management •Process re-engineering	•improved data availability •improved audit trail •improved information management •faster reporting and feedback •accurate/timely information to give valid/accurate decisions •improved process automation •improved version control •better project/program control •timely capture of decisions •fewer information bottlenecks	•reduced mistakes •better risk management			•decreased # of RFIs/Change Orders •decreased spending on administration staff & materials •reduced communication costs •less service workers •reduced litigations and discovery costs

Figure 1. Tangible, quasi-tangible, and intangible benefits at the project and organizational levels

Quasi-tangible Benefits

a) Improved communication

Matheu (2005) suggests that WPMSs improve project communication, align business processes increasing transparency as barriers to communication are removed. Collaborative systems reduce the amount of re-work by storing not just information but the knowledge that derived it. A study conducted by Nitithamyong & Skibniewski (2007) concurs with Matheuôs statement, finding that, ñenhancing coordination among team membersò is 3rd in the rankings of the benefits of WPMS. Alshawi & Ingirige (2003) add that by using a WPMS, the speed of communication is substantially increased, resulting in shorter lead-times for tasks. Alshawi & Ingirige (2003) also comment that such systems result in accuracy of communication which transpires into fewer errors and rework costs.

nation/document availability

This benefit derives from the fact that the technology allows the users to ñreach and search the project information globallyò and thus able to work from anywhere worldwide (Becerik and Pollalis, 2006).

Becerik and Pollalisô(2006) research states that, ñThe technology ensures and forces data population and provides a structured and easy way to store itò. Assistance in searching for files and documents is ranked 4th in Nitithamyong & Skibniewskiôs (2007) study of WPMSs success factors, which corroborates the above findings. Cox (2007) also corroborates with the above commenting that, ñby having a central portal of the most up-to-date project information for all participants provides the opportunity to access whatever is needed to perform individual project responsibilitiesò. Cox (2007) also comments that project participants can access archived historical data through these systems which allows the users to understand project issues as they arise and are resolved.

c) *Enabled complete audit trial*

These systems ensure all project information and communication threads have been tracked and stored in a structured and credible way (Becerik and Pollalis, 2006). Cox (2007) views this as a major benefit of using WPMSs, because project participants can easily see which team member/s may be causing any bottlenecks by holding up a decision or essential piece of information. This results in improved accountability of project team members and reduces the likelihood of delays (Cox, 2007).

d) *Improved information management*

extensive file management system with granted to particular project areas and foldersò which allows for greater ease of searching for specific documents (Becerik and Pollalis, 2006). Nitithamyong & Skibniewskiôs (2007) study concurs, and found, ñfacilitating document transfer and handlingò ranked second out of the most proficient benefits from using a WPMS.

Becerik and Pollalis (2006) suggest WPMSs give members of the project team certainty of information resulting in minimised duplication of effort and wastage on projects. Not only does the user have access to the correct version of documentation, but they also have the ability to track the previous versions and monitor who else accessed or modified the information.

e) *Faster reporting and feedback*

Becerik and Pollalis (2006) suggest project teams can manage complex programs with less administration staff and can communicate with greater effectiveness when using a WPMS. In contrast to this, OõBrien (2000) argues that it should be recognised that these systems are ñnot necessarily labour-saving devices for all individuals on a project teamò.

Ilich, Becerik, and Aultman (2006) suggest that WPMSs increase the speed of communication on a project which is corroborated by Alshawi & Ingirige (2003) who comment that such systems improve efficiency through ñspeedy and accurate information between head office and sitesò. The study by Matheu (2005) also suggests WPMSs create a reduction of the response time for RFIs (Requests for Information), COs (change Orders) and specifications clarification. Nitithamyong & Skibniewskiôs (2007) study ranks ñenabling immediate report and feedbackò 5th from all WPMS benefits.

ccurate decision making

With faster, more complete information flows comes faster decision making. The web-based software also increases awareness meaning ñproject managers can easily realise any changes that would affect a project or a contractorò (Becerik and Pollalis, 2006). Alshawi & Ingirige (2003) also acknowledge ñBetter management and decision-makingò as a benefit of WPMS implementation.

g) *Improved process automation and standardisation*

Documents are generated in a structured way providing the users with a clear and familiar format to interpret. A participant of Becerik and Pollalisô (2006) research commented that it is very easy to issue or answer an RFI or write meeting minutes once the software is up and running and all the contacts are in the system.

h) *Improved version control*

Becerik and Pollalis (2006) state that WPMSs ensure all members of the project team have access to the most up-to-date documents without the requirement to wait for hardcopies ï a very important aspect to any construction project which saves time and money. Matheu (2005) agrees and comments that this reduces project risk as well; ñThe latest information is always available as soon as it is published, minimising the risk of working on old informationò. Alshawi & Ingirigeôs (2003) study concurs with these findings stating that, Mistakes are avoided because all drawings and documents are always up-to-date and instantly availableò. They also suggest that risk is diminished because team members are not acting on information that is outdated or incomplete, which corroborates the information by the other authors above.

oniewskiôs (2007) study found ñenhancing
ted recordsò was ranked as the biggest benefit of using a WPMS. Improved version control also assists in avoiding delays because team members do not have to wait for the arrival of updated drawings (Alshawi & Ingirige, 2003).

i) *Better project/program monitoring and control*

The key words in this benefit are ótrackingô and ósearchingô. These systems allow users to create reports and easily search documents to find what they need. (Becerik and Pollalis, 2006) state that, ñHaving all project information stored in one centralised space helps the project managers to control the budget and the schedule more effectivelyò. Matheu (2005) agrees and states, ñAll actions are recorded to be audited and monitoredò.

j) *Improved timely capture of design/construction decisions*

Minimising the need to revisit sites and having the ability to review several projects results in more effective management. The need for meetings and travel also is reduced as online approvals and comments can be achieved in real time (Becerik and Pollalis, 2006). Matheu (2005) agrees and comments that, ñThe fast dissemination of information shortens consultation cycles and speeds up decision makingò.

k) Reduction of costs and wasted time

Printing, postage and document administration costs are reduced as all documents are stored centrally (Matheu, 2005). Alshawi & Ingirige (2003) add that visits to site and travelling time can also be reduced as the most up-to-date progress photographs are constantly accessible for viewing on the system. Due to the complete audit trail it provides, WPMSs also reduce time and money spent on disputes (Alshawi & Ingirige, 2003). Cox (2007) concurs, stating that WPMS, ñreduce the costs incurred by change

ecord maintenance, as well as minimise or eliminate

Nitithamong & Skibniewski (2006) comment that access to certain documents or areas can be restricted to particular levels of responsibility, seniority, or specialisation due to the fact that a closed network is used. Therefore, ñmistakes caused by poor communication and delays caused by the time it takes to move documents and people around for approvals and meetings can be minimisedò (Nitithamong & Skibniewski, 2006).

l) *Reduction of storage space*

Alshawi & Ingirige (2003) comment that their study indicates less storage space for paper work is required due to more and more electronic storage being used.

Intangible Benefits

These benefits cannot be quantified monetarily rather are represented by qualitative benefits. According to the research of Becerik and Pollalis (2006), ñBusiness benefits rather than cost savings have been more important for the participating investors in most casesò. Their research continues, explaining that most important to organisations when deciding whether to implement these systems are goals such as, ñperforming the right tasks correctly, staying consistent with the organisationôs mission, vision, and values, and supporting its goals and objectivesò.

Becerik and Pollalis (2006) acknowledge some performance benefits as: ñsupply chain integration, process reengineering, gained market access, improved customer relationships, gained competitive advantage,

ing, knowledge management, and increased

To summarise, it is obvious that many benefits are derived from utilising WPMSs and most are reflected in multiple literature. The implementation of ICTôs/WPMSs in the AEC industry is a way to ñreduce costs; maintain or create a competitive advantage; save time; and improve productivity, safety, and the accessibility and exchange of information. There is no lack of potential solutions; however, the measurement of benefits and barriers to implementation is not straight forwardò (Rankin & Luther, 2006). Prima facie, when observing these significant advantages, one may question why these systems are not utilised on every construction project in New Zealand. There is a growing body of research suggesting the construction industry has been slow to adopt and take advantage of the ICT tools available.

Slow Adoption and Implementation

There is little argument that, ñEffective application of ICTôs will lead to more efficient management of project execution and to a more productive industryò (Rankin & Luther, 2006). However, there is a growing amount of studies suggesting the Architectural Engineering and Construction (AEC) industry is proving to be relatively slow at utilising this technology.

Peansupap & Walker (2005) state that many studies have revealed the benefits from using ICT, but go on to comment that, in general, the construction industry remains

when comparing it to advanced manufacturing say that, ñalthough ICT benefits are recognised, the level of ICT use in the construction industry is still lowò. Dossick & Sakagami (2008) reiterate this point, stating that although many businesses have reported substantial savings from using WPMSs, there is still a reluctance to use this technology in the construction industry. Again, a study by Hewage, Ruwanpura & Jergeas (2008) suggests that the construction industry is seen as backwards when it comes to implementing IT systems and tools. They continue in this vein stating that, ñDespite an explosive growth in Internet use in the last decade in many areas of business and commerce, the construction industry has not kept pace to the same degreeò.

A study undertaken by Dossick & Sakagami (2008) demonstrates the underutilisation of Web-based project management systems in the Japanese and the U.S. construction industries. ñAlthough these markets are high-tech intensive and both cultures have embraced technology, a relatively small sector of the construction industry in both countries have implemented WPMSsò. Nitithamyong, & Skibniewski (2007) also argue that the current rate of WPMS implementation is still lower than the projected uptake.

Substantiating that trend is Stewart & Mohamed (2004) who acknowledge the need to increase the efficiency throughout the construction business processes and comments that, ñthe use of IT in construction has not progressed to the level that can been seen in other industriesò. Alshawi & Ingirige (2003) concur and state that, in contrast to the manufacturing and retail industriesé .the overall construction industry has shown a relatively slow uptake of web technologies to improve its practicesò.

It is argued the main reason for this slow rate of embracing ICT is due to the highly complex and fragmented nature of the AEC industry (Peansupap & Walker, 2005). Chassiakos & Sakellaropoulos (2008) corroborate this, suggesting that improving communication in construction projects is a difficult task due to the, ñextended fragmentation of the construction industry and the huge amount and wide

that is involved in the construction processò. Others ork environment, the wide variety of work scope, dust and moisture, and portability issues (as cited in Hewage et al, 2008). Nuntasunti & Bernold (2006) corroborate these statements and listing the following as reasons for the AEC industryôs slow adoption rate of ICT:

- ñFragmentation of the industry,
- Temporary relationships between project participants,
- The adversarial relationships between parties founded on the lowest-bid or zero-sum game ñcultureò of the industry,
- Constantly changing jobsite environment,
- Weather and other unforeseen conditionsò.

Limitations and barriers to the adoption and implementation of ICT and WPMSs in the construction industry

Earlier studies of this topic indicate that cost and technological issues were the major barriers to ICT implementation in the construction industry. However, recent studies have shown a shift away from these barriers with a move towards management problems within construction organisations as the major barrier (as cited in Peansupap & Walker, 2005). The International Council for Research and Innovation in Building Research (CIB) W78 conference papers identifies the management of IT/ICT as a major theme, especially itôs adoption and implementation (as cited in Peansupap & Walker, 2005). Ahuja, Yang & Shankar (2010) acknowledge this in their research also, stating that studies in this area, until recently, have had a predominately technical focus rather than a managerial focus.

Hewage (et al, 2008) suggests that, ñConstruction companies lag behind other industries in the creation of long-term strategic plans for the implementation of information technologyò. According to Peansupap & Walker (2005) ICT adoption should be planed and strategically thought through and implemented otherwise an

nefit from an ICT investment. For example, it may onstruction companies because they are unsure of how to commence the implementation process which may result in loss of competitive advantage (Peansupap & Walker, 2005). Unplanned ICT adoption may cause ongoing issues such as user confusion, technical problems, lack of clarity surrounding the software and what the ICT benefits are. This may lead to a negative perception of ICT use among potential users resulting in a resistance to its adoption (Peansupap & Walker, 2005).

Other limitations identified are as follows:

Limitations

1. *Lack of Understanding*

   Many construction practitioners have insufficient experience in understanding organisational and social issues of strategic ICT adoption which is recognised as an important implementation barrier (Peansupap & Walker, 2005).

   There is also a lack of understanding by the users in terms of the benefits derived from using WPMSs. Hewage (et al, 2008) suggests, ñThe number one barrier to implementation of technology is that construction managers are not aware of proof that the addition of technology has benefits and what possible problems might be experiencedò.

2. *Security & Access*

   Because much of the information flowing through these systems is commercially sensitive the Application Service Provider (ASP) must be trusted, reputable and secure (Matheu, 2005). OõBrien (2000) argues there is concern over who has access to the project Web site and asks the question; ñWhat is the boundary to the site?ò He comments that it is virtually impossible to give everyone working on a project a password, and also warns that often the greater the security, the greater

ı and this deters occasional users from applying the

03) comment that security is a major issue and that it, ñ imposes a lot of financial constraints on project teams as the costs need to be incorporated into project feasibility studiesò.

3. *Infrastructure and difficult Internet access.*

   Matheu (2005) suggests that most companies do not have the necessary infrastructure to support these systems and most construction sites do not have access to the internet. Not surprisingly, a study by Nitithamyong & Skibniewski (2007) indicates the more project members have access to the internet on site and the faster and more reliable that is, the more beneficial the WPMS is to the project. The systems are subject to crashes of both the software and the Internet itself and because the systems are web-based, there is a constant need to upgrade the firewall protection (Alshawi & Ingirige, 2003).

4. *Need for training*

   There is an allowance required for time and money in order to get the users trained and competent using the system. However, projects that provide more training to team members gain higher WPMS performance in all perspectives (Nitithamyong & Skibniewski, 2007).

5. *Cost and time over-runs*

   Unclear ICT implementation strategy and processes can result in excessive technological investment costs, delay the implementation, and cause business uncertainty (Peansupap & Walker, 2005). That said, Nitithamyong & Skibniewskiôs (2007) study suggests that when more resources in terms of money, time, and personnel are provided, WPMSs performance tends to be higher. According to Alshawi & Ingirigeôs (2003) research, an issue when implementing WPMS is the cost of having to treat the web server as a full scale IT project, involving the appropriate funding and appropriate staffing.

pport or organisational commitment to ICT implementation can result in user resistance. OôBrienôs (2000) study found that ópragmatistsô, who make up the bulk of the population, need to see some form of benefits when using Web-based systems before they adopted it, whereas óinnovatorsô experiment and commit to their Web use and only accept those with perceived potential benefits. óScepticsô are at the other end of the scale and resist any change on principal. This indicates that the type of user can influence their adoption decision (as cited in Peansupap & Walker, 2005). According to Dossick & Sakagamiôs (2008) there is a resistance from small contractors because of low-cost effectiveness or merit.

According to Hewageôs (et al, 2008) study, managers indicate they have experienced resistance from ólderô workers whenever a modern technology has been introduced. Many of the decision makers around the implementation of WPMSs are older and more experienced, and these are the same type of workers who have shown resistance to the technology.

7. *Task-technology fit*

   A poor fit between the technology and the organisations requirements is known as ótask-technology fitô. óTask-technology fitô refers to the technology fitting and being conducive with the userôs requirements to perform various tasks (as cited in Peansupap & Walker, 2005). Obviously if the two are not compatible, then the investment has been somewhat worthless.

8. *Declining work performance*

   Researchers present many benefits of using ICT, such as reducing time and cost of information transfer and improved communication. However, Peansupap and Walker (2005) suggest that ñthese benefits will only be realised if technology is fully used and integrated into an organisationò.

d as low is often a result of poor organisational mangers of the company. However, it is argued that the introduction of new IT into an organisation can cause a decline in work performance due to training having to take place and staff adapting to the new system. Uncertainty during the time ICT is implemented can also cause a performance reduction (Peansupap & Walker, 2005).

9. *Communication channels*

   Having more familiar technology available, such as emails, it makes it easy for members of a project team to bypass the WPMS and simply send or forward an email. ñA project team needs real discipline to adopt a Web site and use it to replace other communication channelsò (OðBrien, 2000).

10. *Generic systems*

    Often these WPMSs are generic in nature and not project specific, which means the software is simpler to develop and simpler to support. However, not everyone does the same job and not everyone has the same needs for communication and information management. OðBrien (2000) suggests that the systems are not complete communication and information management solutions for everyone and says this makes it harder for team participants to integrate the WPMS into their jobs.

11. *Collaborative Maturity*

    Collaborates maturity is the term used by OðBrien (2000) indicating the level to which individuals and projects teams are willing to work together, sharing information and experience for the good of the project. He states that WPMSs implemented on projects where the team members have little collaborative maturity will be far less useful. He also comments that there is a need for clearer usage plan, making more explicit the type of communication required and how this is to be achieved.

It has been observed by OôBrien (2000) that the established legal environment provides reasonably comprehensible guidelines regarding how to operate in the current paper-dominated construction industry. ICT tools such as WPMSs are positioned to change the way we work, making legal responsibilities in the Web-based era unclear and opening the door to potential risks (OôBrien, 2000) Nitithamyong & Skibniewski (2004).

13. *Project Characteristics*

According to Nitithamyong & Skibniewski (2007), private projects gain less performance from WPMSs than public projects in regards to time and risk improvement benefits. They suggest this may be because public projects are generally larger, more complex and involve more parties than private projects. Nitithamyong & Skibniewskiôs (2007) results also indicate that residential projects benefit less from the systems which they suggest may be because they are of less complexity and comprise of less personnel meaning there are less communication barriers.

Nitithamyong & Skibniewskiôs (2007) research found that WPMSs perform better when they are used in projects with higher budgets. Projects with higher budgets usually involve more parties and require superior communication and data sharing capabilities. These projects commonly take longer to design and construct, which allows more time for gaining experience using the WPMS. This is reflected in Dossick & Sakagamiôs (2008) study which suggests larger organisations have embraced the technology more than smaller ones which have shown some reluctance in adopting it. A study by Ahuja, Yang & Shankar (2010) makes a similar observation, citing that, ñIt is easier for large firms to be in the deployment and adoption of the emerging technology, whereas SMEs (small to medium sized enterprises) have difficulty in dedicating resources to research, development and training.

its

Rankin & Luther (2005) argue that, ñIntangible factors in the construction industry make it difficult to quantify the costs and benefits of ICT innovation and therefore to assess the gains madeò from it. As a result, justifying an ICT investment becomes a major barrier to its implementation. This correlates to Hewageôs (et al, 2008) study who state, ñCompanies do not have clear procedure to evaluate the return on investment on any information technologies they may purchaseò. Nitithamyong & Skibniewskiôs (2004) corroborates this, commenting that, ñThe temporary nature of relationships in a construction project also provides little or no incentive for investing in innovative technologiesò.

Recommendations

1) *Initiation*

   Research conducted by Dossick & Sakagamiôs (2008) suggests ñowner initiated propagationò, where the owner encourages team members to implement the WPMS, is more successful than ñcontractor initiated propagationò, where the general contractor leads the WPMS implementation.

2) *Evaluation*

   Peansupap and Walker (2005) state that it is essential to evaluate feedback from users of the system and to rectify any issues they encounter. This recommendation is echoed by Ahuja (et al, 2010) who suggests ICT implementation should be supported by usersô feedback.

3) *Level of Support*

   There are multiple studies that suggest support is required internally from within the user organisation and also externally from the Application Service Provider (ASP) in order to gain successful implementation of a WPMS.

)08) state that, ñFor successful implementation, there needs to be support from upper management and the leaders of the primary user organisations. Research by Nitithamyong & Skibniewski (2007) also suggests, ñThe level of support from top management has significant positive correlations with all WPMS performance perspectives (i.e. strategic, cost, and quality)ò. Therefore, a strong level of commitment from top level personnel to a WPMS is required if it is to be successful.

An essential element to adopting ICT is to provide organisational [technical] support for users and create a long-term relationship between supplier and user, otherwise the implementation of ICT is likely to fail (as cited in Peansupap & Walker, 2005). Nitithamyong & Skibniewskiôs (2007) study goes further, stating that, in order for the system to provide the best results for the users and ultimately the project, Application Service Providers (ASPs) should have:

- Easily accessible contact facilities,
- The resources to respond quickly to any queries,
- Staff with good attitudes towards their customers,
- Staff with the ability to understand technical issues related to the system and to provide solutions to such issues,
- A good understanding of the construction sector to ensure the success of system implementation.

4) *System Controller*

OôBrien (2000) recommends designating a few project team members as champions of the WPMS who have responsibility of not only ensuring itôs operational and performing in the correct manner, but also encouraging team members to use it during and prior to implementation. Nitithamyong & Skibniewski (2007) concur with this statement, adding that a WPMS should

by an owner otherwise the system will tend to lack a result in failure.

Somewhat in contrast to Nitithamyong & Skibniewski (2007) is Dossick & Sakagami (2008) who suggests the ideal person to lead the implementation of the system is the owner who then requests the use of WPMS in the project contract.

5) *Define Use*

a) *What*

By defining *what* uses the system should be implemented for, users gain clarity and it also defines their job tasks in relation to those uses. By defining specific uses it creates a purpose for the system and gains credibility with the team members. Uses and boundaries of the system should be defined early in the project and it should not be seen as a fluid tool but rather a solid ally in achieving operational goals (OôBrien, 2000).

b) *Who*

According to Nitithamyong & Skibniewski (2007), it is recommended that all associated team members should have access to a WPMS and access should not be restricted to personnel that are at high authority or management levels. However, they do mention that a very large number of users can be chaotic and difficult to control. The study also states that, ñIn order to prevent implementation problems, it is important to decide early in the project on an adequate number of project team members who can obtain access to the systemò.

c) *How*

- Etiquette

uette for the utilisation of WPMSs is an important ful implementation according to OõBrien (2000). He states that there must be a place for formal and informal communication and it should be decided when which is used. He defines formal communication as the equivalent of letters and normal written correspondence and informal communication as the typical content and style of an email and verbal communication. OõBrien (2000) also recognises the need for determining who communicates with whom. Dossick & Sakagami (2008) reiterate this point by stating, ñThe important thing is that users be able to distinguish how to use new processes and conventional processes, such as fax or telephones, and select the best tool for the communication that needs to take placeò.

- Information Flow

  OõBrien (2000) suggests mapping the information flow on the project when designating uses of the Web site assists in its implementation, so itõs clear who has access to what areas and may highlight any boundary issues.

6) *Enforce Use*

OõBrien (2000) recommends enforcing the use of the systems because they are most effective when they contain all the information related to a specific issue. Even when a small piece of information is missing, the system can be far less useful. In concurrence with this, Dossick & Sakagami (2008) recommend enforcing the use of such systems by way of contract specifications. Ahuja (et al, 2010) agree, stating that, ñImplementation will include introducing contract clauses defining ICT adoption as scope of work of the projects and managing building projects utilising the new systemò.

using a WPMS from the beginning of a project and not to force it into projects already in motion as they have too much momentum and investment in other communication strategies to successfully assume a WPMS (Nitithamyong & Skibniewskiôs (2007) findings reiterate this, as their results show that ñboth the time and performance of WPMSs are substantially reduced when the systems are introduced during the construction phaseò.

8) *Populate the Site*

By populating or ñseedingò the software tool with useful information and examples of how to use it, will create a good first impression to first-time users and ñis one of the most powerful ways to promote Web site use on the projectò (OôBrien, 2000).

9) *Internet Access & Connection*

Nitithamyong & Skibniewski (2007) recommend that a cable modem connection is the most reliable means of Internet access and thus, advocates it to be selected if available. They highly recommend providing Internet access to all project team members in order for the system to succeed, especially in terms of time performance. The study states that, ñJust one team member not being able to access the Internet to input his/her information can effect the system not working as intended and its time performance can significantly decreaseò.

10) *Training*

It is strongly recommended by Nitithamyong & Skibniewski (2007) to continue providing training opportunities for team members so they can

der to meet the changing needs of business processes.

hoed by Dossick & Sakagami (2008) whose study found that it is not only important to train team members on how to use the system, but also to communicate the benefits of the system. According to this research, this facet appears to be one of the most important barriers to implementing WPMSs.

Peansupap & Walker (2005) suggest that a strategic ICT adoption strategy or plan ought to be employed by construction organisations in order not to come unstuck by issues such as user confusion, technical problems, lack of clarity surrounding the software, and unaware of what the benefits are. Ahuja (et al, 2010) argues that training, education and examples of successful implementation are required to modify perceptions and to persuade industry practitioners to increase ICT adoption. If this occurred, and people perceived high benefits and low barriers to the use of ICT, it would increase effective adoption of ICT for project management teams (Ahuja, et al, 2010).

11) Functionality / Ease of Use

Nitithamyong & Skibniewskiôs (2007) research suggests that a system that is easier to use yields higher performance in terms of communication, cost and strategic. Nitithamyong & Skibniewski (2007) state that, ñWhen a WPMS is proven to be easy to use and reliable, team members will be more willing to use it as a central communication channel to coordinate and exchange information with othersò. Dossick & Sakagami (2008) continue this theme in their research, suggesting people are like water: they find the path of least resistance. That comment implies that engineers and managers have little time on the job to learn new systems and processes, and will default to the easiest and fastest way to work the work done. Therefore, they say, the best way to implement ICT and WPMSs is to ensure they are easiest and fastest way to get

Sakagami, 2008). Cox (2007) suggests that through in fact, be accomplished better, faster, and cheaper.

Nitithamyong & Skibniewskiôs (2007) study also states that, having good quality screen-based and printed outputs can help reduce misinterpretation of data which could potentially result in miscommunication and disputes. Research by Dossick & Sakagami (2008) agrees suggesting that, ñFrom a user interface and customer service perpestive, the software and hardware tools have to be easy to implementò.

12) Reliability and Security

WPMSs perform better when they are reliable and provides data that is more secure and accurate (Nitithamyong & Skibniewski, 2007). Data reliability and security are the main concerns to construction practitioners when deciding whether to implement an IT system or project (as cited in Nitithamyong & Skibniewski, 2007). If the internet or the software frequently crashes, users will abandon the system and revert to previous strategies or another, more reliable, process (Dossick & Sakagami, 2008).

Data that is produced and maintained by a WPMS that is proven to be accurate, current, reliable, and secure is critical to the success of the system in regards to its time, quality, and risk performance (Nitithamyong & Skibniewski, 2007).

13) Integration

Nitithamyong & Skibniewski (2007) suggest that the WPMS should have the ability to integrate internally and externally to other software and systems, as this will enhance the workflow of project information, which will result in success of the system and eventually success of the project. Dossick & Sakagami (2008) add that the WPMS technology must be integrated into, and

of, the daily work processes of the users. If this does until last and infrequently used.

14) Project Type

According to Nitithamyong & Skibniewskiôs (2007) research, projects that are highly complex, that is, heavily engineering and industrial constructions, or relatively uncomplicated projects such as residential work may not benefit from the utilisation of WPMSs, as much as moderately complicated projects such as commercial construction. This is particularly true for the cost and risk benefits.

15) Project Duration

Nitithamyong & Skibniewskiôs (2007) research concludes that project duration is a critical factor in the strategic and cost performance of a WPMS. They suggest that it would be much easier to implement a WPMS successfully on a project with a longer duration because:

- It usually takes some time before a projectôs team members accept and use a WPMS effectively;
- WPMS implementation generally requires considerable changes to current business processes, and these changes require time to be achieved which is reasonably difficult to achieve in a short project.

16) Ability of Project Managers

Project managers have been identified as the most important person in the project team (as cited in Cheung, Suen, & Cheung, 2004). Studies have found that factors (i.e. competency, authority, involvement, and commitment) of project managers have a strong bearing on how successful a WPMS performs and how successful a construction project is delivered (as cited in Nitithamyong & Skibniewski, 2007). Alshawi & Ingirige (2003) suggest that there is a need for a project manager to have knowledge of the IT infrastructure. It is recommended by Nitithamyong & Skibniewski (2007) that

pate in the WPMS implementation process in order to ng of the systems and how it can be integrated into current business practices.

17) Usage Frequency of Advanced WPMS Features

Nitithamyong & Skibniewskiôs (2007) research found when users of WPMSs increased their use of the advanced features of the systems, performances of time, quality and risk all increased significantly. The study, therefore, suggests a project team with goals of saving communication time, improving the quality of documents, or increasing risk management benefits by using a WPMS, should seek a system that provides these advanced features.

18) Strategy

It is recommended by Ahuja (et al, 2010) that strategic ICT adoption is required at industry level and organisational ICT adoption strategies should be aligned with the industry wide strategy. An industry wide strategic ICT adoption plan requires understanding, participation and support from all pertinent professions, enterprises and government agencies. According to Ahuja (et al, 2010), such strategies have been employed in the UK (óConstruct ITô and óAvanti projectô), Finland (Vera program), Singapore (CORENET project), and Australia (CRC CI initiative). Thus, it is apparent that strategic adoption of ICT in the construction industry needs to become a business objective in order for it to be adopted by the industry as a whole. OôBrien (2000) recommends that any implementation strategy should accommodate the impact of application limitations and manage user expectations, because it is unlikely an ICT application can support everyoneôs system requirements.

Web-based Project Management System

Web-based Project Management Systems or WPMSs have other guises such as óOnline Collaboration and Project Management (OCPM) Technologyô and óProject Management Systems ï Application Service Providersô (PM-ASPs). For the purposes of this research and the sake of generality, the use of Web-based project management systems (WPMSs) shall encompass the previously stated commonly used terms, even if such terms are not definitively accurate.

Application Service Providers (ASPs)

ñASPs are third party entities that manage and distribute software-based services and solutions to customers across a wide area network from a central data centre. In essence, ASPs are a way for companies to outsource some or almost all the aspects of their information technology needsò (Matheu, 2005).

Construction Project Management

ñ*Construction Project Management* is the planning, control, and coordination of a project from conception to completion (including commissioning) on behalf of a client. It is concerned with the identification of the clientôs objectives in terms of utility, function, quality, time, cost, and the establishment of relationships between resources. The integration, monitoring and control of the contributions to the project and their output, and the elevaluation and selection of alternatives in pursuit of the clientôs satisfaction with the project outcome and fundamental aspects of Project Managementò (as cited in Matheu, 2005).

Chapter Three – Methodology

3.1 Introduction

This research was undertaken to determine what key factors influence the implementation of Web-based project management systems (WPMS) in the New Zealand construction industry. Similar research in this area has been completed in the markets of Japan and the United States of America of which both economies are tech-tech intensive and both cultures have embraced technology and its role in business and society. However, it was noted in this research that a relatively small sector of the construction industry within these countries has implemented Web-based project management systems (Dossick & Sakagami, 2008).

WPMS, if employed effectively, adds many benefits to the management of construction projects. Benefits such as the speed of communication, reduction in the cost of communications, and provides productivity savings (Ilich, Becerik, & Aultman, 2006). Despite these advantages and the proven advances in the technology itself, the construction industry is yet to fully embrace these tools and this research is designed to understand why this is so.

3.2 Research Design

Participants will be selected from the population to form a sample group (see ôPopulation & Samplingô below). These participants were phoned by the researcher to: 1) qualify them in terms of the selection criteria, 2) ensure they have the willingness and availability to participate in the research and, 3) to obtain their email address.

ail which thanked them for their participation and
ne survey. The online survey contained four topic areas each with three questions. These questions gathered data relating to their individual perspectives regarding WPMS and allowed them to answer questions on a nominal scale and an ordinal scale (that is, Likert scale). This allowed me to gather specific data relating to the barriers of implementing WPMS and why the implementations of WPMS are impeded.

After analysing this data and based on the four topic areas and three questions in the on-line survey, interview questions were then formed. The participants were contacted by phone and interview times were arranged. These interviews were designed to clarify any answers given in the on-line survey, but were mainly used for gathering data on the means and methods of overcoming the barriers to implementing WPMS which were identified in the on-line survey.

3.3 Population & Sampling

Population

The population for this study is every Project Manager (PM) on every construction project valued over $5 million within New Zealand.

Sampling

Sample members were selected from the population in a non-random manner and, therefore, classified as a non-probability sampling method. Two non-probability sampling methods were used in this research; convenience sampling and judgement sampling.

Convenience sampling was employed because the researcher was interested in getting an inexpensive approximation of the truth. The researcher/interviewer was located in Hamilton and because the study involved interviewing participants from Auckland and

ent for the researcher. However, it was the kland and Waikato regions would give a fair representation of the rest of the population as there would be few variables between these regions and the rest of the country in terms of WPMS.[1]

The sample size of the study consisted of 12 PMs based either in the Auckland or Waikato regions. They were selected on merit having worked on or currently working on $5m+ projects and worked/working with WPMS. Selection size was also dictated by the availability of potential participants for interviews. The criteria for selecting the sample were as follows:

Project Manager (preferably senior) or Project Director

Has/is worked/working on a $5m+ construction project/s and has experience working with WPMS.

This sample was chosen because PMs are in a position which allows them to have an overall perspective of projects and are the individuals who are most aware of the influences affecting the implementation of WPMS. They have the most knowledge of the implementation of such systems as they utilise all aspects of the system as apposed to other associated users such as construction managers for example.[2] Projects over $5 million is an element to the sample criteria because projects smaller in value become less reliant on efficient project management systems and often projects are managed by a quantity surveyor, architect or construction manager, meaning a specialised PM is not required. The sample PMs must have experience in working with WPMS as the data gathered would not be as accurate, detailed or as rich if the sampled participants did not have knowledge or experience in WPMS.

[1] Internet speed in other regions maybe a factor which distinguishes itself from the sample.

[2] Not gathering data from other users of WPMS such as construction managers may be a limitation of the study.

Online Survey

The initial online survey to participants is a form of quantitative research which attempts to determine what the barriers are to implementing WPMS on construction projects over $5 million. This was undertaken because of the nature of quantitative research and online surveys.

Online surveys were used to extract data from the participants because the respondents receive the survey almost immediately and can complete the survey at a convenient time for them, with time to think about their answers. Information is already electronic which can speed up/simplify data management which means itôs usually straightforward to analyse and is collected in a standardised way.

As many barriers to implementing Web-based project management systems are already documented in the literature review, the survey is to verify the various barriers and potentially establish any original barriers not documented in the literature review. Therefore, this process was required to be done with relative haste to ensure the interview questions, which are at the centre of this study, were developed quickly and accurately, which is something an online survey could deliver.

Personal Interview

The task of defining and understanding successful implementation strategies required a qualitative research approach that encouraged the participants to discuss barriers to WPMS implementation and their methods for overcoming these barriers. A qualitative approach was undertaken because the study seeks to find out why things happen as they do and determine the meanings which people attribute to events, processes and structures (Fellows & Liu, 2008). The qualitative approach ensured the data collected was órawô and detailed, and hence órichô in content and scope.

ues from industry project managers who have MS first hand, a semi-structured qualitative in-depth interview methodology was utilised to explore the pertinent issues from the participantôs perspective. The interviews were carried out face-to-face because of the rapport this builds between the interviewer and the interviewee which is an important factor when trying to extract the most reliable and accurate data from the interviewee. Face-to-interviews also allow the interviewer to take advantage of social cues, such as voice, intonation and body language which the interviewer can gain more information from, adding to the verbal answers received (Opdenakker, 2006). A face-to-face in-depth interview also assists to ensure the participant understands and interprets the question/s correctly which will in-turn ensure the data collected in accurate.

Personal, semi-structured interviews were utilised by the researcher using an óinterview guideô of three to five pre-identified topic areas with three to four questions within each topic area, which the interviewee has a great deal of freedom in how to respond. Questions that are not included in the guide were able to be asked as the interviewer picked up on things. However, overall, the questions asked to each participant were the same and a similar wording used for all interviews.

All the interviews were electronically recorded and later transcribed. This procedure is important for detailed analysis required in qualitative research and to ensure that the intervieweesô answers were captured in their own words and terms. By transcribing, it helps to correct the natural limitations of our memories and of the intuitive elucidation that we might place on what people say in the interviews.

By undertaking personal, semi-structured interviews, it opens the door for more detailed questions to be asked and usually achieves a high response rate. Any ambiguities can be clarified and incomplete answers followed up.

The interviewer used probes and prompts to ensure the information gathered was comprehensive and accurate. Probes were used when a participant said something

ed to know more about what was said. They were
r.

Prompts were used if the participant gave a very short answer or got side-tracked and didnôt exactly answer the question. They were used to encourage the interviewee to talk about a certain issue or topic which they had thus far failed to do.

This study could be identified as óapplied researchô as it is directed to end uses and practical applications and ñseeks to address issues of applications: to help solve a practical problem (the addition to knowledge is more óincidentalô than being the main purpose)ò (Fellows & Liu, 2008).

3.5 Analysis Plan

Quantitative

All data from the surveys was recorded and sorted by Survey Monkey, the website program used to execute the survey. This data was then coded into nominal and ordinal data. A descriptive statistical analysis was then undertaken using percentages, rankings, and measures of central tendency such as mean, medium, mode and range. This data is displayed in excel tables in appendix one. This data analysis method was used to accurately and clearly show what the project managersô opinions were regarding the barriers to implementing WPMS.

Qualitative

As stated earlier, all interviews were record electronically and transcribed. A thematic analysis was then undertaken using coding to compare and contrast themes that arose in the interviews. Common themes are described and discussed which ultimately illustrate the results of the research.

Qualitative thematic analysis is based on the identification of themes in qualitative material, often identified by means of a coding system (Encyclo, 2010). By using óopen

ng categories, it creates an effective way to
les are essentially key words or statements documented on the side of the transcript where they were originally found resulting in a theme being flagged, which can then be compared to other ócodesô, not only throughout the transcript but throughout other transcripts and, thus, identifying common themes in the research.

A qualitative thematic analysis was chosen because it best represents the output this research is trying to produce. That is, themes as to what means and methods could be employed to breakdown the barriers to implementing WPMS in New Zealand. These are the key findings.

The key findings in the themes are compared to findings found in the literature review, interpreting the data in view of past research. The implications of the key findings and the findings that both support and contradict prior studies are discussed.

3.6 Validity and Reliability

Validity

Validity refers to the accuracy or truthfulness of a measurement, the degree to which the study accurately reflects or assesses the specific concept that the research is attempting to measure. Having got a ñpretend respondentò with knowledge of WPMS (however, not a participant) to complete the online survey and the interview questionnaire before distribution to ñreal respondentsò, they were able ask any questions they wished, which then indicated a defective item that needed clarification or a complete change. Real respondents have no opportunity to ask questions so those items were put right immediately before they were distributed to them. The process was done again by a new ñpretend respondentò, no questions were asked by them indicated no changes were required. This provided face validity to the study.

gained through obtaining an external audit from a cipant in the study. The Project Director checked the questions in the research against the objectives of the study and checked that the results from the measures fit the theories around which the research was designed.

The validity of the research is also upheld by using both quantitative and qualitative methods, sending transcripts back to the respective participants for them to check what they stated was indeed what they meant to say, and ensuring the data gathered was both rich and thick.

Reliability

Reliability is synonymous with repeatability, dependability and stability. A measurement that yields consistent over time is said to be reliable. When a measurement is prone to random error, it lacks reliability (Walonick, 2005).

To ensure reliability in the research, questions in the online survey were asked with slightly different wording in a different part of the survey and the correlation between the items is a measure of their reliability. This strategy formed part of the reliability of the personal interview also. The administration procedures were standardised, the questionnaires were carefully scored, and the questions were clear, well written, and appropriate for the samples, also contributing to the studyôs reliability.

3.7 Ethics Considerations

As this study required the participation of human respondents, specifically project management professionals, certain ethical issues were addressed. The consideration of

or the purpose of ensuring the privacy and

To ensure the privacy of the participants and confidentially of the data remained secure, the researcher restricted access to responses to the minimum possible and used codes rather than names to link respondents to responses. No respondentôs names were used; instead participants were numbered 1 through 12. The participants were made aware of these measures.

In order to secure the consent of the selected participants, the researcher relayed all important details of the study, including its aim and purpose, to the participant. By explaining these important details, the participants were able to understand the importance of their role in the completion of the research which made them more inclined to sign the participant consent form.

The researcher endeavoured to ensure that participation in the research was totally voluntary and that all data was treated with appropriate confidentially and anonymity.

Chapter Four – Results

4.1 Introduction

The use of Information and Communication Technology (ICT) in the AEC industry is creating new opportunities for collaboration, coordination and information exchange among organisations that form a construction project team (Matheu, 2005, p38). In recent times the concept of how ICT can manage construction projects has been widely acknowledged by practitioners (Matheu, 2005, p1). This concept is now commonly referred to as a Web-based Project Management System (WPMS). Many authors believe that WPMSs improve overall coordination, collaboration, and communication on construction projects in a variety of ways. However, despite proven advances in the technology and the considerable and recognised benefits Web-based Project Management Systems (WPMSs) offer, adoption and implementation of this technology still remains slow within the Architectural Engineering Construction (AEC) industry.

4.2 Data Collection

why Web-based Project Management Systems lemented in the New Zealand construction industry, data was collected from eight qualified participants who had knowledge and experience working with these systems. Although some had more than others, participants qualified to partake in the research because they either have previous or current experience working with a WPMS on $5+ million construction project within New Zealand.

The collection of data was undertaken by two methods:

- Online survey,
- Semi-structured interview.

The online survey results were automatically collected and sorted by the web-based survey program. The results were entered into an Excel spreadsheet for ease of interpretation and visual comprehension. Eight participants started the survey but only seven finished because one participant ñgot distractedò and missed the last two questions. These two questions were instead asked at the interview stage and expanded on within the interview also.

The subsequent interviews expanded on the information gathered from the online surveys in order to collect more in-depth and rich data from the participants. Because the survey gave participants the opportunity to comment after most questions, it allowed for an expansion of the answer should the participant wish to do so. The majority of óCommentô boxes appended to survey questions were utilised providing an explanation or justification of the answers was given. This then assisted in the interviewing processes, as there was a clear direction in which the subsequent interview questions could follow.

The first question of the interview was based around Microsoft Project and how and when it is used. The researcher was aware that MS Project was employed on many construction projects operating within New Zealand; however, was unaware

ntly and the extent to which it was used. It was also o whether project managers used the software in place of web-based project management systems.

The remaining interview questions were structured around Web-based project management systems (WPMSs) and the participantôs survey responses.

The interviews were officially recorded and transcribed to ensure all relevant and significant data was captured.

4.3 Data Analysis

Having transcribed the interviews, a thematic analysis was undertaken in which the data was coded into themes, ideas and categories. The codes are meaningful descriptions that give an indication of the idea or concept underpinning the theme or category. This data is located in Appendix 3.

Themes and sub-themes to evolve from this process are as follows:

Question One – Microsoft (MS) Project

(a) Online survey

Question one asked how often the participant or their organisation used MS Project on a $5+ million construction project. 75% of respondents said ôalwaysô while the other 25% responded with ôalmost alwaysô. No additional comments were made by participants when answering this question.

(b) Interview

the MS Project data, the interviewees where generally questions which featured around when and how they used the software, the other was based around how they rated it.

- *The use of MS Project*

  Although it was clear from the participantôs responses that the software was implemented purely as a programming tool, it was also well represented that the participants knew MS Projectôs capabilities offered much more than what they used, but chose not to utilise those other functions. The main reason for this was that they felt the information generated became ñtoo deep and too detailed [and the client] just gets confused even if theyôre experiencedò.

  Another reason that was echoed by the participants was the fact that construction projects are óever-changingô; so to plug the software with considerable speculative data, committing much more precious time to doing so, only to be forever changing costs and resource allocation, is not a productive task.

  It was generally accepted by all the participants that software tools be implemented to manage three essential elements of construction projects. These include the management of resources and finances; the management of information; and the planning management of a project. It was generally acknowledged in this research that there are tools in the marketplace better equipped and easier to use than MS Project for resource and financial management and information management. It is still, however, widely applied to the planning of $5+ million construction projects in New Zealand.

research indicates that MS Project is viewed and used ogramming tool and is not employed for managing other aspects of a project due to its perceived complexities, the nature of construction projects, and the idea that there are better software tools in the market to manage other aspects of construction projects.

- *The rating of MS Project*

  Most participants rated the MS Project software reasonably high in regards to a planning tool. However, a consistent criticism was that, ñPeople donôt understand itò and ña lot people donôt know how to use it properly and donôt use it wellò.

MS Project Summary:

The result from the Microsoft (MS) Project question generally recognises that MS Project is used on almost every construction project over $5 million in New Zealand. According to the participants, the reason for this is essentially because itôs probably the best programming tool in the market right now.

Although this topic has limited literature, MS Project has over 20 million users worldwide and is largely viewed as the leading scheduling tool in the market (Hauduc, L, 2010).

It is interesting to note that MS Project has other functions other than programming such as managing budgets and allocating resources to tasks. However, these functions are rarely utilised according to the participants in this research. The software is utilised predominately as a programming tool. This is because the information generated when the other functions are included becomes too complicated and will often change substantially in any case. There is also a general thought that there are better tools on the market available for the functions

eb-based project management systems (WPMS) are

ument management/control.

Most participants were satisfied with MS Projects abilities and functions; however, many commented that people donôt understand it. The researcher questions to what level other people (other than those with direct control over the programme itself) *need* to understand it. As a planning tool however, MS Project appears to satisfy the majority of user requirements.

The research now focused specifically on WPMSs.

Question Two – Frequency of Use

(a) Online Survey

This question asked how often the participant or the participantôs organisation used a WPMS on $5+ million construction projects within New Zealand. Responses to this question were spilt between óAlwaysô (37.5%), óAlmost Alwaysô (12.5%), and óSometimesô (50%).

Some respondents made comments below commonly stating the name of the software they use or are currently using.

(b) Interviews

Having read their survey answer back to them, the participants tended to expand their answers without prompting (although, reading the question back to them maybe viewed as a prompt).

A common theme was that the majority of respondents that answered óAlwaysô in the survey work for an organisation that subscribes to a particular WPMS, and therefore implements the software on every project they or their company are involved in. By subscribing to a system and óalwaysô using it on

ny is óenforcing the useô of the system which OôBrien gami (2008), and Ahuja (et al, 2010) recommended. The remaining participants experience in implementing these systems was a project-by-project basis.

Question Three – Satisfaction Level

(a) Online Survey

This question was based around the overall satisfaction level of the WPMS software they had experienced.

A relatively even spread of answers was given to this question ranging from óVery Satisfiedô (25%), óSatisfiedô (50%), and óNeither Satisfied nor Dissatisfiedô (25%).

The participants that responded with óVery Satisfiedô use the same software package, Aconex, and implemented the system on every project they worked on.

The majority of participants also made a comment in the box provided, briefly explaining or justifying their answer. The respondents that were ;óNeither Satisfied nor Dissatisfiedô commented that this was due to a lack of experience using the system and felt this was the most appropriate answer accordingly.

Comments made by the remaining respondents were based around the benefits of the system. Such comments as, ñFor document control we find Aconex to be a very good systemò, and, ñIt is an excellent way of tracking information. It removes the need for bulky archivesò, and, ñAll project

ame system which means that correspondence
a lot easier to forward/reply to enquires. A reference trail is also easily established and the majority of time it is automatically done by the systemò. These comments gave the researcher a good platform on which to build more in-depth data about the benefits of using such software.

(b) Interviews

Again, once the author had read back to the participant their answer they gave in the survey, it prompted the participant to expand on those answers without much direction from the author. The data gained from this section extracted from the participants generally outlines the benefits of using a WPMS.

- **Searching**

  Searching for emails, documents, drawings, and even files from past projects was acknowledged as a major benefit of implementing a WPMS. Obviously this is also a time saver as this quote from Participant four states; ñI can go and find it and know itôs there. Itôs not in an inbox somewhere in an email. I donôt have to go rooting through filesò. This benefit echoes that found in the earlier literature, especially by Becerik & Pollalis (2006) who commented that by having the information stored in one centralised area made searching far easier.

- **Filing**

  Corresponding with the ôSearchingô theme above, the filing system these software packages provide means a saving on administration costs because the filing is generally done by the software. Participant one stated that, ñIt saves a person. By the time you pay someone to file the piece of paper it would have cost you more [than using the

l definitely be a cost benefitò. Multiple literature orates these comments, especially Matheu (2005) who suggested printing, postage and document administration costs decrease as all documents are stored centrally. However, OõBrien (2000) deviates from Participant ones statement, claiming the systems are ñnot necessarily labour-saving devicesò.

Archived information is also easily accessible through the web-based software. Participant three stated, ñBefore we had the web-based system to retrieve data from archived information can be very time consuming and costly and quite frustrating, but if you have everything archived on your web-based systemé it is far easier to look back on old information in the future, so thatôs a big benefitò. This corroborates Coxôs (2007) comments regarding how users have access to archived historical data which allows them to understand project issues.

The statement made by Alshawi & Ingrige (2003) that less storage space was required due to storage being electronic, was also acknowledge by Participant two that WPMSs are a great benefit for live projects in terms of filing documentation and drawings and ñprevents the need for bulking filing systemsò.

Having a high-quality filing system for drawings, documents, specifications, etc, allows for a quality search tool to be utilised also.

- **File size**

  Another benefit commonly addressed by the participants was that of being able to send and receive large files without the concern that their or the person theyôre sending it to, inbox is too full and/or does not have the capacity to cope with the large files.

ommented that, ñé it does make sense to have a ecause you make it everyoneôs responsibility to go on and look for the drawings. It does help especially when you see the amount of drawings you start going throughò.

- **Risk**

  Comments were made by participants that by implementing a WPMS it reduces the risk of something adverse and potentially costly occurring on the project. By spending more time onsite, and thereby monitoring the construction processes and execution, as apposed to searching for and processing paper work, problems or issues are more easily observed and deal with.

  Participant seven was one that acknowledged this benefit by saying that, ñyour mitigating risk of things going wrong because youôve been bogged down with a manual system trying to find stuff that you havenôt been able to go out on site and seen something happen that you otherwise would have picked up.

  The literature reviewed agrees that the implementation WPMS can reduce your project risk, especially Matheu (2005) due to improved version control.

- **Security**

  Having the data stored in two or three external data halls, you never have to back up because it is all done for you through the software (Participant seven).

This quote by Participant one sums up question three. ñThe beauty about the system is that the filings done, your searchingôs simple, your not storing stuff in your own server here, so youôve got a bit of reliability and

You donôt have boxes and boxes of documents at the have to archive, so itôs cheaper. You could chuck the green thing in there as well I suppose.ò

Question Four – Improvements

(a) Online Survey

Participants were asked how they would improve the web-based project management system they were or had been working with.

Reliability and more user-friendly were the common themes to evolve from this question.

- **Reliability**
  It was suggested that to improve the system it must be reliable, especially in regards to not crashing and uploading documents when you want it to.

- **User-friendly**
  Also suggested by some participants was that the systems they use could improve by becoming more user-friendly and simplified especially in terms of the user interface.

All other comments related to, how to improve the systems were focused, not on the software itself, but how it is being used. These answers are as follows:

- The biggest issue is gaining **buy-in** from all consultants as various practices use different systems (Participant one).
- The area that I see for improvement is not the system; it is the **skills of the users** (Participant three).
- More **practice and experience** using it (Participant four).

Having read back to the participant their answer they gave in the online survey for this question, to expand on these answers I then óprobedô them why they believed these improvements should be made. The result was, the participants outlined what they perceived as the limitations of their WPMS were and some common themes became more apparent.

- **Reliability**

  This theme continues from the online survey results and remained an issue throughout the interview process for many participants. It was noted, particularly by participants one and five, that because it is web-based software they are relying on both the software, which at times will ñchug out and dieò halfway through loading a document, and the internet connection, which if lost, ñis a painé ., because everything is on the netò. This theme is especially corroborated by Nitithamyong & Skiniewskiôs (2007) research which recommends a cable modem connection because of reliability.

  Support is a sub-theme under reliability. The comments were that if youôre paying for this system and you rely on it to run your project, an available and dependable support network must be in place for the WPMS to maintain its reliability.
  The level of support required was a massive theme found in the literature which focused on both support from upper management and the Application Service Provider (ASP). While the literature had greater emphasis on upper management support, the Participants were more concerned about receiving the technical the support from the ASP.

- **User discipline**

ation of systemôtheme was that the software can be that people get copied in to far too many messages which do not concern them. ñInformation can be spread out like on a scattergun approach whereby itôs so easy to think, óOh someone else might be interested in this so Iõll send it to them and them, and them and so onò participant three states. This leads to a congested mailbox and unread messages, some of which may be important.

ñYouôve got to have some discipline around itò participant seven stated. Improvement suggestions included only using the system for contractual communication and also having a user manual with guidelines on how and when to use it. This is a major theme found in the literature also. As stated in Chapter Two, many authors recommend ódefining the useôof the system is an important aspect in determining its success. Defined in terms of, ówhatôuses the system should be implemented for; ówhoôcan obtain access to what; and óhowôit should be utilised on specific projects.

- **Buy-in and training**

  These two themes have been grouped together by the author as they are interrelated. Building on their initial response in the online survey, buy-in by consultants was an area for improvement according to some participants. This had two aspects to it; 1) was that the other members of the project team (including the consultants) will all have different in-house systems which they used as well as whatever WPMS for the specific project. Participant one especially see that the integration of these system would improve a projects process and outcome immensely, and 2) the other members donôt embrace it because they donôt entirely understand it. Thatôs where training comes in. As Participant one commented, ñWhen you first use it, you go, óoh this is painfulô, but itôs brilliantò. Participant one also said that, ñOnce subs

Consultants donôt like to use it, but when they do they

Another very relevant and well documented issues in the acknowledge literature. The first point regarding other members of the project team having various different systems which they had to use as well is what was called ñIntegrationò in Chapter Two. Nitithamyong & Skiniewski (2007) recommended that WPMSs should have the ability to integrate with other internal and external software and systems, substantiating the Participants comments.

The second point made about the lack of understanding associated around the systems causing user resistance, is view by many as the number implementation problem with ICT and WPMSs. The literature suggests all users, including upper management, should be trained, not only in how to use the systems, but also the benefits that are derived from using the systems.

Questions Five – Access to Project Information

This question was included to discover what parties had access to project information through the WPMS.

The answer was conclusive; all project team members had access to information on the WPMS that specifically related to them or their organisation.

No further clarification was required in the interview stage of the research.

The literature on the subject suggests the more people with access to the internet and the WPMS, the better. Nitithamyong & Skiniewskiôs (2007) recommend

project team members in order for the system to

Question Six – Main Function

(a) Online Survey

The participants were asked to clarifying what they believed to be the main function of the WPMS to be. 75% of respondents indicated ôInformation Managementô was the main function of their WPMS, with 12.5% indicating ôImproved Communication Between Project Team Membersô, and 12.5% indicated they believe ôProgrammingô to be its main function.

(b) Interview

Expanding on these answers was used to clarify exactly what the participants used their WPMS for.

The key function was Information Management as per the online survey. As a consequence of improved information management, the communication between project team members become more efficient and effective and programming was generally undertaken on MS Project.

Although the two are somewhat interrelated, the literature found that improved communication was the major aspect of WPMS utilisation. Because the software is aimed at amongst others, project managers, and project management is predominately focused around effective communication, this was viewed by the author as the major theme. Also, WPMSs are a form of information communication technology (ICT) which somewhat defines the use. However, the author understands the Participants point-of-view, in that efficient ôinformation managementô can result in ôimproved communicationô.

nent of Software

This question was seeking to if most WPMSs in use were developed by organisations for their individual use or in fact were just purchased óOff-the shelfô.

The participants responded with 75% used óOff-the-shelf software, the other 25% óDidnôt knowô.

No further clarification was required for the question and the interview stage.

Question Eight – Non-Implementation of a WPMS

This question was centred on reasons why the participant or their organisation would not implement and WPMS on a $5+ million construction project in New Zealand.

As mentioned above, participant one did not complete this section of the survey, however, this participant was asked these questions at the interview stage (see appendix 3 with participant oneôs answers).

(a) Online Survey

The online survey required the participants rank eleven reasons why they or their organisation would not or do not implement a WPMS. Nine of eleven reasons were acknowledged as óWeakô reasons with only two being sighted as a óSomewhat Strongô reason not to implement a WPMS. Those two reasons were; óEase of Useô and óTeam / Other Stakeholders are Unaware of the Benefits of WPMSsô which the majority of participants acknowledged as óSomewhat Strongô reasons why they wouldnôt implement a WPMS.

he literature reviewed where multiple authors have or training to occur based around how to use the system, but almost as importantly all users should be trained in how using the systems can benefit the project. Many authors also comment that the easier a system the greater performance yields it produces and the greater buy-in from users.

(b) Interviews

For this question in the interview, the author placed in front of the participant their answers from the online survey and questioned the participant why they answered what they did.

- **Cost**

  50% of respondents indicated this as a weak reason for not implementing a WPMS.

  - *Smaller projects*

    The majority of participants indicated that generally a project of $5+ million value could justify implementing a WPMS. It was commonly acknowledge that using such systems may not add enough value to the project to justify using it on smaller projects. Also with smaller projects, in terms of size and complexity, often smaller contractors will be employed which have less knowledge and experience in using such systems. As Participant two commented; ñSmaller companies, they will probably say, ódôve got enough on my plate without having to manage a WPMSôò. This is likely why literature states that smaller construction operators are showing some reluctance in adopting WPMSs (Dossick & Sakagami, 2008) and have difficuly dedicating resources to research, development, and training (Ahuja et al, (2010).

a strong correlation with Nitithamyong & Skibniewskiôs (2007) research also which states that ña project with a smaller or tighter budget can experience cost constraints that will impact the level of personnel required to keep a PM-ASP (i.e. WPMS) operating and the time required to populate that database with updated information regularly (pg. 47).

That being said, Participant two commented that WPMSs will become more utilised in the future, on projects large and small.

There is significant correlation here between these responses and the data found in Nitithamyong & Skibniewskiôs (2007) research which indicates the larger and more complex a project is, the more likely time and cost savings are realised (pg. 47). This research generally states that larger, more complex, longer projects generally comprise of higher budgets and greater amounts of documentation to be managed. It is found that when this is the situation, WPMSôs tend to gain higher strategic and cost performance.

- *Efficiency and Quality*

  The companies that have essentially brought into the system and pay an annual fee for its use, view the cost as, ñnot an issueò. This is because, although it probably makes their prices and fees higher than the organisation that doesnôt have such a system, they feel they can perform their tasks and execute their projects in a far more successful manner than their opposition. Participant seven commented that most experienced clients know that these systems really benefit the builder and, ñit

entually heôs gonna get a better building out of it; heôs ve more guys out there supervising more onsite rather than mucking around chasing paperò.

Again, these findings echo the literature reviewed as part of this research, especially that of Alshawi & Ingirige (2003). These authors concluded WPMSs increase the speed of communication which results in shorter lead times for tasks, and such systems improve efficiency through speedy and accurate information exchange.

- *Risk*

  This is related to the reduction of risk. Many participants believe the cost was justified because of the reduced risk these systems provide. Having an efficient WPMS means less time spent on paper work and more time onsite resulting in preventative or mitigating measures of potentially costly issues.

  Although the reduction of risk in projects is mentioned in the literature, the reasons for this reduction were not the same as sited by the participants. Risk diminution in the literature was focused more around the fact that by having the latest versions of documents published and available, the risk of working on old information is minimised (Matheu, 2005).

- *Time*

  Because WPMS saves time, they also save money. This theme was echoed by many participants. This quote from Participant seven sums up the consensus of this theme reasonably

; ñYouôre never going to say that itôs going to cost [illegible] and hereôs a direct saving, but maybe job share a project administrator because that whole logging of correspondence and particularly drawing management and sending on to people is literally done with a couple of clicks of a button here. Whereas literally within two minutes you can send that out online, they get and print it out at their end, which saves us the cost of printing it all out at our end as wellò.

Again, much of the literature corroborates these sentiments from Participant seven. Becerik & Pollalis (2006) for example state that, ñThe fast dissemination of information shortens consultation cycles and speeds up decision makingò. Matheu (2005) reiterates Participant sevenôs comments, suggesting that printing costs will be reduced by WPMS implementation.

From another, more negative point of view, Participant four remarked that; ñthe cost and time of changing and training and getting use to it [means] itôs a big change and your productivity goes down, and you do that across 200-300 people, thatôs a lot of money down the toilet over a couple of monthsò. Most of the negative comments in concurrence with this topic in the literature are about what can happen when organisations try to implement ICT without a clear strategy or plan. There is also this perception because of the difficulty in being able to quantify the costs and benefits of these systems (Rankin & Luther, 2005) (Hewage et al, 2008) (Nitithamyong & Skibniewski, 2004).

- *The Future*

ponses from participants expressed a need to spend y on these systems, ñbecause you have to move with the times otherwise you just get left behindò. This basically underwrites what all the literature is saying about ICT and WPMSs, that they may not be 100% perfect but thatôs the way things are going and they can only but improve as knowledge and technology improves.

- **Donôt know enough about WPMSs and their associated benefits**
  75% of respondents believed this to be a weak reason not to implement a WPMS. The main reason for this was that it is easy enough to find out from other industry users and then it just comes down to training.

- A similar reason to *ñTeam / Other stakeholders are unaware of the benefits of WPMSò* which is explained in greater depth below.

- **The Project team would not know how to use it.**
  62.5% of respondents believed this to be a weak reason not to implement a WPMS. Again, simply by undertaking training of the system, would this issue be rectified. Training was the simple and central reason why this was a weak reason.

- **Related legal issues**
  62.5% of respondents believed this to be a weak reason not to implement a WPMS. The main themes determining this response was that these systems are fairly well established in the construction industry now and if you pay for your licenses there should be no problem.

  Although not specifically stating the same issue, the literature does also bring up the legal issue, however, based more around the fact that

s can be directly transferred to ICT, making legal
n the Web-based era at times, unclear and leaving the door open to potential risks.

- **Internet access availability on site**
  62.5% of respondents believed this to be a weak reason not to implement a WPMS. The main reason the majority of participants considered this a weak reason is due to the relative ease in which internet connections are made these days and the fact that it is likely connections will become easier in future years.

  Nitithamyong & Skibniewskiôs (2007) research indicates that the greater number of team members with access to the PM-ASP (i.e. WPMS), the more effectively it will perform (pg. 29). It is the authors belief that the majority of the participants recognise this and is why they consider internet access availability on site a weak reason not to implement such a system.

- **Internet speed no adequate**
  Although 50% of participants considered this a weak reason not to implement a WPMS, those who had experience with such issues commented that it was incredibly frustrating, although no participant could see this getting worse in the future.

  No issues were observed in the literature regarding internet speed.

- **Ease of use**
  This was a 50/50 split between ôSomewhat Strong Reasonôand ôWeak Reasonô

ipants that answered ôSomewhat Strongô did not have much experience with WPMSs . However, this theme was also recognised in Question Four above ï Improvements.

The four participants that answered ôWeakô were the four participants with the most experience using WPMS. The comments from these participants were that ñitôs a training thingò and ñyou pick up a lot more as you use itò. Participant three stated that, ñitôs easy to use and itôs easy to learnò.

This suggests itôs like many novel experiences, initially they donôt feel comfortable using them but after a while you wonder what you did without it.

However, as discussed above, ease of use is a major factor in the outcome of a successful WPMS implementation. Dossick and Sakagami (2008) agree with these Participants, saying the best way to implement WPMSs is to make them fast and easy to use and Cox (2007) suggests that are exactly that.

- **Don't require it**

  50% of participants considered this a weak reason not to implement a WPMS. The rationale behind this response was primarily due to the size and complexity of the projects these participants are involved in. Meaning that because these participants are all involved in large scale, complex projects, they believe they do require a WPMS. It is related to *'Cost'* above.

  There is significant correlation here between these responses and the data found in Nitithamyong & Skibniewskiôs (2007) research which

er and more complex a project is, the more likely ings are realised (pg. 47). This research generally states that larger, more complex, longer projects generally comprise of higher budgets and greater amounts of documentation to be managed. It is found that when this is the situation, WPMSôs tend to gain higher strategic and cost performance.

In saying that however, participant one commented that everyone requires some form of document control. ñWhether the job is 400K or 40m, youôve still got an electrician, a plumber, a painter, youôve got to send all this information to.ò

The other 50% see it as a óSomewhat Weak Reasonô not to implement a WPMS, again, dependent on the size and complexity of the project. For example, ñIf youôre a tin-pot builder then fair enough. But if youôre going to get into this game at this level, $5m+, itôs really an essential necessityò.

- **Team / Other stakeholder's attitude to using WPMSs – resistance to change.**
  50% of participants considered this a weak reason not to implement a WPMS. The participants rationale behind this was centred on the fact that they believed the other stakeholders may struggle in the beginning but once they began to use and understand it, would wonder how they managed without it. ñInitially people might not like it but thatôs because they donôt understand it, once they get to understand it they generally love itò, Participant three suggested.

  Lack of top management support and organisational commitment to ICT or a WPMS is cited as a common reason for resistance (OôBrien,

quoted in the literature that resistance often comes ection of the industry who have manage perfectly fine before this technology come about.

- **Team / Other stakeholders are unaware of the benefits of WPMS.** This reason had very similar feedback to the previous reason except this resulted in 37.5% of participants considering this to be a ósomewhat Strong Reasonô not to implement a WPMS. The reasons given by the participants for this was that until training was undertaken and the benefits were made clear, resistance to change would be likely. Participant two stated that ñTraining and changing mind-sets is the biggest thingò.

  The literature wholly agrees with these participantsô comments - comments which have been evident throughout this research by many authors including Hewage (et al, 2008) who claims lack of understanding as the number one barrier to ICT implementation.

- **System reliability such as password and security issues.** 62.5% of participants considered this a weak reason not to implement a WPMS. As discussed earlier in the research, the data is backed-up two or three times, however, participants consider the system crashing as a risk when using a WPMS.

  Security and access issues, as previously mentioned in the literature review, were focused around the Application Service Provider and boundary constraints of the software (Matheu, 2005) (OõBrien, 2000).

Chapter Five – Conclusion and Recommendations

5.1 Conclusion

Information and Communication Technology (ICT) is increasingly moving to the core of national competitiveness strategies around the world due to its revolutionary power as a critical enabler of growth, development, and modernisation. It is becoming an integral part of business and society and there is strong evidence to suggest that, if it is not developed and embraced by businesses, industries, or countries, they *will* get left behind. The AEC industry is not immune to this statement and should be looking to take

vances in order to improve information and
luctivity. It is being used with great success in some organisations to combat the notorious industry issue of fragmentation ï the multi-disciplinary nature of the construction game.

Web-based Project management Systems (WPMSs) are the face of ICT in AEC and are becoming increasingly utilised and viewed as an important tool, particularly for successful project management. The basic rationale behind WPMS implementation is that communication and information management control in modern design and construction projects are chaotic which commonly results in lapses in communication, poor understanding, annoyance, conflict, and cost and programming over-runs. Despite the advances made with this technology and the noted benefits from its utilisation, implementation from the AEC industry worldwide has been weak, especially in comparison to other industries such as manufacturing. Why? What are the barriers to this implementation? And how can these barriers be overcome?

Key Benefits and Limitations

The key benefits and limitations are identified as advantages acknowledged by both the literature and the participants, and in the majority of cases recognised by more than one participant.

Key Benefits

The ability to file online without the need for bulky archives proved to be a big drawcard for using these systems. As was the ease of which searching for emails, documents, drawings, and even files from past projects was undertaken. The reduced administration costs due to filing being automatically done by the software and the diminishing need for postage and printing was identified as another key benefit. The problem of Email inboxes

l using WPMSs, as is the concern that outdated
am members to work on which can cause multiple issues.

Key Limitations

User buy-in is typically viewed by literature and participants alike as the most prominent barrier to successful WPMS implementation, followed closely by, and somewhat related to, the lack of training in use and benefits of the system. Reliability in terms of the system and also the internet speed connection is a large concern and annoyance to many. Similarly, support from both upper-management of the user organisations and technical support from the service providers is a key point which was identified as a potential barrier to WPMS implementation.

Non-Implementation of a Web-based Project Management System (WPMS)

When asked why they, or their organisation, would not implement a WPMS on construction projects in New Zealand, there were two answers that stood out from the rest, they were: ôEase of Useô and ôTeam/Other stakeholders are Unaware of the Benefits of WPMSsô. Both of which, were well represented in the literature also.

The concurrence around the ôease of useô was that if the user interface was too complex and complicated implementation would become extremely difficult, as it would be if project team members were not informed about the benefits of using such systems. Both reasons cause a large degree of user resistance to the implementation of WPMSs.

Other reasons acknowledged by an individual or organisation for not implementing a WPMS included the costs associated with it. This was directed at smaller operators and sub-contractors who may find the system costly to implement, time consuming and

changing to a new system in terms of time, money

nised as a reason for non-implementation.

The participants were, 1) given a list of potential reason to start them thinking oabout what reasons there may be to non-implementation of WPMSs and;2) ample time to think about there answers given the online survey they could do in their own time at their own pace, and that set them up for similar questions in the interview which was held a few weeks later. Despite this, no other reasons were identified which would prevent them or their organisation implementing a WPMS on a construction project in New Zealand. However, recommendations were made.

5.2 Recommendations

Although all the recommendations in Chapter Two of this research are likely to be useful when implementing a WPMS, a few stood out as key recommendations due to the amount of times theyôre mentioned both in literature and by participants.

Key Recommendations

There must be a significant effort by the upper-management of all AEC organisations involved in a project to support the use of a WPMS when the decision has been made to implement it. Many studies have shown that a lack of support from upper-management when implementing such systems will likely result in failure and loss of investment. Likewise, if the necessary support offered by the provider of the service (e.g. the Application Service Provider (ASP)) is substandard or inadequate, the implementation of the system is likely to fail and with the investment merely resulting in frustration and lost productivity.

Another strong recommendation is to establish and abide by an instruction manual which describes and defines *what* the system should be used for, *who* should use the system, and

example was given that emails might be appropriate

By contracting other project parties in to using the system and abiding by the ñinstruction manualò, the use of the system is enforced which assists with the functioning of the system and ensures the system will operate the way it is intended.

Training and education is essential to WPMS implementation success. This was stressed by literature and participants alike and both highly recommended users be trained in how to use the system, but also, and just as important, to be educated in the benefits of using such systems. This will not only build the users confidence in using the tool but justify why theyôve been instructed to use it. And if they see support from top management whilst gaining quality support from the service provider, user resistance to implementation should be hugely minimised.

As discussed many times in the research, the user inter-face and general functionality of the system must be easy to use; otherwise team members will become frustrated and resort back to old, more familiar ways.

As identified by much literature and many participants, the risk when using a WPMS is the reliability of the software and the internet connection. Both of which must be trustworthy and dependable otherwise users will, again, become frustrated and it creates a lackadaisical attitude towards using the system. Most see this issue as diminishing as both the software and internet become more resilient over time.

5.3 Summary

"More resilient over time" - a statement which encapsulates this topic.

systems arenôt perfect, and no, theyôre havenôt

rect manner, but we must learn from the past and look forward to the future. This research illustrates lessons of the past which can be applied in the future, achieving more successful WPMS implementation and thus, more successful projects. Love them or loath them, ICT and WPMSs *are* the future and it is high time the architectural engineering and construction industry begin to embrace these technologies with a more pro-active approach. As technology advances and ICT and WPMSs are refined further, both will become more *resilient over time* and more efficient to use. Being at the forefront of these technological systems creates an environment of innovation and improvement, resulting in a significant competitive advantage in a highly competitive marketplace.

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