Effect of project management information systems on project performance: the case of construction projects in Ethiopia

A Thesis Submitted to the School of Graduate Studies of Jimma University in Partial Fulfillment of the Requirements for the Award of the Degree of Master of Project Management and Finance (MA)

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August, 2020

DECLARATION

I declare that the research Report entitled "*Effect of project management information system on project performance: the case of construction projects in Ethiopia***"** submitted to Research and Postgraduate Studies' Office of Business and Economics College is original and it has not been submitted previously in part or full to any university.

Samuel Abera Zewdie ______________

Date: 31 August 2020 __________

CERTIFICATE

We certify that the Research Report entitled "*Effect of project management information system on project performance: the case of construction projects in Ethiopia***"** was done by *Mr. Samuel Abera Zewdie* for the partial fulfilment of Masters of Art Degree under our Supervision.

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Abstract

Projects are supposed to be successfully completed when they are carried out within the delineated scope, time and budget and when they satisfy the relevant stakeholders. There are many unpredictable issues that arise during project execution which might affect these project dimensions. The study aims to examine the effect of implementation of Project Management Information Systems (PMIS) on project performance in the construction industry of Ethiopia. It examines how project performances are related to PMIS from the system, information quality, use and user perspectives using survey data collected from selected enterprises engaged in construction business. Structured questionnaire was administrated to collect the data required for analysis from 126 randomly selected respondents working in construction enterprises. The final data was then analyzed through the use of descriptive statistics and appropriate regression models. The survey result has shown that about 71% of construction enterprises use PMIS for at least one purpose. The use of PMIS for the different project functions include 20.6% for project formulation and appraisal function; 71% for planning function; 60% for reporting function and 27 purpose for evaluating function. The assessment of the quality of PMIS software, information, use and user indicated that there are several problems regarding quality unlike the reasonable degree of PMIS use in general. The average quality of PMIS software, information, use and user were estimated to be about 67%, 64%, 54% and 69% respectively based on the rating of different parameters. Regarding how the performance of projects influenced by the use of PMIS, 74, 68 and 66 percent of the survey respondents respectively indicated that by implementing the right PMIS, performance of projects with respect to meeting timeline, respecting budget and meeting quality objective could be increased reasonably. The study also revealed that the use of PMIS as well as the quality of PMIS software, information, use and user have all statistically significant association with project delivery time, budget/cost, quality/scope and overall project performance. Both the results of bivariate and multivariate analysis depict that PMIS has greater effect on project delivery time performance followed by project quality and budget. The regression model results showed that PMIS quality have some positive and significant effect on the overall project performances with quality of system software and information having greater effect followed by PMIS user and PMIS use. The evidences generated in the study will serve as an important input for futures researches on how PMIS use could affect project performance in the context of Ethiopia.

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Chapter One

1. Introduction

1.1 Background for the study

Project management systems help an organization to reduce the time it takes to develop and market products, to utilize resources and increase their global presence. Neverthless, it is imperative that organizations also utilize tools that enable them to surmount challenges such as: poor time management, overspent budgets, unpredictable teams, lack of a clear flow of project resources, poor project prioritization, delayed decision making and lack of teamwork among project members. During the duration of a project, project managers grapple with these challenges while having to control risks, minimize uncertainties and ensure that all the decisions are made to improve the project. To achieve this, organizations should consider utilizing project management systems to assist their project managers in the selection, planning, organization and control of their various investment portfolios and projects (Kerzner, 2009).

While implementing these projects, project managers encounter unexpected problems such as sub-par documentation, project planning, misguided decision making and the failure or stalling of projects as a result of poor time management. Project management information systems assist managers in the various life cycles of the project to generate ideas, manage risks, manage stakeholders and manage knowledge and information generated by the project long after the project is done. Therefore, using PMIS has become important in the effective and efficient management of projects and in providing support to the project manager so as to enable them to deal with the attendant challenges that come with project management (Naylor, 1995).

It is important to plan, monitor, control, evaluate and staff projects while making sure that the quality of the project is sustained and that the attendant risks are managed accordingly. All projects need to be managed using project management information systems; this ensures that the projects achieve their objectives while dealing with any challenges that may arise throughout the implementation of the project. The practice of project management is a very challenging as evidenced by the fact that most projects are completed late and overshoot their initial budgets (Raymond and Bergeron, 2008).

According to a research, 75% of all Information Technology (IT) projects are managed using Project Information Management Systems (PMIS) succeed while 75% of those that are not managed using PMIS do not succeed (Light et al., 2005). Even though the usage of PMIS in project management does not guarantee project success, PMIS usage has become necessary in the management of various types of projects from the big projects to the small ones, public projects to private projects.

In Ethiopia the construction sector has registered a remarkable growth, over the last 11 years there has been increased investment on the development and expansion of various infrastructure projects. Among the major developments, construction of road infrastructure, real estate developments, and condominium housing projects are some of the examples. More specifically public infrastructure development projects by ministry of Education and Health and road infrastructure projects accounts the significant portion of the investment outlay on construction activities. Its contribution to the GDP at constant price has increased at an average annual growth rate of 12.43%. Similarly, the percentage share of the construction sector to GDP at constant price has increased from 4.0% in 2010/11 to 9.4% by 2013/14 (CSA, 2014, MOF, 2014). The sector holds an estimate of 2.6 million jobs, which is 7.1% of the country's total employment, according to the Ethiopian Construction Project Management Institute. The sector is also expected to make significant contribution to growth and structural change during the period of GTP II. According to the Construction Survey carried out in 2013 by the Central Statistical Agency of Ethiopia, it was established that the construction industry is one of the major drivers of the Ethiopian urban economy and that the industry has been growing fast over the past decade.

Conventional project management systems produce textual and graphical outputs with convoluted schedules for managing projects; while current projects are complicated, more time conscious and have numerous participants and parts, it is imperative to utilize simple effective and efficient project management tools. This brings out concerns about the integration, conception and management of construction products; it is consequently important that chosen tool for project management provides not only information on how to manage the project but is also capable of conceptualizing the project so as to aid the distribution of information and to simplify communication.

Internet based PMIS are advantageous because they are cheap, easily accessible and easy to use unlike conventional methods since they can be used at any location, they are fast and are reliable when it comes to the transfer and storage of data and the sharing of project related information. Usage of these internet-based PMIS increases the competitive edge of an organization while also augmenting the efficiency and effectiveness of the management of projects throughout the life cycles of these projects (Caldwell, 2004). During the utilization of Project Management Information Systems it is believed that the costs that come with the acquisition and usage of these systems will be balanced by the benefits that the organization is set to achieve (Kaiser and Ahlemann, 2010). The increase in the scope and reach of PMIS systems enables organizations to not only manage stand-alone projects but also manage their entire portfolio of projects.

1.2 Statement of the problem

Ordinarily, projects can only be accepted as successfully completed when they are done within the pre-defined scope, time, and cost constraints, according to the laid down stipulations and to the satisfaction of stakeholders. PMIS attempt to gather the correct information, data and documents in an accurate and economic manner using the proper means. The data and documents that are collected are then analyzed using the appropriate tools and techniques and then this information is relayed to the relevant individual which enables them to make the correct decisions.

In environments where the firms are not utilizing PMIS, the engineers and those responsible of project management are not capable of communicating the status of the project to the upper departments and senior management levels. PMIS also makes it possible for the senior management to track the projects in its organization's portfolio (Raymond and Bergeron, 2008). As the complexity and size of current projects increases coupled with an increase in the threat of environmental risks, the need to relay information to the relevant decision-making bodies that relates to the marketing, design, estimating, procurement, organization, co-ordination and execution, is assuming greater importance that it did a few decades ago. In the past the paper-based, project-generated data was rarely analyzed for want of time and effort. Advances in information have revolutionized data processing, information retrieval, document storage and communication processes. The increase in the usage of computerized software in retrieving project data , measuring the time taken to carry out a project and in the planning of projects has improved the storage of documents, improved decision making and improved time and cost management since these decisions are made based on accurate and real-time information (Kaiser and Ahlemann, 2010).

Project implementation encounters unpredictable problems. Consequently even the best efforts cannot ensure the execution of a project as per the original plan. It is therefore important to note that projects require an effective system that continually monitor and control them to prevent diversions from the prescribed plans and to also remedy the situation should a deviation happen. These unknown factors demand constant vigilance and decisions which have to be taken to ensure the smooth progress of the project work. Relevant information is required in order to make timely decisions in modern multi-division, multi-location and multinational projects (Chitkara, 2009).

There is poor service delivery by construction contractors in the country as a result of improper or lack of documentation, bad decision making processes and the extension of project timelines which leads to the stalling of the projects or even their cancellation or total failure. It is well known that there are poor project monitoring mechanisms as well as information management mechanisms. While the documents that pertain to these projects exist, there is no system in place to track the implementation of these plans or even a repository for storing the data and documents associated with the progress of these projects (MOUDC, 2014). However, there is no as such clear empirical evidence to show supported by research, and hence several researches on different aspects of project management need to be conducted in the future.

This research wants to investigate how the usage of Project Management Information System (PMIS) can enable administration of projects in Ethiopian context. Thus the aim of this research is to explore the effect of implementation of PMIS on the performance of projects with regard to the System used, the quality of information given and the System usage during the entire project life cycle in order to increase the performance of the project. The result of this research will be very crusial to know the status of PMIS use in the construction sector, the factors associated with the use of PMIS and its effect on project performance.

1.3 Research hypothesis

The study attempts to address the following research hypothesis

1. What are characteristics of construction enterprises in Ethiopia in terms of utilizing quality project management information system?
2. What are the challenges of the construction enterprises in order to implement of project information management system in their organization?
3. How does the use of project management information system be related with the performance of projects in terms of delivery time, cost, scope?
4. How does the quality of project management information system software, information, use and user influence the different dimensions of projects performance in the construction sector?

1.4 Objectives of the research

This research study will be guided by the following research objectives:

- ✪ Examine the practice of information management system among public and private construction projects in Ethiopia;
- ✪ To find out the influence of Project Management Information System software on the performance of construction project;
- ✪ To investigate the influence of quality of PMIS information, use and user on the performance of construction project;
- ✪ Investigate the challenges and capacity gaps in using modern and standard project management software in the construction industry
- ✪ Assess the perceptions of professionals engaged in construction industry about the role of PMIS in project success

1.5 Scope of the study and coverage

The aim of this study is to investigate the effect of the usage of Project Management Information Systems on the performance of projects in Ethiopia by considering the construction industry as a case study. Construction industry covers those engaged in building of new structures, including site preparation, as well as additions and modifications to existing ones, and maintenance, repair, and improvements on these structures. Enterprises engaged in at least one or more of such construction activities and registered by the federal ministry of construction and urban development of

Ethiopia will be the target population of the study where sample selection and data collection would be carried out. The study does not entertain clients of construction projects or any other stakeholder relevant for the successful completion of projects.

1.6 Organization of the thesis

The thesis is organized as follows: chapter one presents the purpose of project management information system in the construction industry; it begins by describing the role of project management information system implementation on performance of projects in the construction industry in the Ethiopia. Chapter two presents a review of literature in relation to the themes of the study while chapter three presents the research design methodology that was used in collecting and analyzing data. Chapter three describes the research design, sampling, data collection approach as well as methods of data analysis techniques used in the research. Chapter five present and discuss the results of the analysis including descriptive, bivariate and regression analysis results. The last chapter, chapter five, finally summarizes the main findings of the study, make conclusions and pinpoint the limitations of the research and suggest possible research areas for future studies.

Chapter Two

2. Literature Review

2.1 Introduction

This chapter reviews the existing literature according to the themes of research study. It further looked into conceptual framework and the theoretical framework of the study. The review of the literature helps to show the gaps in the field and what could be achieved by this project.

2.2 Project Management Information System

Project management information system (PMIS) can be defined as the tools and techniques used in the management of projects whether simple or complex. It can also be described as an electronic information system used to plan, schedule, control, report, communicate, forecast and handle cost for most aspects of a project. According to Project Management Body of Knowledge (PMBK, 2017), PMIS are system tools and techniques used in project management to deliver information. Some PMIS tools include Microsoft Project, dotProject and Primavera. The major challenge of Project Management is to achieve all of the project goals and objectives while honoring the preconceived project constraints of time, budget, quality and scope as well as optimizing the allocation and integration of inputs needed to meet pre-defined objectives while mitigating any risks.

PMIS are important building blocks of efficient and effective project management and have considerably changed from being just scheduling applications to complex information systems that cover wide range of project processes while addressing multitude of stakeholders (Kaiser and Ahlemann, 2010). They have become comprehensive systems that support the entire life cycle of projects, project programs and project portfolios. They can support project managers in their planning, organizing, control, reporting and decision-making tasks while evaluating and reporting at the same time (Raymond and Bergeron, 2008, Caniëls and Bakens, 2012).

Inadequate balancing of scarce resources often results in additional pressure on the organization leading to poor quality of information and longer lead times of project (Davis, 1989, Adams et al., 1992). PMIS is considered advantageous to project managers because of the alleged contribution regarding on time decision making and project success (Raymond et al., 2008).

2.3 Application of PMIS in construction industry

Currently there are two types of project management systems that are used in the construction industry. First, there is an off the shelf project management software that is distributed to many people by service providers whereby project management is done using Gantt Charts, PERT (Program Evaluation and Review Technique) and CPM (Critical Path Method) .These types of PMIS are very popular and mainly used by private companies. Therefore, many of the PMIS software systems that are available commercially normally employ the aforementioned techniques and they include SAP, Primavera Project Planner and Microsoft Project. Secondly we have PMIS software that is custom made for particular types of capital projects and is used in- house by many companies. If the existing commercial software does not satisfy the requirements of a particular construction or engineering program or company, a custom program is made by the company that satisfies the requirements of their program or firm; there are several examples of such programs such as CTCI, Bechtel, Parsons, Kajima and Brinckerhoff PMIS software.

Howard et al. (1989) reports that the AEC (architectural, engineering and construction) industry has a lot of fragmentation within different phases of projects and within specific project phases; as a result of this disintegration there is a lack of efficiency and effectiveness among the different players that are in charge of managing these projects when they are coordinating, collaborating and communicating. IT is therefore employed routinely in the construction industry so as to decrease this fragmentation and allow for seamless communication by different players in the project (Jung et al., 2011). The complexity of construction programs was increasing due to a constant increase in the number of those participating in the projects and the amount of information that was being generated by the programs; this revealed the increased need for project management tools that are effective and that are able to manage, integrate and communicate project needs and decisions.

Project management refers to the usage of current management methods and systems when a project is being carried out from the beginning to the end; the importance of the usage of project management techniques in the construction industry has increased exponentially over the last years.

The main aim of utilizing project management techniques is to attain the set of objectives for a project which includes its scope, time allocation, budgetary and allocation and to fulfill the expectations of the relevant stakeholders; the usage of PMIS is therefore recommended to those in charge of the management of a project so as to help them attain the goals of the project within the allocated time frame and within the allocated budget while maintaining the quality standards of the project (Ali and Money, 2005).

Ali and Money (2005) report that while the usefulness of PMIS systems in the effective management projects is not in question, there is still room for improving the systems; these software still give textual, basic graphical outputs and convoluted network schedules that facilitate the control of projects and make decision making possible. Currently the usage of a powerful PMIS has become a requirement in the management of any program, it ensures efficiency and effectiveness while helping project managers in their decision making processes (Chung et al., 2009). The main advantage of PMIS systems is that they increase the productivity of the project management team while increasing their efficiency and effectiveness and ensuring that relevant information is passed on seamlessly improve employee performance. As compared to other Information Management Systems, Projects Management Systems are more volatile and very context and project specific; therefore they require more customization so as to enhance their functionality.

Regardless of the importance of Project Management Systems, both in theory and in practice, not many studies have been done to investigate their effect of their usage on construction projects; there is therefore a need to increase the body of empirical work that exists on this subject. Most of the studies carried out on the subject of Project Management Systems have focused on depicting the demographic profile of those who use these systems or examining specific types of software and how they are useful during the planning, budgeting, creating schedules, documentation, communication and reporting of a project (Ali and Money, 2005).

The usage of Project Management Software has been described as having numerous challenges and limits, theoretically and practically as compared Project Management Information Systems that researchers have envisioned and that project managers would desire. The utilization of Information Systems based project management software allows for the introduction of information from the Information Systems discipline which helps in better management of projects since they employ knowledge from two different fields; this knowledge helps in understanding the impact of the usage or lack of usage of PMIS (Raymond and Bergeron, 2008).

During the selection of PMIS software, it is important to consider the following criteria: defining the specifications of the required system, identifying the PMIS software that is available for usage, matching the required software and hardware to see if they are capable of supporting beach other, examining the amount of support services and the training that is required and finally evaluating the cost of the PMIS system and the support service that the supplier is offering (Chitkara, 2009).

The quality of the PMIS system chosen determines the quality of the information that is provided by the system, it is therefore important to invest in high quality systems so as to get high quality information; this quality is determined by the technical and service quality of the chosen system. The simplicity of the utilization and the user friendliness of a system determines its ability to project high quality information; this can be done using current technologies such as Graphical User Interfaces (GUI) which allow for the presentation of data in a simple format that is easy to understand thus allowing for effective usage of the system (Chung et al., 2009).

In environments where firms are not utilizing project management information system, project participants such as project managers and project engineers are unable to relay the status of the project to the upper management sufficiently; the usage of PMIS systems allows for the relay of sufficient information to the management of an organization on the status of the project (Kaiser and Ahlemann, 2010, Kerzner, 2005, Raymond and Bergeron, 2008).

2.4 Components of PMIS and project performance in the construction industry

2.4.1 Software quality and project performance

All IS are created using IT and are intended to help managers when they are performing their tasks; PMIS software is intended to assist project managers when they are making decisions about their projects, planning their projects, organizing them and controlling them. Even though the usage of PMIS does not guarantee that the project will be successful, they are very instrumental in the management of the construction industry and have played a significant role its evolution and have therefore become mandatory in most construction projects (Chitkara, 2009, Cleland, 2004).

The utilization of a PMIS system enables project managers to collect, store, organize and process the information that they gather from their projects; it also allows the project manager to assess the standing of the project with regards to the time spent , the costs used and if the objectives and the goals of the project are being achieved. It also allows the organization's management to assess the contribution of the project to the company's strategic goals and envisioned accomplishment. The usage of PMIS systems increases the chances of a project succeeding by 75% if a PMIS system of high quality is used correctly (Love and Irani, 2003, Naylor, 1995, Raymond and Bergeron, 2008).

The key PMIS components consist of: Hardware – entire electronic and electro-mechanical equipment, Software – operating procedures and instructions, Operators – computer operators, systems analysts, programmers, data preparation personnel, information system management, data administrators and Procedures–manuals, instruction booklet, standard operating procedures (Chitkara, 2009, Cleland, 2004, Light et al., 2005).

Due to increased competition in both local and international markets, projects in fields that were considered to be non –competitive such as construction, IT and engineering now require more management and the input of a lot of effort to plan, schedule, organize, monitor and control them; these projects should therefore be carried within the prescribed time, cost and objectives to be achieved framework.

Up to 1960, Information Systems played a very simple function; they were charged with the processing of electronic data (EDP), the processing of various transactions, keeping records and in the accounting process. The processing of electronic data involves keeping a record of data, its classification, manipulation and summarizing; this process is also known as TPS (transaction processing system) which involves the processing of data or information automatically. The mid-to late 1990s saw the progressive rise of ERP (enterprise resource planning) frameworks. This organization particular type of a vital data framework coordinates all aspects of a firm, including how it plans, manufactures, sells, manages its resources and customer care, manages its inventory, controls stock, tracks orders and manages finances, markets and manages its human resources. The essential preferred standpoint of these ERP frameworks lies in their normal interface for all Computer-based hierarchical capacities and their tight coordination and information sharing required for adaptable key basic leadership (Chung et al., 2009). Information systems have changed a lot in the past decade, however they are still evolving from software that is intended for a single user or project to systems that are more complex, have multi-users, have multiple functions and can be used over long distances (Cleland, 2004). Currently, project management is more dependent on information technology; this can be deduced from the increase in the number of project management as exemplified by KMS (Knowledge Management System), VR (virtual reality), MIS (Management Information Systems), RM (risk management), DDS (Decision Support Systems), ESS (Executive Support Systems), BIS (Business Intelligent Systems) and SCM (Supply Chain Management). WBS (work breakdown structure), (PERT) and CPM (critical path method) and the Gantt Chart are information technology (IT) based solutions that enable a project manager to plan the project, manage the program costs, analyze the attendant risks, monitor and control the projects; nonetheless these systems require specialized knowledge of IT and that particular software whose acquisition is time consuming and may need to be improved as the project progresses through various phases. These knowledge requirements may reduce the opportunity for using this software if the project timelines, conditions and budget is limited. However all projects that are carried out by various organizations in various fields require effective management which involves planning, staffing, monitoring, organizing, controlling and evaluating the project in all its various phases (Liberatore and Pollack-Johnson, 2003).

Program Evaluation and Review Technique (PERT) makes it possible for the project manager to visualize various scenarios during the project which helps them in the decision making process; the usage of PERT during projects without the usage of PMIS is very time intensive; PMIS assists the project manager in planning and preparation for any risks that might occur and to examine the results of these risks (Choudhury, 2014). Constant and clear communication during the entire project is very important and allows the manager to efficiently manage the information that pertains to the project; this theme has been gaining a lot of attention from the various project management stakeholders since it is a great determinant for the success of the project (Lee et al., 2010).

The quality of a system refers to the characteristics that one requires from a PMIS; it is characterized by the ease of using the system, how flexible the system is, how reliable it is, the ease of mastering the system and how intuitive, responsive, sophisticated and flexible the system is (Peter et al., 2011). The quality of the PMIS has a significant impact on the project that its being used in and in the entire organization as a whole; this is because a high quality system ensures that the quality of information produces, its usefulness, the decision making process and the satisfaction of the stakeholders is also increased.

2.4.2 Quality of information and project performance

The quality of the information refers to the quality that project managers require from the outputs provided by the Management information system of their choice; the quality of the information produced is a measure of the outputs of the information system as opposed to a measure of its performance; the quality of the information produced by the system has a huge effect on the decision making process by the upper management of the organization (DeLone and McLean, 1992).

An analysis of the information produced by a project management system gives those managing a project an opportunity to understand where their project stands at the moment, where it has been during previous periods and where the project is going to in the future. Enough information will allow for the proper management of a project while there is insufficient information management becomes challenging due to lack of a clear scenario. In order to deal with the challenges of lack of information, project managers may be tempted to create roles within the organization which only duplicate roles and waste time, money and efforts. Conversely, when a project is inundated with too much information that has not been filtered and sorted properly leads to challenges in managing the project due to lack of direction. It is the role of upper management to ensure that relevant information is disseminated properly to enable the proper making of decisions (Adams et al., 1992). Consequently, the quality and the quantity of the information produced by management information systems determines the quality of the project.

The main causes of project failure include inadequate project formulation which is a result of inadequate project information. An efficient PMIS produces information that helps ameliorate the how productive the employees and materials used by the system are, ensure that resources are being used economically, increase the comprehension of how time and money is being used, serve as an early warning system for risks, enables the planning of resources and preventing loss of items through pilferage and fraud and in formulating incentive plans so as to motivate employees.The author describes following key characteristics associated with useful information that includes: degree of accuracy with which the reality is represented, reliable, comprehensive, error-free, precise, clear, consistent, understandable by those who need them, available in time, economical enough to support the situation that warrants a decision (Chitkara, 2009).

The decisions that are made by a project manager depend on the quality of the information provided by the management information system; when erroneous or faulty information is used in the decision making in a project, these decisions are normally wrong and might have a negative effect in the results of the project. It is therefore the role of a Project Management System to generate information that can be used by project management teams to store, keep, process and manage the resources that they have (Lee and Yu, 2011). It is therefore the quality of information created by the PMIS that defines if the system is of high quality or not; it how accurate and timely the information is what determines the quality of the information (Lee and Yu, 2011).

How accurate, available, precise, current, correct, concise, consistent and right the information generated by a system that determines if the information collected by management information system is of a high quality or not. Project managers are susceptible to being overwhelmed by the amount of information available to them which might lead them to making poor decisions as a result of the inability to discern what information is relevant or not. Project Management Information Systems create relevant and correct information which enable them to run projects easily and accurately (Ibid 2011).

It is the role of PMIS in the practice of project management to point out the information that is required in a project and how relevant that information is to the project and how it is going to be implemented. The PMIS is required to compare the current state of the project to the objectives and intentions of the project that have been set out and then recommend measures that can be taken to remedy the situation; the usage of a PMIS should not cause the project manager to lose their control of the project since the data in the PMIS should have been gathered by manager before. A project manager should ensure that a mechanism has been put in place to monitor the quality of the project outputs, its costs and the time it takes to achieve it; it is important to ensure that roles and information is not duplicated as it leads to the wastage of time and human resources which are scarce (Raymond and Bergeron, 2008).

Information gathered by a PMIS helps the project manager in planning, organizing and controlling the project; the system should create enough information that can be utilized by the various stakeholders in the project. In the event that there are other projects in that organization the PMIS should have data on those projects so as to facilitate interlinkages with these projects. The PMIS should emphasize the leakages in the project where time and resources are being lost so that remedial action can be taken; this information should provide a basis a decision making which is used in the implementation of the project or in its monitoring. It is important to avoid a system that gives too many details since they can hinder the decision making process (Choudhury, 2014). It was revealed that PMIS has a strong positive impact in PMPD (project management decision making) and produces information that is of high quality and that is effective and leads to efficient project management (Kwon and Ko, 2005).

The first Information System was introduced by DeLone and McLean (1992). This model depicted that a system is differentiated by two concepts: the quality of the system and the quality of the information created by the system. The quality of the information generated by a PMIS is defined by how accurate, relevant, available, reliable, complete, personalized, secure, consistent, timely and how easy it is to understand (DeLone and McLean, 2003, Raymond and Bergeron, 2008). The quality of the information produced is a great determinant of if the users of the PMIS will be satisfied or not; therefore the quality of the information produced is difficult to discern since it is also a measure of the satisfaction of the users. As a result it is difficult to measure the quality of the information generated by an IS, a scale to measure the quality of the information produced, while other scales have been developed using the previous literature that has been generated on the subject (Wixom and Watson, 2001).

The information generated during the project provides a base for the decision making process during project implementation and is used to create project plans, makes schedules, creating networking diagrams and projecting project trajectories. High quality information improves project understanding, helps in the creation of project objectives, strategies and goals, developing control systems, communicating the status of the project, projecting the future status of the project and reinforcing project strategies. Planning projects creates a platform the organization to supervise the information generated in their projects, this includes: information definition, project information organization and structuring, anticipation of information flow, information quality review, information use and source control and usage of information as the basis for project policy formulation(Naylor, 1995, Love and Irani, 2003).

2.4.3 PMIS use and project performance

The main purpose of the PMIS is to ensure that a project runs seamlessly among the various players in the project, consequently, if this information is shared among various users within the project as opposed to a single user which magnifies the impact of the project. Therefore, the progressive effects of PMIS should create increased intention to use the system and not to reduced satisfaction with its usage; this leads to increased usage of the information produced by the system and better information sharing and management which increases the efficiency and effectiveness of project management especially in the construction industry (DeLone and McLean, 2003).

Caldwell (2004) suggests that it is not all the time that a PMIS refers to a complicated piece of technology and that each project has specific information requirements both in terms of the quality of the information required and the quantity required. Each project needs disparate amounts of technology to fulfill its information management requirement, as a result, small projects with few information needs will require a simple PMIS while a big project with huge information requirements will benefit from a more robust and complex system (Caldwell, 2004). The usage of a custom made PMIS enables the project management team to produce high quality information since they have a quality system.

Davis (1989) defined the perception of the usefulness of a system as the level to which a system user believes that the usage of that system can increase their performance at work. It is this perception of the usefulness of a system that influences the satisfaction of a project manager with a PMIS system and has a bearing on their ability to make decisions. An example of this situation is when a those who are charged with decision making in an organization think that the usage of a PMIS will make it easier for them to make decisions, increase their decision making speed, enable them to make more effective decisions, improve their productivity at work and better their performance at work.

A study carried out by Raymond and Bergeron (2008) to investigate the impact of the usage of PMIS on the success of the projects was unable to establish a direct correlation between PMIS usage and project success. Nonetheless, they found an indirect correlation between the influence of PMIS usage on the project manager and on the speed of making project decisions. Additionally, there is a substantial relationship between the usage of PMIS in a project and the technique that the project manager uses to make project decisions (Ali and Money, 2005). It can therefore be concluded that the usage of PMIS information was determined by the extent to which PMIS function tools that are used to plan, monitor, control, evaluate and report project process are actually used by project managers.

The Information Systems (IS) model developed by DeLone and McLean (2003) has been instrumental in evaluating the success or failure of IS systems; this model has been used by numerous researchers that are interested to understand and measure the parameters of successful IS systems. The degree of usage of PMIS which refers to the how often and for what reason employees use a system, this usage can be measured by how often the system is used, how much it is used, for what reason it is used, the level of usage, the suitability of usage and the reason for usage.

Various empirical research studies have taken up many parameters to measure the usage of IS systems; these include the purpose for usage, how often the system is used, usage that is self-reported and actual usage. The usage of different parameter has led to different results being presented by researcher on the usage of IS systems and other things in the DeLone and MacLean model. There were good example researches (Collopy, 1996, Payton and Brennan, 1999) which found that there was a substantial difference between actual usage of IS systems and self- reported usage; this can be attributed to the fact that those who use the system a lot normally underestimate their usage while those who use the system a little normally overestimate their usage. Consequently, IS system usage that is self- reported might be a poor reflection of the actual usage of the system, however, a study by Venkatesh et al. (2003) established a substantial correlation between intended system usage and actual use.

2.4.4 PMIS user and project performance

According to DeLone and McLean (2003), the most popular measure of the success of Information Systems (IS) is the satisfaction of the IS system user. The major reason for using PMIS systems is to ensure that there is a smooth flow of information among the various stakeholders in a project, therefore it is important to increase the use and information sharing of these systems to multiple users as opposed to one user as this leads the organization to get more benefits from the usage of the system. Consequently, the usage of IS systems should cause to increased intention to use the system and not just increased satisfaction with usage which leads to increased usage of the system, improved information sharing mechanisms and bette of project information management which increase the efficiency and effectiveness of project management. Ajzen (1991) defines behavioral intention as attest of the power of an individuals need to carry out a specific behavior.

The studies that have been done on the usage of PMIS systems show that the many factors that increase the usage of PMIS systems by project managers. The first is the quality of the information given by the system which is a big determinant of whether project managers will use the PMIS or not. The second determinant is the amount of detailed information that a system can give, these details are important since they determine the amount of work and the number of tasks that can be done using a particular system. The ability of the system to be used easily is the third factor.The system should not be complex, the project manager should be able to share the generated information with other project stakeholders and it should be easily understandable. The fourth factor is the size of the project, when a particular project is both complex and big, then project managers are more likely to use PMIS systems since they reduce the amount of work that needs to be done and make it easy to monitor and control the projects (Ali and Money, 2005). Bendloy and Swink (2007) report that that when a manager has more than 15 projects that are complex then they are more likely to use a PMIS since the time and effort taken to update and maintain the system can be justified by its.

The level of the performance of a PMIS or the services it provides is determined by the satisfaction that the user gets from the usage of the system. Therefore the satisfaction of the user is the most commonly used parameter to measure the success of an IS system as it has a bearing on the quality of the IS system. The satisfaction of a user is determined by the ability of the PMIS system to meet the information needs of its users, this can only be measured after one experiences both the services and goods that are offered by a particular PMIS and the evaluating the associated results (Light et al., 2005). An IS system is required to have a look and a feel that is friendly to the users; this friendliness can be enhanced by having helpful short cut keys, a simple menu, vivid colors, enough information display on each screen , data that is easily modifiable, ability to generate reports easily, ability to generate printouts easily, consistent screens and little learning to gain proficiency with the system (Liberatore, Pollack-Johnson 2004).

According to the *Project Manager Competency Development Framework* (PMI, 2007) user competency includes the knowledge, skills, attitudes and other individual characteristics that influence a huge part of an individual's work and strongly related to an individual's work performance. These competences are tested against established industry standards and can be upgraded through continuous training and development. Therefore it is only a responsible project, program or portfolio manager that can be considered as competent and competence is what enables them to be capable of carrying out their roles.

It is important to note that there are different types of competences that an individual can have; competencies that facilitate change and time management are not the same as those that enable one to deal with complex situations and projects. Competences can be broadly divided into those that help an individual carry out their technical duties and personal one that enable managers to deal with people and difficult situations effectively and efficiently. Examples of key personal competences are attitude, behavior and personality that determine an individual's ability to manage complex projects; when a project manager improves their personal competences they are able to utilize information efficiently and carry out their duties effectively and competently (Ibid 2007).

All members of a project should have good personal and professional competences regardless of whether they are team members, project, and portfolio or program managers. Nonetheless, it is important to note that situations, projects and objectives are different and therefore require different competences and it is therefore important to continuously define the key competences that are required within the framework of a specific program, project or situation as there is no standard approach to competences. Personal competences such as knowledge, skill, experience, talent, creativity and other similar characteristics form the human capital of an organization (Ajzen, 1991, Kaiser and Ahlemann, 2010). Human capital is deemed as the well spring of suggestions and answers that help organizations to improve their products, processes and services in the implementation and management of their projects.

When a PMIS generates quality information then the project manager is impacted since they feel professional and competent when they have access to quality information; they are also more likely to increase the extent and intensity of their usage of a PMIS (Raymond and Bergeron, 2008). Additionally, when the PMIS user's satisfaction is enhanced it increase the usage of the PMIS System which in turn increase the rate of information sharing within the project and the organization leading to better, efficient and effective management of construction projects.

2.5 The practice of PMIS in Ethiopian construction industry

It is known that the construction sector in Ethiopia has been growing in the last few decades. The country's huge infrastructure expansion and urban centers' building construction activities provided an opportunity for taking up the issue for further analysis. In pursuit of economic development and globalization, the country has made unprecedented investments in the construction of infrastructural and networking systems. In most developing countries where construction projects define the rate of growth and progress, constructions are now defined by a complex matrix of profitability, performance, and cost-time balance (Choudhury, 2014). Despite many challenges, PMIS has become a critical tool for construction companies in Ethiopia to help manage the timeline and increase success rate of projects.

2.6 Gaps in literature reviewed

1. **Project performance**: Project success is relative to the project management success. Raymond and Bergeron (2008) noted that most projects will succeed when they use PMIS in the management of projects. Dimensions such as the quality and usage of PMIS are extremely important for project success. Satisfaction of the expectations of the stakeholders needs to be well-thought-out to measure project success especially in construction industry.
2. **System influence**: The system quality is the necessary characteristics to an information system (Peter et al., 2011). High PMIS system quality means high quality of information, supposed efficacy, decision makers' satisfaction and better decision making by managers (Caniëls and Bakens, 2012). However, many studies focused on large-scale construction projects in developed

countries. Studying the effect of PMIS on construction projects in developing countries like Ethiopia is needed.

3. **Information quality** (DeLone and McLean, 1992): The quality of the information influences the satisfaction of the user and the intentions of usage by the user which has the ability to impact the results that the system will produce to the user and their organization. The quality of the information is used as a measure of the quality of the system and not as a standalone parameter. Investigating the influence of quality information in provision of predictive management capabilities in the construction sector. Thus, there is need for further research.
4. **System use** Raymond and Bergeron (2008). Usage of PMIS helps those managing projects to attain success in their project especially through timelier decision making. Investigating the influence of PMIS use in timelier decision in performance of construction projects and also gauge the influence of the usage as opposed to the time taken and how frequently the system is used.
5. **System user** (DeLone and McLean, 1992): The satisfaction of the user is the most popular measure of the success of an information system. Research only focus on large and complex projects thus need for the impact on smaller construction projects.
6. **Ethiopian context**: To the best of our knowledge studies on the influence of PMIS implementation on the success of projects in general and construction projects in particular are not available. The evidences to be generated in this study somehow would light on the research gaps to some extent.

2.7 Theoretical and conceptual framework

The basis of this study was the Information Systems (IS) concept which has been acknowledged worldwide as the correct basis for the examination and evaluation of PMIS; these models have been utilized by a large number of empirical studies to evaluate the success and performance of Information Systems (IS) (DeLone and McLean, 1992, Jung et al., 2011, Raymond and Bergeron, 2008)

2.7.1 DeLone and McLean Information Success Model (ISSM)

This model was introduced in 1992 by DeLone and McLean and is grounded on Shannon and Weaver's communication theory; this model puts forward two different concepts for evaluating information systems: the quality of the system and the quality of the information generated. The usage of these systems has an irrefutable impact on how projects are managed and the success or failure of these projects which might ultimately impact the performance of the concerned organization. This model was the premier definer of the parameters that those researching IS would use to measure the success of the IS. This model is derived from empirical and theoretical research carried out by numerous researchers in the 70's and 80's; DeLone and McLean did a literature review of over 100 papers that were published in papers between 1981 and 1987. They distilled all the research that was carried out to six parameters: the quality of the system, the quality of the information, the user of the information, the satisfaction of the user, the impact on the individual and its impact on the organization.

This model has integrated the dependent variables that have been studied by those IS researchers. This model was updated after 10 years incorporating the criticisms leveled against it to include the aforementioned success parameters.

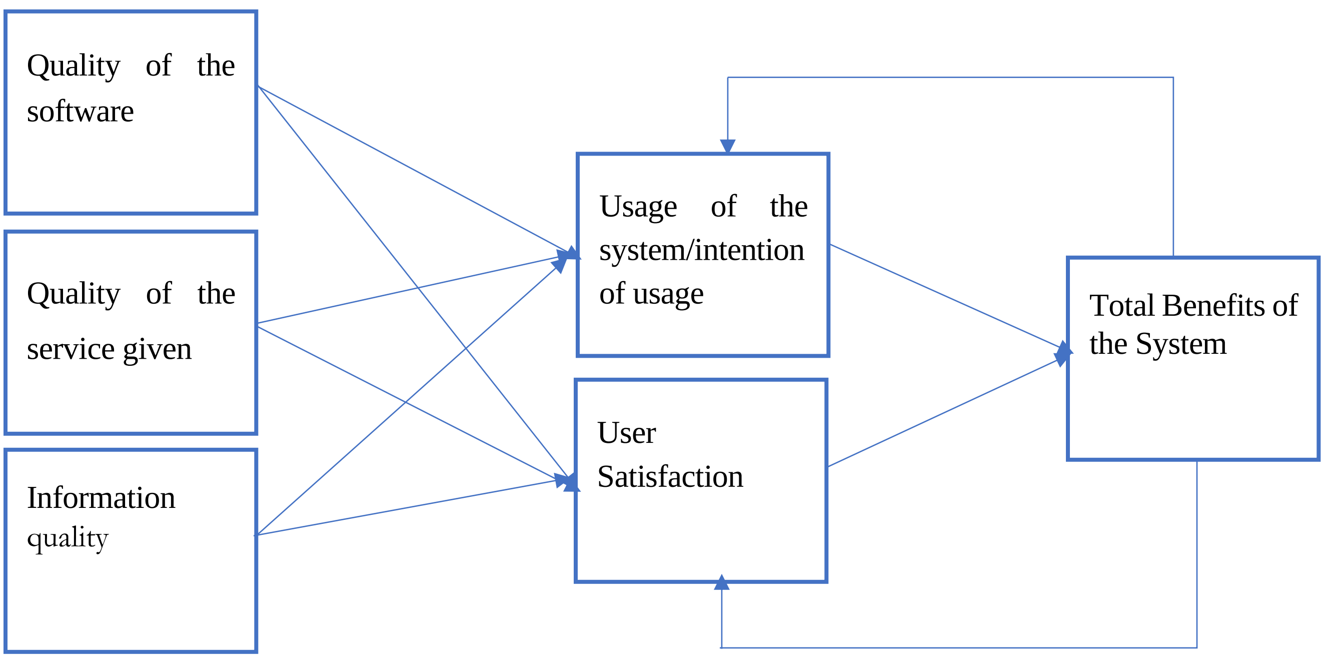

Figure 1- The Updated Information System Success Model (ISSM) (DeLone, McLean 2002, 2003)

In conclusion, this study will be based on the ISSM (Information Systems Success Model) model that was derived by DeLone and McLean in 1992 and was later restructured in 2003. This model includes the quality of the information and the quality of the system as precursors of the usage of IS which affects the effects that the usage of these IS systems has on its users and the projects as it affects effectiveness and efficiency (Raymond and Bergeron, 2008). The ISSM gives an explanation of IS phenomenon that has been accepted by many researchers (Larsen, 2003, Lee et al., 2003, Rai et al., 2002).

2.7.2 Conceptual framework

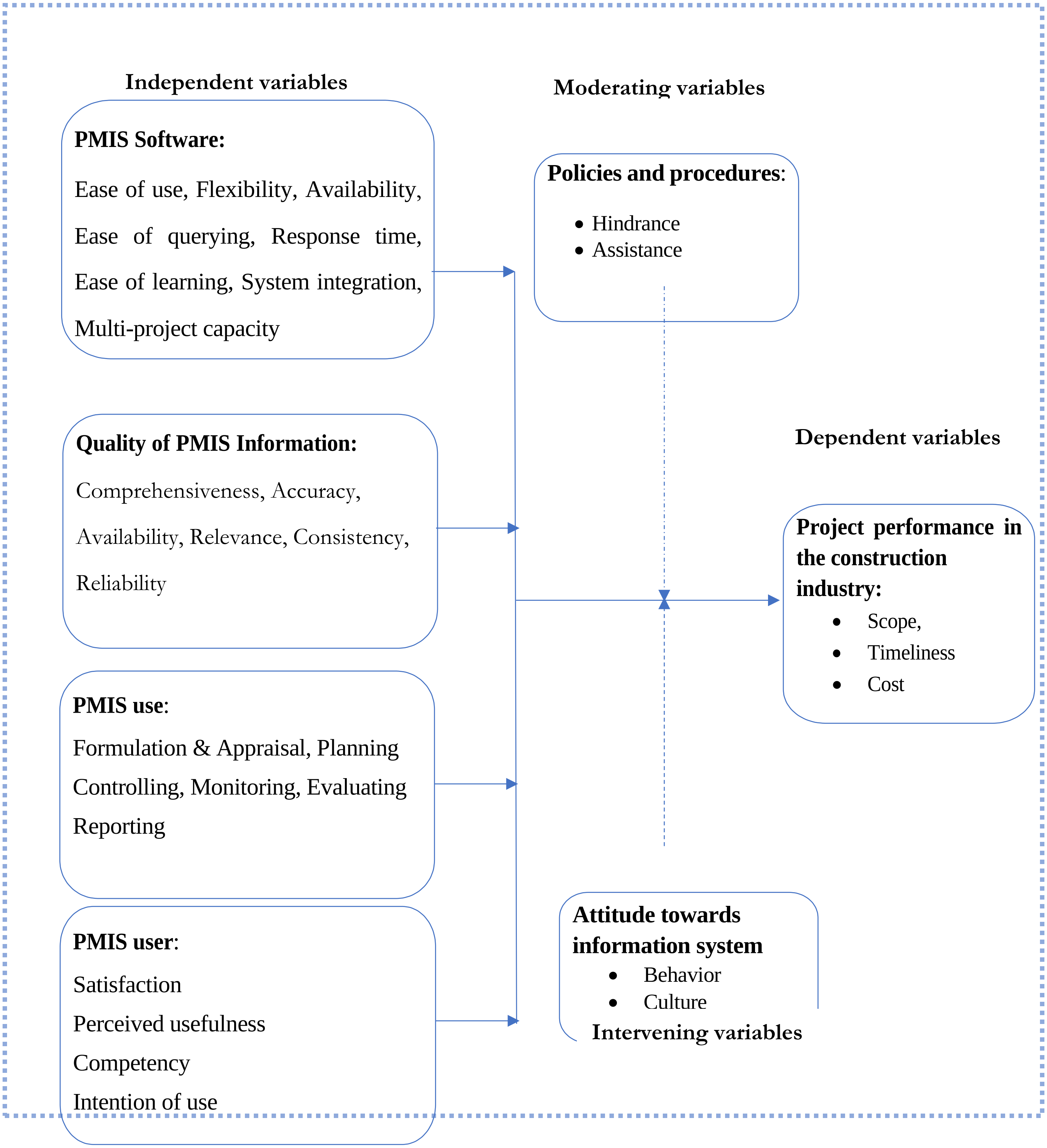

Figure 2- Conceptual framework that the relationship between dependent & independent variables

2.7.3 Explanation of relationships of variables in the Conceptual framework

This studies conceptual framework was organized into four independent variables and one dependent variable. The independent variables identified for the study were: the System itself, information quality, the System Use and the System User, in PMIS (Project Management Information System). The performance of the project which is the dependent variable assess on whether the project is completed within the set timelines, budget and within the specified specification or objective of the projects. The project performance is also linked to a large extent on an Organization's policies and procedures (moderating variable). Lastly, the performance of project tasks with regards to cost, time and quality is expected to be affected by the manager of the project and team attitude towards Information system to aid in decision making and managing the project (intervening Variable).

2.8 Summary of Literature Review.

At the moment, studies that have been carried out on the usage of PMIS individual projects reveal that there are a number of factors that compel project managers to utilize PMIS systems. Firstly, the usage of PMIS by project managers depends on the information that is generated by the PMIS system and its quality. Secondly, the probability of PMIS usage by those managing projects increases when the PMIS system generates information that has an adequate amount of details as required by their profession. Thirdly, the information generated by the system should be simple, easily understandable and makes communication between project teams easier. Fourthly, the usage of PMIS increases when managers have huge numbers of projects that are complicated since PMIS usage makes their work easier for them to control the progress of the project and reduces their workload. Those managing projects that are simple and few might not want to use PMIS systems since the amount of time and spent on updating and maintaining the system might be more than the reward that they hope to accrue from using the system.

Chapter Three

3. Research Design and Methodology

3.1 Introduction

This chapter describes the research design and methodology used in the study. The research design section presents the type of research design including the data source and collection method, sampling method and sample size determination, data collection tool and related process up-to data cleaning. In the next section, descriptive and inferential analysis techniques utilized in the study shall be presented.

3.2 Research design

The study implemented both descriptive and correlational research designs. The descriptive research design solely involves in describing the situation or status of PMIS among construction enterprises in the country. On the other hand, the correlational research design aims at studying the relationship between the performance of construction projects and the use of PMIS. The factors affecting PMIS use were also investigated using this approach. The source of data, collection, processing and analyzing methods are described below.

3.2.1 Data Source & Collection Methods

The study was based on primary data collected from selected enterprises (contractors) which have private and public projects recently completed and still going on. The respondents would be selected contractors (owners), consultants, project managers, and other professionals working in the enterprise. Representative samples of the respondents were selected based on appropriate sampling scheme.

In order to identify the enterprises engaged in construction activity surveyed, the list of construction enterprises was obtained from the Ministry of Construction and Urban Development of Ethiopia. The sampling procedure is shown in the next sections. The data collection process carried out by administering a structured questionnaire consisting of questions designed to address the research objectives indicated in Chapter 1.

3.2.2 Target Population & Method of Sampling

The list of construction enterprises by grade was obtained from the Ministry of urban development and Construction. The list contained construction enterprises of grades (levels) 1 – 10. This list was used as sampling frame to carry out the construction enterprises survey for the purpose of this study. Multistage stratified random sampling was used to select the respondents. The sample selection followed the following procedure. First, sample contractors were selected from the sampling frame using simple random sampling techniques stratified by the grade of contractors. Secondly, from the selected contractors, respondents were selected randomly who will be asked to provide information or complete the questionnaire prepared for that purpose

3.2.3 Sample size determination and sample selection

For any research, the sample size of any study must be determined during the designing stage of the study. However, before determining the size of the sample that needed to be drawn from the population, a few factors must be taken into consideration.

According to, the size of the sample is determined by four factors: (1) how much sampling error can be tolerated; (2) population size; (3) how varied the population is with respect to the characteristics of interest; and (4) the smallest subgroup within the sample for which estimates are needed. Estimation of sample size in research using Krejcie and Morgan (1970) is a commonly employed method. Krejcie and Morgan used the following formula to determine sampling size:

$$S = \frac{\chi^2 NP(1-P)}{d^2(N-1)} + \chi^2 P(1-P) \qquad (1)$$

S = required sample size

χ^2 = the table value of chi-square for one degree of freedom at the desired confidence level (3.481)

N = the population size (10, 250)

P = the population proportion (assumed to be .50 since this would provide the maximum sample size) d = the degree of accuracy expressed as a proportion (.075)

Substituting the all the parameters in the above formula, the sample size required for the survey was computed as follows

$$S = \frac{3.418 * 10250 * 0.5(1-0.5)}{0.075^2 (10250-1)} + 3.418 * 0.5(1-0.5) = 155$$

This implies that from the total population of 10,250 construction firms, a sample size of 155 would be needed to represent a cross-section of the population. Therefore, we planned to collect data from about 155 enterprises.

3.2.4 Data collection instruments

The construction data was collected from enterprises involved in the business of construction in Ethiopia by interviewing the enterprises and recording the data to obtain the required information on construction activities. Based on the type of data that has to be gathered, questionnaires wasutilized to collect data from selected construction project supervisors, construction managers, enterprise owners, etc. The questionnaire was designed as self-administered and has several sections including the follwing major components.

- General characteristics of the enterprise
- Demographic and other charateristics of the respondent.
- Project management information system (PMIS) practice in the enterprise
- Performances of construction projects handled by the enterprise.

The data obtained are recorded in a set of forms designed for this purpose as a questionnaire. An online data collection form was designed using Google Form to help facilitate the data collection process. In a situation where the online form is not feasible, two field workers were hired to assist the collection of data using tablets after delivering the necessary trainings.

3.2.5 Data cleaning and processing

The raw data collected was edited and checked for any kind of data errors and non-responses. Each and every variable were verified with appropriate techniques. In case of implausible data values, the responsible enumerator was consulted and necessary corrections were made.

3.3 Method of data Analysis

Once the data is collected and edited, the dataset is supposed to be ready for analysis. The kind data analysis utilized usually depends on the type of data available. In the study, both qualitative and quantitative analysis were conducted. Stata software version 16 were used in order to make the analysis. In utlizing quantitative methods of analyzing data, there are two kinds of analysis expected: descriptive and inferential analysis. Descriptive analysis is used to describe the nature each of the study variables separately through the computations of various statistical measures, while in inferential statistics we intend to analyze relationships among different variables such as between project performance and its factors as in the case of this study.

3.3.1 Descriptive analysis

The researcher has used descriptive statistics methods such as frequency, average, percentage and standard deviation in the data analysis and results would then be presented using frequency tables and graphs so as to ensure sinkable reading and understanding. At this stage, the relationship between the dependent variable which is project performance and independent variables which are the PMIS software, information quality, usage of the system and the user of the system was established using analysis of variance (ANOVA) method where each of the five-point scale rating of project performance are used as goups. In addition, the assocation between PMIS use and respondent and enterprise level characteristic variables are analyzed using standard t-test. All the descriptive analysis including the graphs were done with the help of the statistical package, Stata version 16.

3.3.2 Cronbach's alpha analysis

Cronbach's Alpha was developed to meet the need of finding an objective way of measuring the internal consistency reliability of an instrument used in a research work. It is mostly used when the research being carried out has multiple-item measures of concept (Tavakol and Dennick, 2011). (Joseph AG and RG, 2003) concluded in their paper that when using Likert-type scales, it is imperative to calculate and report Cronbach's Alpha coefficient for internal consistency reliability for any scales or subscales that a study is adopting. The value of Cronbach's Alpha is usually expressed as a number between.00 and 1.0. A value of.00 means no consistency in measurement while a value of 1.0 indicates perfect consistency in measurement (Tavakol and Dennick, 2011). The acceptable range is between 0.70 and 0.90 or higher depending on the type of research. Cronbach's Alpha of 0.70 is acceptable for exploratory research while 0.80 and 0.90 are acceptable for basic research and applied scenarios respectively (Tavakol and Dennick, 2011). Furthermore, the number of items used on a scale usually affects the estimated reliability. A low value (e.g. or poor interrelatedness between items, while a high value of alpha (e.g. >0.90), maybe as a result of some redundant items in the instrument.

The formula for Cronbach's Alpha is

$$\alpha = 1 - \frac{kr}{(1+(k-1)r} \qquad (2)$$

Where k is the number of indicators or number of items; r is the mean inter-indicator correlation; The value that is obtained for α usually indicates the percentage of the reliable variance. An example is the value of 0.80, which means that 80% of the variance in the scores is reliable variance and that 20% is error variance.

For the purpose of this study, Cronbach's Alpha was computed for sets of variables under three groups: variables related to respondents' characteristics, variables related to the characteristics of enterprises and project performances related variables. The results of these analysis will be presented in the next chapter.

3.3.3 Ordinal logistic regression model

Logistic regression is the model utilized in this study in order to address the main objectives of the study which is analyzing the relationships between the use and quality of project management information system by construction enterprises and project performances in different dimensions. Hence, in the next sections we will first discuss the notion of logistic regression models. Both binary and ordinal logistic regression models are used in this study.

Logistic regression is a technique that allows categorical response variables which have binomial errors to be modeled using a regression analysis. It extends the techniques of multiple regression analysis to the case where the outcome variable is categorical and allows one to predict a discrete outcome, such as group membership, from a set of predictor variables that may be continuous, discrete, dichotomous, or a mix of any of these (Gelman and Hill, 2007). Logistic regression is mathematically flexible and requires fewer distributions assumptions (Hosmer and Lemeshow, 2000). Binary logistic regression is used when the dependent variable is dichotomous. If the response variable has more than two categories which can be ordered according to their importance, ordinal logistic regression should be applied. Logistic regression does not require the assumption of linearity of independent variables, equal variance (homoscedasticity) or to be normally distributed. It has a peculiar property of easiness to estimate logit differences for data collected both retrospectively and prospectively (Gelman and Hill, 2007). The two main uses of logistic regression are predicting group membership and providing knowledge of the relationships and strengths among the variables.

Ordinal logistic regression is a special kind of logistic regression where the dependent variable has more than two levels and classified according to some order of magnitude. There are several ordinal logistic regression models such as proportional odds model (POM), two versions of the partial proportional odds model-without restrictions (PPOM-UR) and with restrictions (PPOM-R), continuous ratio model (CRM), and stereotype model (SM). The most frequently used ordinal logistic regression model in practice is the constrained cumulative logit model called the proportional odds model. The POM is widely used in epidemiological and biomedical applications but POM relies on strong assumptions that may lead to incorrect interpretations if the assumptions are violated.

If the data fail to satisfy the proportional odds assumption, a valid solution is fitting a partial proportional odds model. Another simple and valid approach to analyze the data is to dichotomize the ordinal response variable by means of several cut-off points and use separate binary logistic regression models for each dichotomous response variable. However, this procedure would result in a loss in statistical power and the reduced generality of the analytical solution.

3.3.3.1 The cumulative logit model

The most common ordinal logistic model is the proportional odds model, also called cumulative probabilities of the response categories. If we pretend that the dependent variable is really continuous, but is recorded as ordinal having ‘C’ categories (as might, for instance, happen if income were asked about in terms of ranges, rather than precise numbers), then the application of ordinal logistic model is the appropriate method.

Attempts to extend the logistic regression model for binary responses to allow for ordinal responses have often involved modeling the cumulative logit. Consider a multinomial response variable Y with categorical outcomes denoted by 1, 2, 3… C, and letX_i denote a k-dimensional vector of covariates for the i^{th}subject,$i = 1, 2, \dots, n$. The cumulative logit model was originally proposed by Walker and Duncan (1944) and later called the proportional odds model by McCullagh (1980). Suppose the response variable Y has C ordered categories with probabilities

$$p\left(Y_i = j \mid X_i\right) = \prod{}^{(j)}(X_i) \text{ for } j = 1,2,\dots,C \qquad (3)$$

In multinomial logistic model, we have(C-1) ratios:

$$\frac{p(Y_i = j \mid \boldsymbol{X_i})}{p\left(Y_i = 1 \mid \boldsymbol{X_i}\right)} = \frac{\prod^{(j)}(\boldsymbol{X_i})}{\prod^{(1)}(\boldsymbol{X_i})} \text{ for } j = 2,3,\dots,C; i = 1,2,\dots,n \qquad (4)$$

and the respective model for each can be estimated. Unlike multinomial logistic model, we will consider the C-1 cumulative probabilities:

$$\gamma^{(j)}(x_i) = p\left(Y_i \leq j \mid X_i\right) = \prod{}^{(1)}(X_i) + \cdots + \prod{}^{(j)}(X_i), \text{ for } j = 1, 2, \dots, C-1, \text{ i=1,2,…,n} \qquad (5)$$

and write down a model for each of them. Note that $\gamma^{(C)}(x_i) = p\left(Y_i \leq C \mid X_i\right) = 1$and hence, it need not be modeled.

The following holds for $\gamma^{(j)}(x_i) = p\left(Y_i \leq j \mid X_i\right)$, for each subject $i = 1,2,\dots,n$ and for each category $j = 1, 2, \dots, C-1$:

$$\log\left(\frac{\gamma^{(j)}(x_i)}{1-\gamma^{(j)}(x_i)}\right) = \log\left(\frac{p\left(Y_i \leq j \mid X_i\right)}{1-p\left(Y_i \leq j \mid X_i\right)}\right) = \alpha^{(j)} - (\beta_1 X_{1i} + \beta_2 X_{2i} +, \dots + \beta_k X_{ki})$$

$$= \alpha^{(j)} - X_i' \boldsymbol{\beta} ,$$

where $\boldsymbol{\beta}$=$(\beta_1, \beta_2, \dots, \beta_k)'$ and $X_i = (X_{1i}, X_{2i}, \dots X_{ki})'$. $\quad (\mathbf{6})$

That is, the ordinal logistic model considers a set of dichotomies, one for each possible cut-off of the response categories into two sets of 'high' and 'low' responses. This is meaningful only if the categories of Y do have an ordering. A binary logistic model is then defined for the log-odds of each of these cuts.

The odds of success or the odds of using PMIS are defined as:

$$\frac{\prod(\mathbf{X_i})}{1-\prod(\mathbf{X_i})} = \quad exp\{\boldsymbol{\beta}'\mathrm{X_i}\} \qquad (7)$$

The log-odds (logit) are then given by:

$$\log\left(\frac{\prod(\mathrm{x_i})}{1-\prod(\mathrm{x_i})}\right) = \boldsymbol{\beta}'\boldsymbol{X_i} , \mathrm{i} = 1,2,3, \dots, \mathrm{n} \qquad (8)$$

In the case of this study, the are four distinct ordinal regression models to be fitted for each of the types of project performances: timeliness, budget/cost, scope and overall project performance. It implies that Y in the above model specification shall be substituted by Y1, Y2, Y3 and Y4 respectively for each of the project performance dimensions. On the other hand, X or the vector of explanatory variables included in the model are:

- PMIS use (1 if the enterprise uses PMIS and 0 otherwise)
- Grade of the enterprise
- Current Capital in Birr
- Number of employees the enterprise employs in a typical month
- Number of projects completed till the time of the survey
- Number of projects currently under implementation
- Gender of respondent
- Age of respondent
- Level of education of the respondent
- Position of the respondent in the enterprise
- Number of years of experience of the respondent working in the enterprise

Quality of PMIS and project performance are also modelled by ordinal logistic regression model where the dependent variables are the same as the above models while the set of independent variables are quality of software, system, user and use as well as those explanatory variables listed above. The main interest here is that how the quality of PMIS software, system, user and use affect project performance after analyzing the impact of the general PMIS use in the above set of models. This indicates that, there are eight ordinal logistic regression models which need to be fitted in order to address the objectives of the study.

The model for the cumulative probabilities is

$$\gamma^{(j)}(x_i) = p\left(Y_i \le j \mid X_i\right) = \frac{exp\left[\alpha^{(j)} - (\beta_1 X_{1i} + \beta_2 X_{2i} +, \ldots + \beta_k X_{ki})\right]}{1 + exp[\alpha^{(j)} - (\beta_1 X_{1i} + \beta_2 X_{2i} +, \ldots + \beta_k X_{ki})]}$$

$$= \frac{exp\left(\alpha^{(j)} - \boldsymbol{X}_i' \boldsymbol{\beta}\right)}{1 + exp(\alpha^{(j)} - \boldsymbol{X}_i' \boldsymbol{\beta})} \qquad (9)$$

The intercepts $\alpha^{(1)}, \alpha^{(2)}, \dots., \alpha^{(C-1)}$ must satisfy the condition that $\alpha^{(1)} \leq \alpha^{(2)} \leq \cdots \leq \alpha^{(C-1)}$ to guarantee that $\gamma^{(1)} \leq \gamma^{(2)} \leq \cdots \leq \gamma^{(C-1)}$. The parameters $\beta_1, \beta_2, \dots, \beta_k$ are the same for each value of j. McCullagh (1944) calls this assumption of identical log- odds ratio across C-cut points proportional odds assumption, hence the name 'proportional odds' model. The validity of this assumption can be checked based on a $Chi - square$ score test. The model that relaxes the proportional odds assumption can be represented as $logit\left[\gamma^{(j)}(x_i)\right] = \alpha^{(j)} - \boldsymbol{X}_i'\boldsymbol{\beta}^{(j)}$, where the regression parameters $\boldsymbol{\beta}^{(j)}$ are allowed to vary with j. The usefulness of this latter model is to test the assumption of the proportionality that there is perfect homogeneity within the categories collapsed.

The probabilities for individual responses are:

$$p\left(Y_i = 1 \middle| X_i\right) = \gamma^{(1)}(x_i) = \frac{exp\left[\alpha^{(1)} - (\beta_1 X_{1i} + \beta_2 X_{2i} +, \dots + \beta_k X_{ki})\right]}{1 + exp[\alpha^{(1)} - (\beta_1 X_{1i} + \beta_2 X_{2i} +, \dots + \beta_k X_{ki})]} \qquad (10)$$

$$\begin{aligned} p\left(Y_i = j \middle| X_i\right) &= \gamma^{(j)}(x_i) - \gamma^{(j-1)}(x_i) \\ &= \frac{exp\left[\alpha^{(j)} - (\beta_1 X_{1i} + \beta_2 X_{2i} +, \dots + \beta_k X_{ki})\right]}{1 + exp[\alpha^{(j)} - (\beta_1 X_{1i} + \beta_2 X_{2i} +, \dots + \beta_k X_{ki})]} \\ &\quad - \frac{exp\left[\alpha^{(j-1)} - (\beta_1 X_{1i} + \beta_2 X_{2i} +, \dots + \beta_k X_{ki})\right]}{1 + exp[\alpha^{(j-1)} - (\beta_1 X_{1i} + \beta_2 X_{2i} +, \dots + \beta_k X_{ki})]} \end{aligned} \qquad (11)$$

for $j = 1, 2, \dots, C - 1$ and

$$p\left(Y_i = C \middle| X_i\right) = 1 - \gamma^{(C-1)}(x_i) = 1 - \frac{exp\left[\alpha^{(C-1)} - (\beta_1 X_{1i} + \beta_2 X_{2i} +, \dots + \beta_k X_{ki})\right]}{1 + exp[\alpha^{(C-1)} - (\beta_1 X_{1i} + \beta_2 X_{2i} +, \dots + \beta_k X_{ki})]} \qquad (12)$$

3.3.3.2 Proportional odds assumption and tests

The proportional odds assumption is that βs are independent of j ($j = 1, 2, \dots, C-1$). In other words, if we look at binary logistic regressions of category 1 vs. 2, category 2 vs. 3, and so on, then the intercepts in the equations might vary, but the other parameters would be identical for each model. To compare the ordinal model with the binomial models, determine whether the slopes are meaningfully different. When fitting an ordinal regression, we assume that the relationships between the independent variables and the logits are the same for all the logits. That means the results are a set of parallel lines or planes—one for each category of the outcome variable. We can check this assumption by allowing the coefficients to vary, estimating them, and then testing whether they are all equal.

For this test, the number of response levels (C) is assumed to be greater than two. Let Y be the response variable taking the values $1, \dots, \mathrm{C}$, and suppose there are k explanatory variables. Consider the general cumulative model without making the parallel lines assumption:

$$\mathrm{g}\big(p(Y_i = j|X_i)\big) = (1, \boldsymbol{X}_i)\boldsymbol{\theta}_j \,, \tag{13}$$

where $g(.)$ is the link function, and $\boldsymbol{\theta}_{\mathbf{j}} = \left(\alpha^{(j)}, \beta_{j1}, \beta_{j2}, \dots, \beta_{jk}\right)'$ is a vector of unknown parameters consisting of an intercept $\alpha^{(j)}$ and K slope parameters $\left(\beta_{j1}, \beta_{j2}, \dots, \beta_{jk}\right)'$**.** The parameter set for this general cumulative model is $\boldsymbol{\theta} = (\boldsymbol{\theta'}_{\mathbf{1}}, \boldsymbol{\theta'}_{\mathbf{2}}, \dots, \boldsymbol{\theta'}_{\boldsymbol{C-1}})'$. The null hypothesis of parallelism is that H_o: $\boldsymbol{\beta}^{(1)} = \boldsymbol{\beta}^{(2)} = \dots = \boldsymbol{\beta}^{(C-1)}$, where $\boldsymbol{\beta}^{(j)}$ the vector of parameters in j^{th} category, that is, there is a single common slope parameter for each of the explanatory variables. Let $\beta_1, \beta_2, \dots, \beta_k$ be the common slope parameters. Let $\hat{\alpha}_1, \hat{\alpha}_1, \dots, \hat{\alpha}_{C-1}$ and $\hat{\beta}_1, \hat{\beta}_2, \dots, \hat{\beta}_k$ be the MLEs of the intercept parameters and the common slope parameters.

Then under H_o, the MLE of $\boldsymbol{\theta}$ is $\widehat{\boldsymbol{\theta}}= (\hat{\theta}_1, \hat{\theta}_2, \dots, \hat{\theta}_{C-1})'$ with $\widehat{\boldsymbol{\theta}}_j = (\hat{\alpha}_j, \hat{\beta}_1, \hat{\beta}_2, \dots, \hat{\beta}_k)'$, and the chi-squared score statistic $\mathbf{g}'(\widehat{\boldsymbol{\theta}})\mathbf{I}^{-1}(\widehat{\boldsymbol{\theta}})\mathbf{g}(\widehat{\boldsymbol{\theta}})$ has asymptotic chi-square distribution with $k(C-2)$ degrees of freedom. This tests the parallel lines assumptions by testing the equality of separate slope parameters simultaneously for all explanatory variables (SAS Institute Inc., 2008). If we fail to reject the null hypothesis, then the test of parallelism is recognized to be satisfied, or that the proportional odds assumption is met.

3.3.4 Interpretation of logistic regression

The coefficient of a continuous covariate is interpreted as the change in the log-odds of an event of success per unit increment in the corresponding covariate keeping other covariates constant. In case of a categorical predictor variable, it is interpreted as the log-odds of an event of success for a given category compared to the reference category. For instance, in the regression of project overall performance, the coefficient of number of employees in a typical month is interpreted as the chance in the log-odds of project success for an increase of one employee. On the other hand, the coefficient of gender is interpreted as the change in the log-odds of project performance due to female respondent compared to male respondent.

3.3.5 Odds Ratios

The odds ratio is the ratio of the odds of an event occurring in one group to the odds of occurring in another group. In a cohort study, odds ratio can be calculated by determining the odds of a risk factor among individuals with the event of interest divided by the odds of a risk factor among individuals without the event of interest (Cornfield, 1951).In binary logistic regression, odds ratio is the exponential of the estimated coefficient $\hat{\beta}$ ($\exp(\hat{\beta})$). An odds ratio of one corresponds to an explanatory variable that does not affect the outcome variable. For a continuous covariate, $\exp(\hat{\beta})$ is the predicted change in odds of being malnourished (underweight) for a unit increase in a predictor variable. In case of categorical predictor variables, $\exp(\hat{\beta})$ is the predicted change in odds of being malnourished for a given category of the predictor variable with respect to the reference category.

3.3.6 Assessment of the Fit of Logistic Regression Model

After fitting the logistic regression model or once a model has been developed through the various steps in estimating the coefficients, there are several techniques involved in assessing the appropriateness, adequacy and usefulness of the model. First, the overall goodness of fit of the model will be tested. Then the importance of each of the explanatory variables will be assessed by carrying out statistical tests of significance of the coefficients (Agrresti, 1996).

i. Deviance and Pearson's Goodness-of-Fit Test

By goodness of fit of a model we mean how well the model describes the response variable. Assessing goodness of fit involves investigating how close values are predicted by the model with that of observed values (Bewick et al., 2005). We can compare the likelihood of the current model (**L_c**) with that of the full model or saturated model (**L_f**). The scaled deviance is often defined, in generalized linear model (GLM) terminology, as:

$$D(c,f) = -2\log\left(\frac{L_c}{L_f}\right) \qquad (14)$$

where the full model is the model that has as many location parameters as observations, that is, *n* linearly independent parameters. Thus, it reproduces the data exactly but with no simplification, hence being of little use for interpretation. The current model is the model that lies between the maximal and the minimal model. The larger the deviance, the less fit is the model to the data

(Lindsey, 1996). The deviance has a chi-squared asymptotic null distribution with degrees of freedom equal to the difference between the numbers of parameters in the saturated and unsaturated models.

In addition, Pearson's goodness-of-fit test is a very common and useful test for several purposes. It can help determine whether a model fits well, or a pair of categorical variables is associated. It is computed as:

$$X^2 = \sum_{i=1}^{C} \frac{(O_i - E_i)^2}{E_i}, \tag{15}$$

where O_i is a count of the number of observed items in category i, E_i is the expected number of items in category i, and 'C' is the number of categories. Since the binomial formula forms the foundation of this test, the expected number of items in a category is determined by the expected value of a binomial random variable. That is, $E_i = np_i$ where *n* is the number of observations and p_i is the probability of obtaining an observation in category *i*. The Pearson chi-square statistics has an asymptotic X^2-distribution with (C-1) degrees of freedom when it is used to test several proportions simultaneously.

ii. *Pseudo-$\boldsymbol{R}^2$*

When analyzing data with a logistic regression, an equivalent statistic to R-squared does not exist. The model estimates from a logistic regression are maximum likelihood estimates arrived at through an iterative process. They are not calculated to minimize variance, so the OLS approach to goodness-of-fit does not apply. However, to evaluate the goodness-of-fit of logistic models, several pseudo R-squares have been developed. These are "pseudo" R-squares because they look like R-squared in the sense that they are on a similar scale, ranging from 0 to 1 (though some pseudo R-squares never achieve 0 or 1) with higher values indicating better model fit, but they cannot be interpreted as one would interpret an OLS R-squared and different pseudo R-squares can arrive at very different values. The most commonly encountered pseudo R-squares are Cox and Snell pseudo R-square, Nagelkerke / Cragg & Uhler's R-square, McKelvey &Zavoina, etc.

Let L_f be likelihood of the model with predictors and L_0 is likelihood of model with only intercept (null model), then the Cox and Snell $\mathbf{R}^{2}$is given by**:**

$$\mathbf{R^2 = 1 -} \left[\frac{L_0}{L_f}\right]^{\mathbf{2/n}} \tag{16}$$

The ratio of the likelihoods in $Eq. 19$ reflects the improvement of the full model over the intercept model (the smaller the ratio, the greater the improvement).Note that Cox & Snell's pseudo R-squared does not attain the value one even if the full model predicts the outcome perfectly. The Nagelkerke$\mathbf{R}^{2}$can be evaluated as:

$$\mathbf{R^2} = \frac{\mathbf{1 -} \left[\frac{L_0}{L_f}\right]^{\mathbf{2/n}}}{1 - L_0^{2/n}} \tag{17}$$

where itadjusts Cox& Snell's so that the range of possible values extends to 1.

iii. Likelihood-Ratio Test

An alternative and widely used approach to test the significance of a number of explanatory variables is the likelihood ratio test. This is appropriate for a variety of types of statistical models. Agrresti (1990) argues that the likelihood ratio test is better, particularly if the sample size is small or the number of parameters is large. The likelihood-ratio test uses the ratio of the maximized value of the likelihood function for the full model (L_f) over the maximized value of the likelihood function for the null model (L_0). The likelihood-ratio test statistic is given by:

$$G^2 = -2ln\left[\frac{L_0}{L_f}\right] = -2\{\ln\ L_0 - \ln\ L_f\} \qquad (18)$$

where L_0 is the likelihood function of the null model and L_f is the likelihood function of the full model evaluated at the MLEs. This natural log transformation of the likelihood functions yields an asymptotically chi-squared statistic with degree of freedom equal to the difference between the numbers of parameters estimated in the two models (Menard, 2002). It tests the null hypothesis that all population logistic regressions coefficients are zero except the constant one. i.e., it tests:

$H_o: \beta_1 = \beta_2 = \beta_3 = \cdots = \beta_k = 0$ Vs$H_1: \beta_j \neq 0$ for at least one j, $j = 1,2, \ldots, k$

iv. The Wald Test

The Wald test is a member of what is known as trinity of classical likelihood testing procedures, the other two being the likelihood ratio (LR) and Lagrange multiplier (LM) tests. It is an alternative test which is commonly used to test the significance of individual logistic regression coefficients. Wald X2(chi-square) statistics are calculated as:

$$Z_j^2 = \left(\frac{\hat{\beta}_j}{se(\hat{\beta}_j)}\right)^2, \text{ j=1, 2..., k} \qquad (19)$$

Each Wald statistic is compared with a chi-square distribution with 1 degree of freedom. Wald statistics are easy to calculate but their reliability is questionable, particularly for small samples. For small sample sizes, the likelihood ratio test is more reliable than the Wald test (Agresti, 1996).

v. Residuals diagnostics

Residuals are very important for logistic regression diagnostics. They can be useful for identifying potential outliers or misspecification of models and checking for normality. (Hosmer and

Lemeshow, 2000) In ordinal models, residual graphs are normally constructed for proportional odds models using adjustment of the models to predict a series of binary events $Y > j, j = 1, 2, \ldots, C$, where C is a cut-off point .Therefore, for the indicator variable $Yand\ \ j$, the residual score for case i and covariate k is given by:

$$U_{ik} = \boldsymbol{X}_{ik}\left(p[Y_i \geq j] - \hat{P}_{ij}\right)$$

$$\hat{P}_{ij} = \frac{1}{1+exp\left[-\left(\hat{\boldsymbol{\alpha}}^{(j)} - \boldsymbol{X}_i'\hat{\boldsymbol{\beta}}\right)\right]} \qquad (20)$$

In residual score graphs, the mean $\overline{U}_{.k}$ and the respective reliability intervals are placed along the vertical axis, with the response variable categories along the horizontal axis. If the proportional odds assumption is valid for each covariate, the reliability intervals foreach category of the response variable should have a similar appearance.

Partial residuals are also widely used for checking if all the covariates of the model have linear behavior. In the context of ordinal regression, it is necessary to calculate binary logistic regression models for all the cut-off points of the response variable Y, with the partial residual for each case i and the covariate k being defined in the following way:

$$r_{ik} = \boldsymbol{X'}_{ik}\hat{\boldsymbol{\beta}}_{\mathrm{k}} + \frac{\mathbf{p}[Y_i \geq j] - \hat{P}_{ij}}{\hat{P}_{ij}\left(1 - \hat{P}_{ij}\right)} \qquad (21)$$

The partial residual graphs provide estimates of how each covariate$x$relates to each category of response variable (Y). So, partial residuals are used to check the need for changes in the covariate (linearity) or even the validity of the proportional odds assumption (parallelism of the curves).

Chapter Four

4. Result and Discussion

4.1 Introduction

In this chapter, the results of various kinds of analysis will be presented. Descriptive statistics of study variables are presented first which includes respondents' characteristics, enterprise characteristics, quality of PMIS software, information, PMIS use and PMIS user as well as project performance related variables. Analytical results of the relationship between PMIS and project performance carried out by the use of relevant regression models are presented at the end. It has to be noted that the study intended to examine the impact of Project Management Information Systems on the performance of construction projects in Ethiopia with primary emphasis on the quality of information, PMIS software, the usage of the system, the users of the system.

4.2 Survey performance

The study had targeted to collect data from 150 contractors which were selected randomly from the list of contractors avilable from the ministry of construction. Despite the challenges, it was possible to collect data from 126 enterprises from which 81 of them responded through the online data collection tool while the remaining responded by complecting the printed questionnaire. This represents a response rate of of about 84 percent. All the analysis presented below are based on the data gathered from the 126 respondents.

4.3 Descriptive statistics of study variables

The main source of data for analysis was survey conducted on selected enterprises engaged in construction sector in Ethiopia. The survey consists of four section: Respondent characteristics, Enterprise characteristics, PMIS software, PMIS system, PMIS use and PMIS user, and project performance. Under each section there were questions primarily targeted to address the research objectives. The summaries of these variables are shown in the upcoming sub-sections.

4.3.1 Respondents characteristics

Respondents of the survey are characterized by either their demographics such gender, age, education, marital status or using their professional related variables such as experience of working in the construction sector or their current specific responsibility or position they held in the organization they work during the survey time. These variables are supposed to have been related with the practice and perception of project management information in the enterprise where the respondent works. After presenting the results of respondents characteristics, the results of the relationship with the respective PMIS related variables will be presented and discussed.

Figure 4.1 illustrates the distribution of gender, age, marital status and education. Looking at gender of the respondents alone, 71 percent of them are male while the remaining 29 percent are females which can be considered as a fair representation of gender equity given the existing situation of the market that the construction sector is dominated by males.

From the findings, 46 (36.5 percent) of the respondents had ages of between 18 and 30 years, 36 (28.5 percent) were aged between 31 and 40 years, and 34 (27 percent) had ages of between 41 and 50 years and 10(7.8 percent) respondents had ages above 50 years. From the study, the results show that most of the project respondents have ages below 50 years.

The marital status distribution of the respondents shows that the majority of the respondents (49.2 percent) are married followed by singles (36.5 percent) and other status (14.3 percent).

Another important variable in the survey was the maximum education level of respondents which was indicated in the questionnaire in the following categories: Master degree and above, Bachelor degree, Diploma and TVET and High school complete and below. As can be seen in the graph, the majority of the respondents have bachelor degree constituting 43 percent of the total respondents while about 28.6 percent of the respondents are MSc/MA degree complete. On the other hand, 25 percent of them have only either diploma or TVET certificates and the remaining 3 percent of the respondents are high school complete or below.

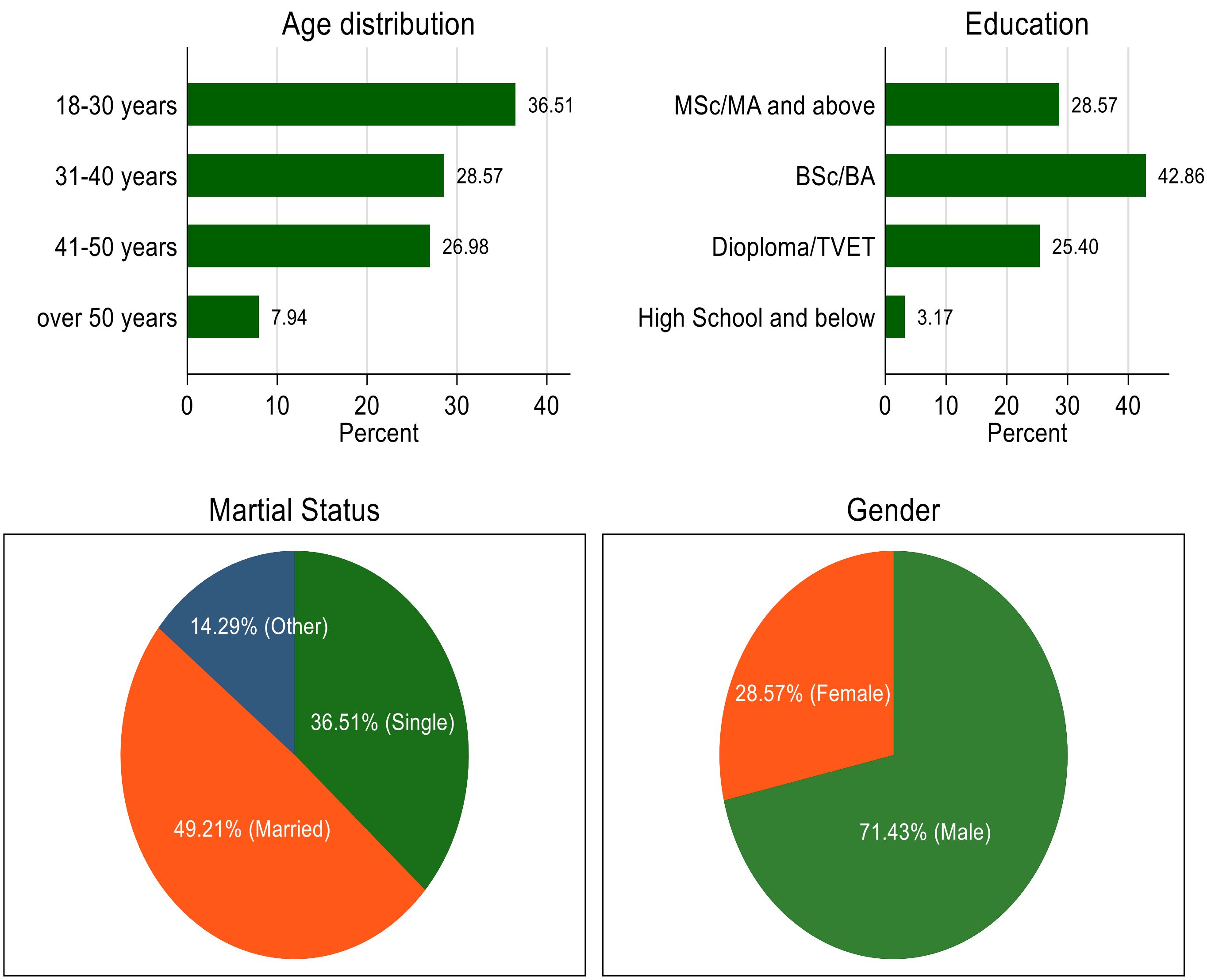

Figure 3- Respondents characteristics

Two other characteristics of the respondents included in the survey were the position of the respondent in the enterprise and his/her experience as measured by number of years working in the enterprise in general and holding the current position in particular. The average number years the respondent worked in the enterprise is computed to be 6.8 years with minimum and maximum values of 1 and 29 years respectively while the number the experience of the respondents holding the current position averaged at 3.3 years and ranging from 3 months to 12 years. By recoding the years of experiences in the enterprise into four classes, it was possible to say that about 65 percent of the respondents have less than five years of experience while 33 percent of them have the experience of working in the enterprise for less than two years. The remaining 36 percent of the respondents have worked in the enterprise for more than five years.

The position held by the respondent is another dimension to assess that needs to be investigated. The figure shown below (Figure 4.2) shows the distribution of this variable together with the years of experience working in the enterprise. The types of position held has almost uniform distribution among the different position types having a percentage of 20 to 22 except the last type of position. This shows that all types professionals like senior management, functional manager, project manager and supervisors are adequately and proportionally represented in the survey.

Figure 4- Respondents' experience and position in the enterprise

The result of Cronbach alpha analysis on respondents' characteristic variables shows an α value of 0.848 which indicates that 85 percent of the score variances of these variables are reliable and that 15 percent are error variance.

4.3.2 Enterprises characteristics

Following the characteristics of respondents, the characteristics of enterprises covered in the survey is another dimension which need due investigation. As discussed in the third chapter, the study only targets construction companies with different levels. The most important variables presented below are grade of the enterprise as a measure of size, age or year since establishment as a measure of experience and number and type of projects completed by the enterprise, number of employees and capital related variables as a measure of experience and performance. Like the respondent characteristics, the enterprise characteristic variables presented here are supposed to be affect the practice of project management system in the enterprise which is the main subject area of the study. To show how these variables really affect the use and quality of PMIS in the enterprise, the associated results presented in the upcoming sections should be referred.

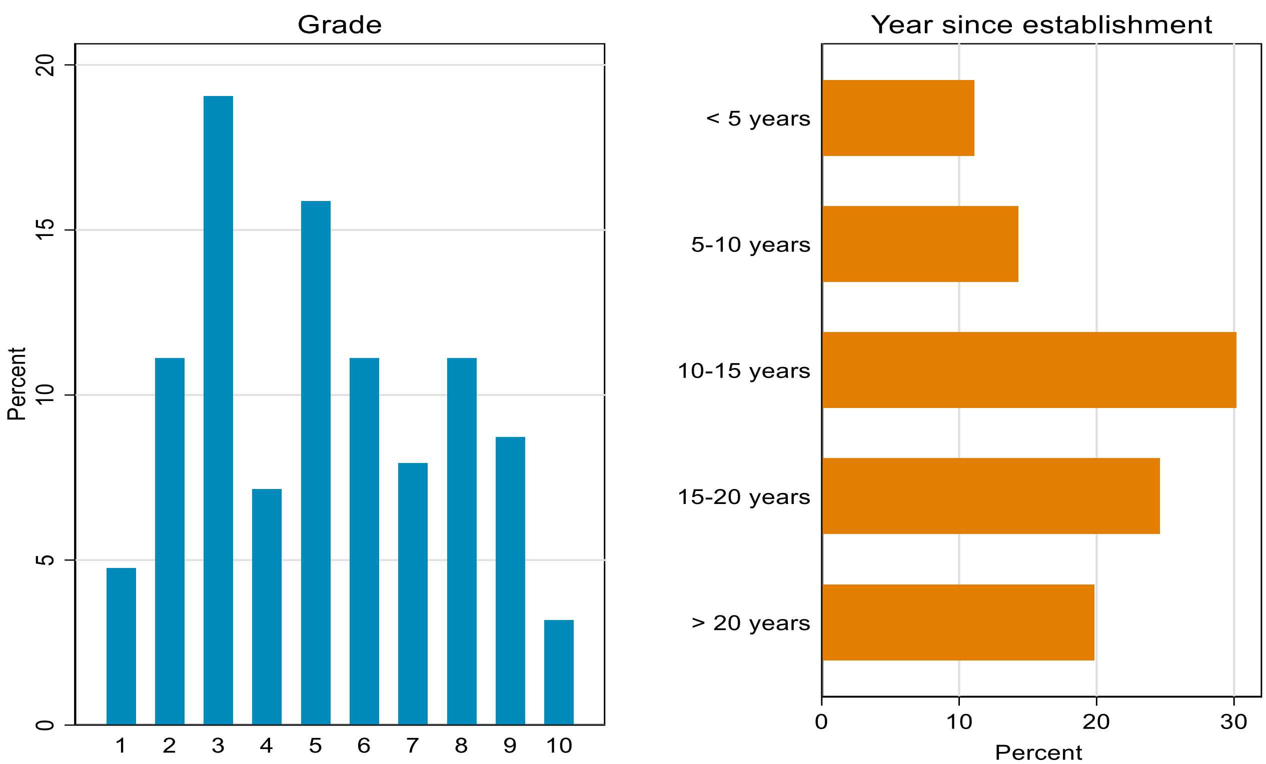

Figure 5- Grade of enterprises and years in service in the business

The survey covers almost all types of grades (Grade 1 to Grade 10) covering from 3 percent (Grade 10 contractors) to 19 percent (Grade 3 contractors). The distribution of enterprises across all the grades is shown in the figure below together with the age of the enterprises. The summary of years past the establishment of the enterprise indicates that the enterprises has in the business from a minimum of 1 year to a maximum of 25 years with an average age of 14.5 years. By re-categorizing the age variable, it can be shown that almost 56 percent of the enterprises have been in the business for less than 15 years while the remaining 44 percent have been in the business for more than 15 years. Both grade and number of years in the business are assumed to be important factors for the performance of the enterprises as well as the use of appropriate project information system.

The survey has also attempted to assess the type and number of projects completed by the respective enterprises over the last five years. The type of projects included are: Road construction, buildings or real estate constructions, and other types of construction as disaggregated by public versus private ownership. The table and figure shown below illustrates the summary of the number and distribution of projects completed or being constructed by the selected enterprises. Based on the responses, there are more public projects than private projects. Projects with private ownerships are dominated by buildings while the public projects are mostly roads.

Table 1- Number and type of projects currently running and completed over the last five years

	Roads	Buildings	Other Projects	
Number of Projects	Public Projects			Total
No Project	39	44	64	147
1-5 Projects	78	56	62	196
6-10 Projects	9	20	0	29
> 10 Projects	0	6	0	6
	Private Projects			0
No Project	106	9	85	200
1-5 Projects	20	47	38	105
6-10 Projects	0	52	3	55
> 10 Projects	0	18	0	18

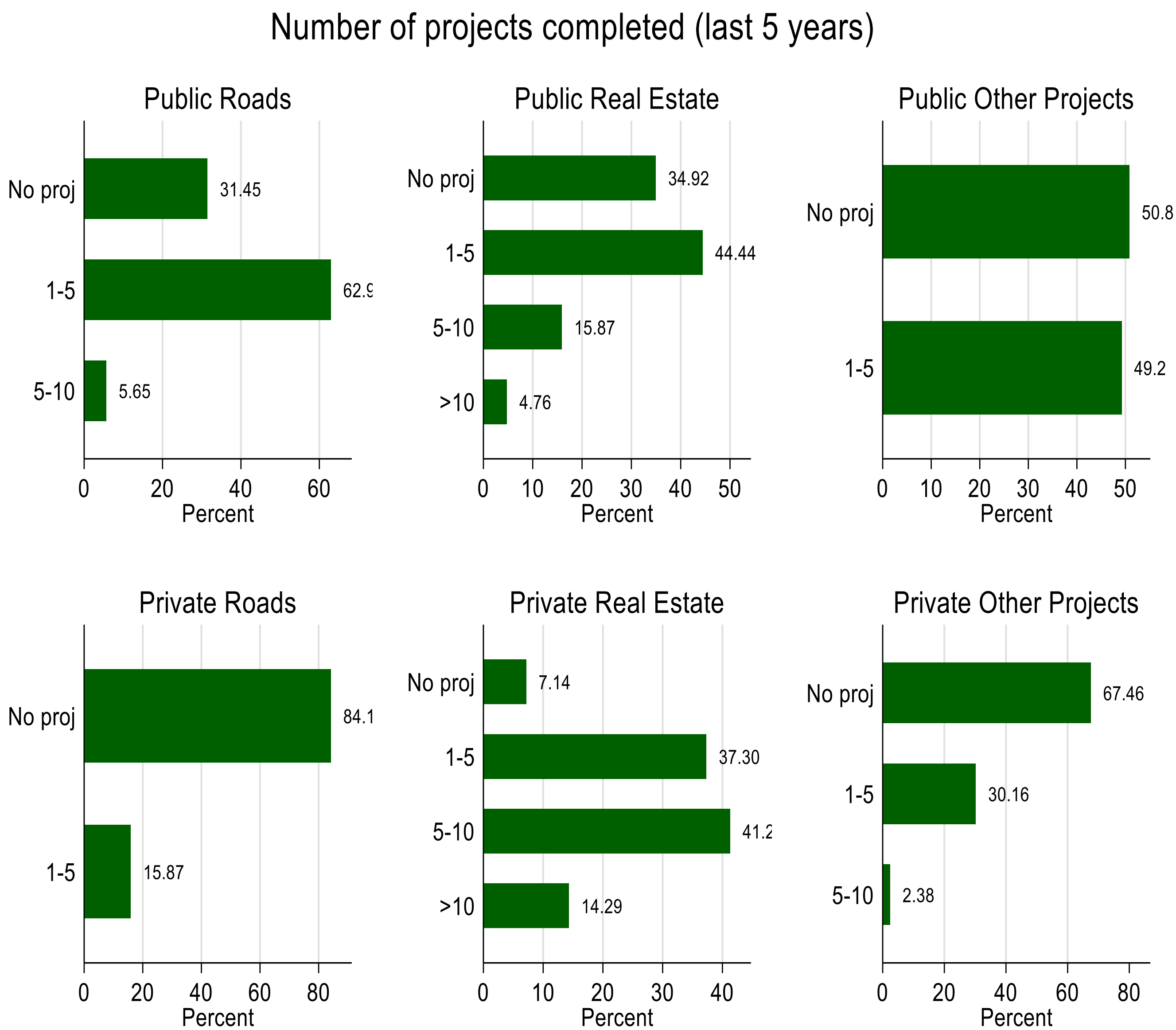

Figure 6- Number of projects completed by the enterprises over the last five years

The result of Cronbach alpha analysis on enterprises characteristic variables shows an α value of 0.834 which indicates that 83 percent of the score variances of enterprises related variables are reliable and that 17 percent are error variances.

4.3.3 PMIS use among enterprises

The respondents of the survey have also indicated the type and functions of PMIS system the construction company use to manage its projects. The types of software being used by those enterprises which have implemented a project management information system are: MS-project (31 %), Primavera (19%), ERP software (15%), Own software (17%), COMFAR (6%) and other software (12%). Figure 7 shows the percentage distribution of these types of software. The project management functions of each of the software types as used by the construction companies is indicated in the table below while the aggregate percent use of each project management function is given under Figure 8. MS-project is preferred for planning and controlling functions compared to the other types of PMIS software while Primavera has been used for most of PM functions except project formulation and appraisal. On the other hand, it seems that COMPFAR is preferred only for project formulation and appraisal function by those enterprise which indeed used PMIS for such function.

Table 2- Percentage distribution of PMIS purpose by type of software used

	PM Function	COMFAR	MS-Project	Primavera	ERP Software	Own Software	Other Software
1	Formulation and appraisal	73.7	1.0	1.6	0.0	16.9	20.0
2	Planning function	10.5	42.7	25.0	8.2	22.0	7.5
3	Controlling function	0.0	29.1	21.9	8.2	22.0	5.0
4	Reporting function	5.3	6.8	20.3	14.3	10.2	2.5
5	Monitoring function	0.0	13.6	18.8	10.2	8.5	2.5
6	Evaluating function	0.0	6.8	10.9	32.7	18.6	12.5
7	Other function	10.5	0.0	1.6	26.5	1.7	50.0
		100.00	100.00	100.00	100.00	100.00	100.00

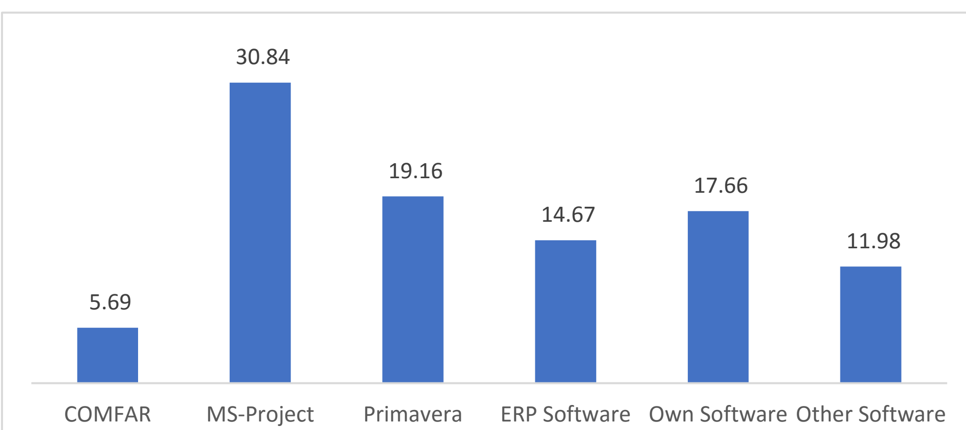

Figure 7: Types of PMIS software being used by enterprises

As shown in the figure below, the major functions of PMIS were planning functions (71%) and reporting function (60%) followed by controlling function (41%) and Monitoring function (37%) while formulation& appraisal function, and evaluation functions have been used by only 21 and 27 percent of the times respectively. On the other hand, PMIS software used for other project management functions constitute about 8.6 percent. These results indicate that in most cases, companies prefer to use PMIS for planning and reporting purposes during the initial and final stage of the project while the uses for project monitoring, controlling and evaluating purposes are very minimal.

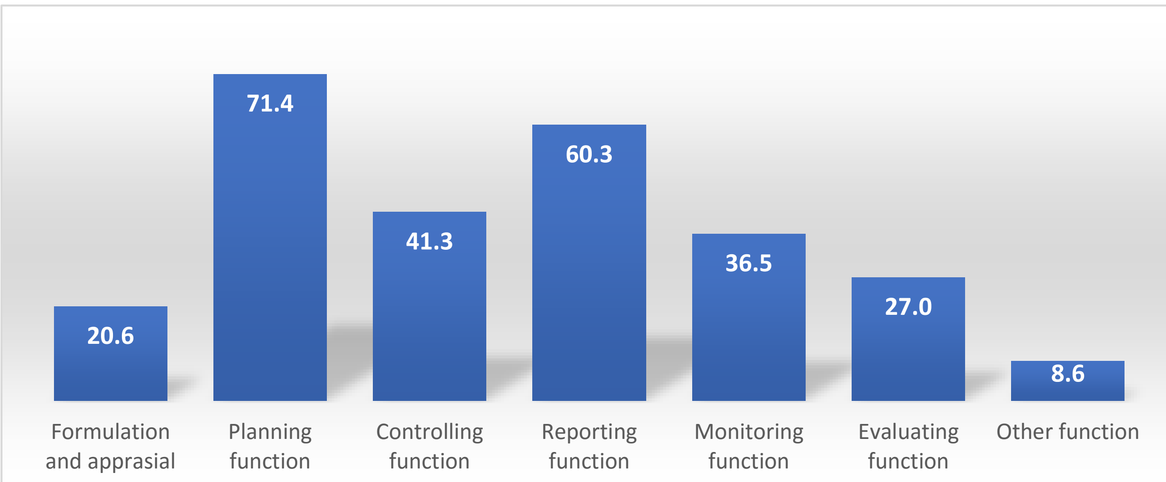

Figure 8: Percent distributions of PMIS functions among construction enterprises

4.3.4 Quality of PM software, information, use and user

Another important dimension of the study was assessment of project management information system quality which is supposed to have substantial contributions towards the impact of PMIS on performance of project. The four dimensions of quality assessed were PMIS software, information, use and user and each of these dimensions were assessed using different parameters. The summary statistics of these parameters are given under Table 3 below. For instance, the ease of use of PMIS software used by enterprises, it is found that about 0, 31, 42, 24 and 2.2 percent of the respondents has rated it as poor, fair, good, very good and excellent respectively which constitutes an average score of 3 in a 1-5 rating scale which is equivalent to 60%. Similarly, flexibility and availability of software has got an average score of 3.1 (62%) and 3.2 (64%) respectively while the score of response time and ease of learning of the software were found to be 3.5 (75%) and 3.9 (78%) respectively. In a similar fashion the parameter estimates of the remaining PMIS quality dimensions can be interpreted.

Table 3- Quality of PM software, information, use and user

PMIS Dimension	Assessment Parameters	Poor	Fair	Good	Very Good	Excellent	Mean
Quality of PMIS Software	Ease of use	0.0	31.1	42.2	24.4	2.2	3.0
	Flexibility	2.2	13.3	60.0	20.0	4.4	3.1
	Availability	4.4	11.1	42.2	40.0	2.2	3.2
	Ease of querying	0.0	6.7	42.2	42.2	8.9	3.5
	Response time	0.0	4.4	11.1	71.1	13.3	3.9
	Ease of learning	0.0	15.6	35.6	46.7	2.2	3.4
	System integration	2.2	8.9	48.9	35.6	4.4	3.3
	Multi-project capacity	2.2	11.1	48.9	24.4	13.3	3.4
	Quality of PMIS User	**Poor**	**Fair**	**Good**	**Very Good**	**Excellent**	Mean
Quality of PMIS Information	Comprehensiveness	8.9	11.1	53.3	26.7	0.0	3.0
	Accuracy	6.7	11.1	44.4	37.8	0.0	3.1
	Availability	0.0	13.3	24.4	60.0	2.2	3.5
	Relevance	0.0	6.7	44.4	44.4	4.4	3.5
	Consistency	0.0	22.2	42.2	28.9	6.7	3.2
	Reliability	2.2	20.0	57.8	17.8	2.2	3.0
	Project Formulation and appraisal	**Never**	**Rarely**	**Occasional**	**Often**	**Very often**	**Mean**
Quality of PMIS use	Need analysis	42.2	28.9	15.6	11.1	2.2	2.0
	Feasibility study	4.4	48.9	26.7	20.0	0.0	2.6
	Investment appraisal	2.2	37.8	35.6	20.0	4.4	2.9
	Project parameters	11.1	24.4	40.0	15.6	8.9	2.9
	Identification	22.2	40.0	26.7	4.4	6.7	2.3
	Planning function						0.0
	Designing project	0.0	4.4	35.6	46.7	13.3	3.7
	Resource allocation & mobilization	8.9	8.9	55.6	20.0	6.7	3.1
	Overall scheduling	0.0	0.0	13.3	48.9	37.8	4.2
	Costing & budgeting	0.0	17.8	17.8	55.6	8.9	3.6
	Quality management	11.1	31.1	37.8	20.0	0.0	2.7
	Risk planning	37.8	35.6	20.0	6.7	0.0	2.0
	Project controlling function						0.0
	Resource control	11.1	40.0	28.9	15.6	4.4	2.6
	Cost control	0.0	22.2	53.3	22.2	2.2	3.0
	Progress control	4.4	2.2	31.1	55.6	6.7	3.6
	Issues management	20.0	40.0	31.1	6.7	2.2	2.3

	Quality control	17.8	42.2	31.1	8.9	0.0	2.3
	Project reporting function						0.0
	An overview of project	13.3	6.7	33.3	44.4	2.2	3.2
	Status of project resource utilization	11.1	11.1	48.9	26.7	2.2	3.0
	Overview of budget and cost overruns	11.1	15.6	33.3	28.9	11.1	3.1
	Status of project timelines	0.0	8.9	33.3	48.9	8.9	3.6
	Status of project achievements	0.0	24.4	53.3	20.0	2.2	3.0
	Project monitoring function						0.0
	Project reports	11.1	20.0	46.7	17.8	4.4	2.8
	Project tasks	6.7	33.3	31.1	26.7	2.2	2.8
	Project schedule	8.9	15.6	13.3	42.2	20.0	3.5
	Project progress	11.4	9.1	47.7	22.7	9.1	3.1
	Project evaluating function						**0**
	Project costing	17.8	24.4	24.4	28.9	4.4	2.8
	Project schedule variance	13.3	17.8	20.0	48.9	0.0	3.0
	Utilization of project resource	24.4	15.6	33.3	20.0	6.7	2.7
	Tracking the project tasks	24.4	13.3	35.6	20.0	6.7	2.7
	Tracking project performance	24.4	17.8	35.6	17.8	4.4	2.6
		Strongly disagree	Disagree	Neutral	Agree	Strongly Agree	Mean
PMIS user	User satisfaction	4.3	25.5	36.2	34.0	0.0	3.0
	Perceived usefulness	2.1	2.1	48.9	42.6	4.3	3.4
	Perceived ease of use	2.1	6.4	40.4	36.2	14.9	3.6
	User competency	2.1	4.3	21.3	44.7	27.7	3.9
	Intention of use	2.1	2.1	44.7	48.9	2.1	3.5

4.3.5 Construction projects performance

Table 4 presents the respondents' perception about the influence of project management information system on construction projects performance with respect to meeting deadline, respecting budget and meeting quality and objectives as well as the ratings of the performances of completed projects by the respective enterprises. The majority of respondents believe that PMIS positively affects the performance of projects in all the three dimensions - 96.7% on meeting timelines, 85.2% respecting budgets and

78.7% meeting quality and objective. This implies that PMIS has a very high contribution on meeting project deadline followed by respecting budget and scope. On the other hand, respondents have also rated the overall performance of actual projects completed so far as 13.5% being bad 52.4% average and 34.1 above average with somehow significant variations among the different dimensions of projects – lowest performance being on budget preceded delivery time and quality/scope as shown in the figure shown below.

Table 4- PMIS and performances of construction projects

PMIS & project performance	Very low	Low	Moderate	High	Very high	Mean
Meeting timeline	0.0	3.3	39.3	42.6	14.8	3.7
Respecting budgets	0.0	14.8	45.9	27.9	11.5	3.4
Meeting quality and objectives	0.0	21.3	45.9	14.8	18.0	3.3
Project Performance	**Poor**	**Fair**	**Good**	**Very Good**	**Excellent**	**Mean**
Delivery time	6.3	30.2	27.0	27.0	9.5	3.0
Budget/Cost	9.5	31.7	37.3	16.7	4.8	2.8
Quality/Scope	0.8	11.1	40.5	38.1	9.5	3.4
Overall project performance	0.8	12.7	52.4	34.1	0.0	3.2

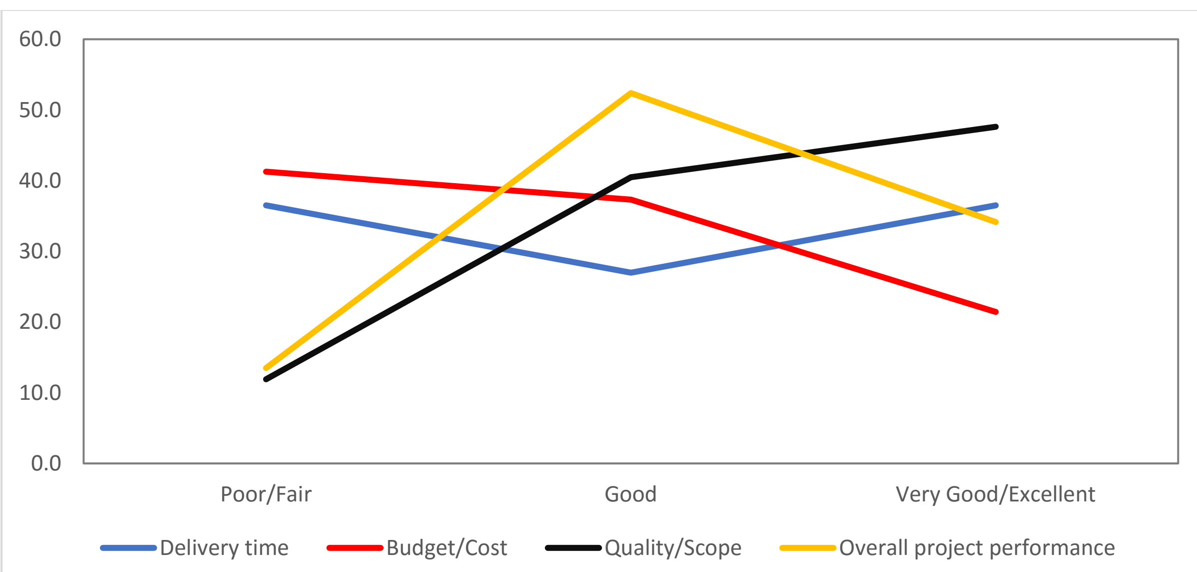

Figure 9- Rating of construction projects' performance as rated by respondents

4.4 Bivariate analysis result

The following section presents the results of bivariate analysis which focuses on the analysis of the relationship between the various determinant variables and project performance as measured by project delivery time, budget utilization, quality of product or overall project performance. The variables of the study were selected based on the conceptual and theoretical framework discussed in the second chapter. Dummy variables were first produced for the categorical variables and the mean of the respective dummies were computed to produce the results shown under Table 5 computing the mean. ANOVA tests were used to compare the means of each variable vary across the project performance ratings under the respective project performance ratings. It can be noted that project management information system uses as well as quality of PMIS software, information, use and user have all statistically significant association with project delivery time, budget/cost, quality/scope and overall project performance. However, some of the exogenous study variable are not significantly related with the performance of certain project dimension. This can be observed by looking at the p-value columns in the table below.

Table 5- Results of bivariate analysis of the independent variables and project performance

	Delivery time						Budget/Cost						Quality/Scope						Overall project performance						
Study Variables	Poor	Fair	Good	V. Good	Excellent	Sig.	Poor	Fair	Good	V. Good	Excellent	Sig.	Poor	Fair	Good	V. Good	Excellent	Sig.	Poor	Fair	Good	V. Good	Excellent	Sig.	Total
Use PMIS	0.50	0.37	0.76	1.00	1.00	***	0.17	0.65	0.76	0.95	1.00	***	0.00	0.14	0.55	1.00	1.00	***	0.00	0.13	0.68	1.00	1.00	***	0.71
Grade	6.3	5.6	5.1	4.8	3.9	*	5.2	6.2	5.2	3.7	2.7	***	9.0	5.3	5.0	5.5	3.8	*	7.0	5.8	5.4	4.5	4.0	*	5.1
Total Capital Expenditure	65	430	172	448	1060	***	233	170	593	444	667	**	65	594	317	405	548		35	535	228	598	1033	***	402
Number of Employees	59	168	170	431	763	***	128	179	266	491	780	***	100	91	199	363	602	***	80	81	199	499	650	***	289
Enterprise Age	10.5	14.4	11.8	16.1	20.7	***	3.25	10.5	15.7	17.9	19.0	***	6.00	15.14	14.51	13.60	17.77	*	11.0	14.6	13.2	16.5	19.0	***	14.51
Gender (Female)	0.00	0.37	0.18	0.29	0.50	*	0.42	0.28	0.24	0.32	0.33		1.00	0.29	0.14	0.45	0.23	**	0.00	0.38	0.18	0.43	0.33	**	0.29
Age (31-40)	0.25	0.32	0.18	0.24	0.67	**	0.25	0.20	0.33	0.36	0.33		1.00	0.29	0.25	0.26	0.46	*	0.00	0.38	0.23	0.35	0.33		0.29
Age (41-50)	0.25	0.32	0.35	0.24	0.00	*	0.25	0.38	0.22	0.18	0.33		0.00	0.29	0.27	0.30	0.15		0.00	0.44	0.32	0.13	0.33	*	0.27
Age (> 50)	0.00	0.16	0.06	0.06	0.00		0.00	0.05	0.17	0.00	0.00	**	0.00	0.14	0.12	0.04	0.00		0.00	0.00	0.12	0.05	0.00		0.08
Education (BA/BSc)	0.75	0.32	0.41	0.47	0.50	*	0.67	0.45	0.33	0.50	0.33	*	1.00	0.29	0.45	0.45	0.38		1.00	0.31	0.41	0.48	0.67	*	0.43
Education (Diploma/TVET)	0.25	0.32	0.35	0.12	0.17	*	0.25	0.35	0.26	0.14	0.00	*	0.00	0.43	0.31	0.17	0.15	*	0.00	0.44	0.32	0.10	0.00	**	0.25
Education (HS and below)	0.00	0.11	0.00	0.00	0.00	*	0.00	0.05	0.04	0.00	0.00		0.00	0.00	0.08	0.00	0.00	*	0.00	0.00	0.06	0.00	0.00		0.03
Position (Functional Manager)	0.25	0.21	0.24	0.12	0.33		0.08	0.33	0.13	0.27	0.00	**	0.00	0.29	0.27	0.13	0.15		0.00	0.25	0.24	0.15	0.00		0.21
Position (Project Manager)	0.00	0.11	0.24	0.41	0.17	**	0.00	0.10	0.33	0.32	0.33	***	0.00	0.00	0.16	0.28	0.54	**	0.00	0.00	0.15	0.40	0.67	***	0.22
Position (Supervisor)	0.25	0.37	0.35	0.00	0.00	***	0.25	0.33	0.24	0.05	0.00	*	0.00	0.29	0.27	0.21	0.00	*	0.00	0.44	0.32	0.00	0.00	***	0.22
Position (Other)	0.50	0.05	0.12	0.12	0.17	***	0.17	0.20	0.09	0.09	0.00		0.00	0.43	0.04	0.17	0.00	***	1.00	0.19	0.11	0.13	0.00	*	0.13
Experience in the firm	1.50	4.81	4.82	6.47	7.50	***	1.90	4.40	6.30	5.45	10.00	***	2.00	2.64	5.69	5.19	7.38	***	1.00	2.75	5.34	6.11	9.00	**	5.31
PMIS - Software	3.31	3.13	2.99	3.61	3.60	***	3.25	3.09	3.36	3.48	3.88	***	.	3.00	3.12	3.37	3.79	***	.	3.38	3.12	3.56	3.83	***	3.34
PMIS - Information	2.75	2.86	3.06	3.33	3.75	***	2.33	3.00	3.18	3.40	3.94	***	.	3.33	3.08	3.21	3.47	*	.	3.17	3.00	3.42	3.61	***	3.21
PMIS - Use	1.75	2.51	2.62	3.15	3.79	***	1.73	2.35	2.95	3.39	4.02	***	.	2.50	2.68	2.86	3.72	****	.	1.77	2.64	3.24	3.69	***	2.92
PMIS-User	3.10	3.51	3.03	3.71	4.03	***	3.00	2.96	3.67	3.74	3.80	***	.	3.20	3.23	3.57	3.80	**	.	3.20	3.21	3.82	3.47	***	3.48

, **, *** statistically significant at 90, 95 and 99 percent.

4.5 Potential determinants of PMIS use

In further assessing the practice of project management information system among construction enterprises, it is important to carry out an evaluation of how the use of PMIS is significantly related to different potential determinants. For this purpose, certain respondent and enterprise level characteristics were selected and a standard t-test was carried out to see whether there is a significant difference between those which are using PMIS and those which are not using. The results of this analysis are given in the table below. For each of the variables, the respective mean values under each group, that is PMIS using and not using, are given together with the corresponding p-value for testing the existence of significant difference in the means. In most cases, there is a significant difference between the two groups which indicates that these variables potential determinants of PMIS use. In the next section we will present the results of regression of project performance on PMIS use where these variables are used as control variables.

Table 6- Determinants of PMIS use among construction companies

Characteristic Variable	Mean of using group	Mean of not-using group	P-Value	Sig.
Grade	5.01	5.44	0.381	
Total Capital Expenditure	446.52	291.11	0.076	*
Number of Employees	354.62	125.00	0.000	***
Enterprise Age	15.07	13.11	0.021	**
Number of projects completed	47.94	34.69	0.049	**
Number of projects under construction	9.87	7.56	0.010	**
Gender (Female)	0.31	0.21	0.092	*
Age (31-40)	0.31	0.23	0.322	
Age (41-50)	0.24	0.33	0.314	
Age (> 50)	0.07	0.14	0.084	*
Education (BA/BSc)	0.47	0.33	0.175	
Education (Diploma/TVET)	0.22	0.33	0.199	
Education (HS and below)	0.00	0.11	0.001	***
Position (Functional Manager)	0.16	0.33	0.026	**
Position (Project Manager)	0.31	0.00	0.000	***
Position (Supervisor)	0.18	0.33	0.059	*
Position (Other)	0.13	0.11	0.738	
Experience in the firm	5.70	4.33	0.086	*

4.6 Ordinal logit model results of project performance

The next most important results belong to the regression results of project performance and project management information system which addresses the question of how the use and quality of project management information system has on project performance in the Ethiopian construction sector. The modeling was done using ordinal regression model which consist of two sets of regressions: one for the relationship between project management information system use alone and project performance and one for the quality of project management information system and project performance. Project performance could be expressed in terms of project delivery time, budget/cost or quality/scope and overall project performance encompassing all the three dimensions. Stata 16 was used to fit the ordinal regression models in all cases.

The result of Cronbach alpha analysis on project performance variables shows an α value of 0.8768 which indicates that about 88 percent of the score variances of these variables are reliable and that 11percent are error variance.

4.6.1 PMIS use and project performance

The first set of regression results are the modeling project performance on PMIS use and other control variables which could be at respondent or enterprise characteristics. The table below shows the four regression results: Delivery time, Budget/Cost, Quality/Scope and Overall project performance. For each of the independent variables, the table consists of estimated coefficients, standard errors and whether the regressors are significant or not at 5 %, 1 % and 0.1% significant levels.

PMIS use is found to be significant in all the four regressions although the level of significance is much stronger. This and the positive coefficients imply that there are clear project performance differences between enterprises who make use PMIS and those which have never used any PMIS. If we look at the magnitude of the coefficients, the use of PMIS has better increased the performances of construction projects in terms of quality than delivery time or budget utilization while the overall project performance is somehow an average. More specifically, enterprises which implemented PMIS in their organizations have 0.617 increase on log odds of being a higher level of project performance in terms of delivery time while they can also get a 0.714 increase on log odds of budget project performance. Similarly, the log odds increase in terms of quality and overall project performance are 3.54 and 2.144 respectively.

Most of the covariates included in the regression models are also significant at different levels. Among enterprise level characteristics, grade of the enterprise, number of employees and number of projects completed are significant while total capital expenditure, the age of the enterprise in operation and number of projects under construction are mostly insignificant. On the other hand, age of the respondent, education level, and position of the respondent in the enterprise are mostly significantly related the performance of projects while gender and years of experience within the enterprise are mostly not significant.

Table 7- Regression results of project performance and PMIS use

Independent Variables	**Delivery time performance**	**Budget/Cost performance**	**Quality/Scope performance**	**Overall project performance**
PMIS use	0.617*	0.714*	3.540***	2.144***
	(1.98)	(2.35)	(7.36)	(5.29)
Grade	-0.128*	-0.111*	0.102*	-0.106*
	(-2.43)	(-2.29)	(2.01)	(-1.91)
Total Capital Expenditure	-0.000352	-0.000541	-0.000920*	-0.00000312
	(-1.24)	(-1.95)	(-2.31)	(-0.01)
Number of Employees	0.00450***	0.000465	0.00183**	0.00215**
	(5.46)	(0.90)	(2.83)	(3.16)
Enterprise Age	-0.00320	-0.00352	0.00851	0.00732
	(-0.40)	(-0.41)	(0.94)	(0.84)
Number of projects completed	-0.0744*	0.162***	0.155**	0.0462**
	(-1.62)	(3.86)	(2.76)	(0.96)
Number of projects under construction	0.483*	0.227	-0.371	-0.156
	(2.14)	(1.02)	(-1.63)	(-0.56)
Gender (Female)	0.930*	0.257	0.139	0.335
	(2.36)	(0.76)	(0.36)	(0.87)
Age (31-40)	-0.846**	-0.366	-0.500	-0.859*
	(-2.65)	(-1.07)	(-1.20)	(-2.48)
Age (41-50)	-2.623***	-1.246**	-0.798	-1.598***
	(-6.59)	(-2.84)	(-1.59)	(-3.40)
Age (> 50)	-2.820***	-0.574	-2.952***	-1.106*
	(-4.75)	(-1.17)	(-4.36)	(-2.19)
Education (BA/BSc)	-0.558*	-0.743*	-1.595***	-0.606
	(-1.96)	(-2.03)	(-3.43)	(-1.72)
Education (Diploma/TVET)	1.593***	0.349	-1.224*	0.439
	(3.62)	(0.82)	(-2.39)	(1.05)
Education (HS and below)	-1.284	-0.117	3.085***	1.099

	(-1.51)	(-0.19)	(4.09)	(1.56)
Position (Functional Manager)	0.995**	0.516	0.740	-0.161
	(2.84)	(1.12)	(1.65)	(-0.37)
Position (Project Manager)	0.550	0.922*	1.697***	1.055*
	(1.45)	(2.33)	(3.53)	(2.42)
Position (Supervisor)	-0.824*	0.0252	1.586**	-0.912*
	(-2.04)	(0.06)	(3.22)	(-2.25)
Position (Other)	0.235	0.149	0.281	-0.562
	(0.47)	(0.30)	(0.58)	(-0.97)
Experience in the firm	0.178***	0.0900*	-0.0317	0.0543
	(3.89)	(2.46)	(-0.71)	(1.18)
/				
cut1	-0.855	0.0682	-1.937	-3.303**
	(-1.02)	(0.08)	(-1.92)	(-2.90)
cut2	1.129	1.628*	-0.111	-1.340
	(1.40)	(1.97)	(-0.12)	(-1.37)
cut3	2.511**	3.298***	3.583***	2.262*
	(3.19)	(4.06)	(3.69)	(2.46)
cut4	4.907***	5.040***	5.980***	5.379***
	(6.23)	(6.35)	(5.49)	(5.12)
N	126	126	126	126

T-statistics in parentheses; * p<0.05, ** p<0.01, *** p<0.001

4.6.2 PMIS Quality and Project Performance

The next set of regressions attempt to model the relationship between construction project performance and quality of project management information system software used, information generated, use and user of the software. Like the first set of regression, four different ordinal logistic regression models were fitted for delivery time performance, budget/cost utilization performance, quality/scope of project and overall project performance. The measurements of system software, quality information, PMIS use and user are just the averages of the rating on the different characteristic of each of the dimension of PMIS quality. In the regression models, these variables are used as continuous outcomes despite the limitations.

From the regression results one can observe that system software has strong positive impact on project delivery time performance followed by project quality performance while the impact on budget is insignificant. The log of odds of project delivery time and quality performance increases by 3.67 and 1.58 due to the characteristics of system software utilized by enterprises. Somewhat similar results are observed for the impact of quality information on performances with log of odds values 2.66 and 0.97 respectively for delivery time and scope. PMIS use has strong and positively significant impact on budget utilization and scope performance while PMIS user has significant impact on delivery time and quality although the level of significance looks weak. The logs of odds of project performance in terms of budget and scope due to PMIS user are 1.25 and 1.35 whereas for PMIS user the logs of odds on delivery time and scope are 1.39 and 0.12 respectively. Note that system software, quality information and PMIS user has no significant impact on budget/cost performance and PMIS use has insignificant effect on delivery time. However, all the four dimensions have some positive and significant impact on the overall project performances with logs of odds of 6.12, 2.78, 0.52 and 0.76 respectively for system software, quality information PMIS use and PMIS user.

The respondent and enterprise characteristics which were included in the regression models as control variables can similarly be interpreted. Most of the results have similar interpretation as the first set of regressions given above.

Table 8- Regression results of project performance and PMIS quality

Independent Variables	**Delivery time performance**	**Budget/Cost performance**	**Quality/Scope performance**	**Overall project performance**
System Software	3.661***	0.650	1.576**	6.131**
	(4.04)	(1.36)	(2.12)	(2.67)
Quality Information	2.659***	0.367	0.974*	2.785*
	(4.31)	(0.71)	(1.20)	(2.36)
PMIS Use	0.259	1.247***	1.349**	0.520*
	(0.59)	(3.47)	(2.87)	(0.60)
PMIS User	1.378*	0.535	0.118*	0.758*
	(2.40)	(1.24)	(1.22)	(1.14)
Grade	-0.140*	-0.210*	0.235**	-0.358**
	(-2.52)	(-2.49)	(3.13)	(-2.65)
Total Capital Expenditure	-0.00127	-0.000115	0.0000387	0.00352*
	(-1.89)	(-0.22)	(0.07)	(2.46)
Number of Employees	0.00233	-0.00381***	0.000245	-0.00410
	(1.41)	(-3.82)	(0.20)	(-1.59)
Enterprise Age	0.0673**	0.0384**	0.00849	0.115*
	(3.18)	(2.98)	(0.60)	(2.00)

Number of projects completed	-0.155*	0.122*	0.228**	0.0276
	(-2.01)	(2.07)	(2.64)	(0.18)
Number of projects under construction	1.497***	0.476	-0.789**	-0.391
	(3.77)	(1.52)	(-2.92)	(-1.00)
Gender (Female)	0.931	0.458	0.723	0.885
	(1.20)	(0.76)	(1.09)	(0.98)
Age (31-40)	-1.635**	0.340	-0.558	-3.140*
	(-2.81)	(0.64)	(-0.90)	(-2.26)
Age (41-50)	-7.505***	0.115	-0.451	-5.413**
	(-7.28)	(0.17)	(-0.56)	(-2.69)
Age (> 50)	-7.119***	1.607	-3.783***	-0.375
	(-6.93)	(1.88)	(-4.14)	(-0.27)
Education (BA/BSc)	0.609	-0.321	-3.196***	-3.424*
	(1.48)	(-0.64)	(-4.97)	(-1.96)
Education (Diploma/TVET)	4.122***	-1.097	-3.128**	-7.175
	(3.36)	(-1.45)	(-3.23)	(-1.82)
Education (HS and below)	5.542***	-2.267	-2.281**	-4.571
	(2.36)	(-1.64)	(-2.32)	(-2.28)
Position (Functional Manager)	1.871**	0.816	3.497***	5.253*
	(2.60)	(1.21)	(4.82)	(1.99)
Position (Project Manager)	2.433***	1.220*	3.951***	8.538**
	(4.49)	(2.18)	(5.51)	(2.73)
Position (Supervisor)	-2.572	0.534	5.003***	-2.338
	(-1.91)	(0.75)	(5.12)	(-1.40)
Position (Other)	3.668***	-0.599	2.851***	6.582*
	(4.85)	(-0.99)	(4.10)	(2.37)
Experience in the firm	0.207	-0.178**	-0.161*	-0.192
	(1.90)	(-3.26)	(-2.36)	(-1.38)
N	90	90	90	90

T-statistics in parentheses; * p<0.05, ** p<0.01, *** p<0.001

4.6.3 Predicted project performance and marginal probabilities

The following graphs demonstrate the predicted construction project performance calculated based on the respective models using the survey data collected. Each of the graph indicated what percent of the projects are completed in excellent, very good, good, fair and poor conditions after introducing the effect of project management information system and controlling for the effect of respondent and enterprise level characteristics. For instance, 4.5, 15.5, 29, 38, and 13.3 percent of the delivery time performance of the projects were poor, fair, good, very good and excellent while in terms of cost, these the performances were 2, 29, 39, 23 and 7 percent respectively.

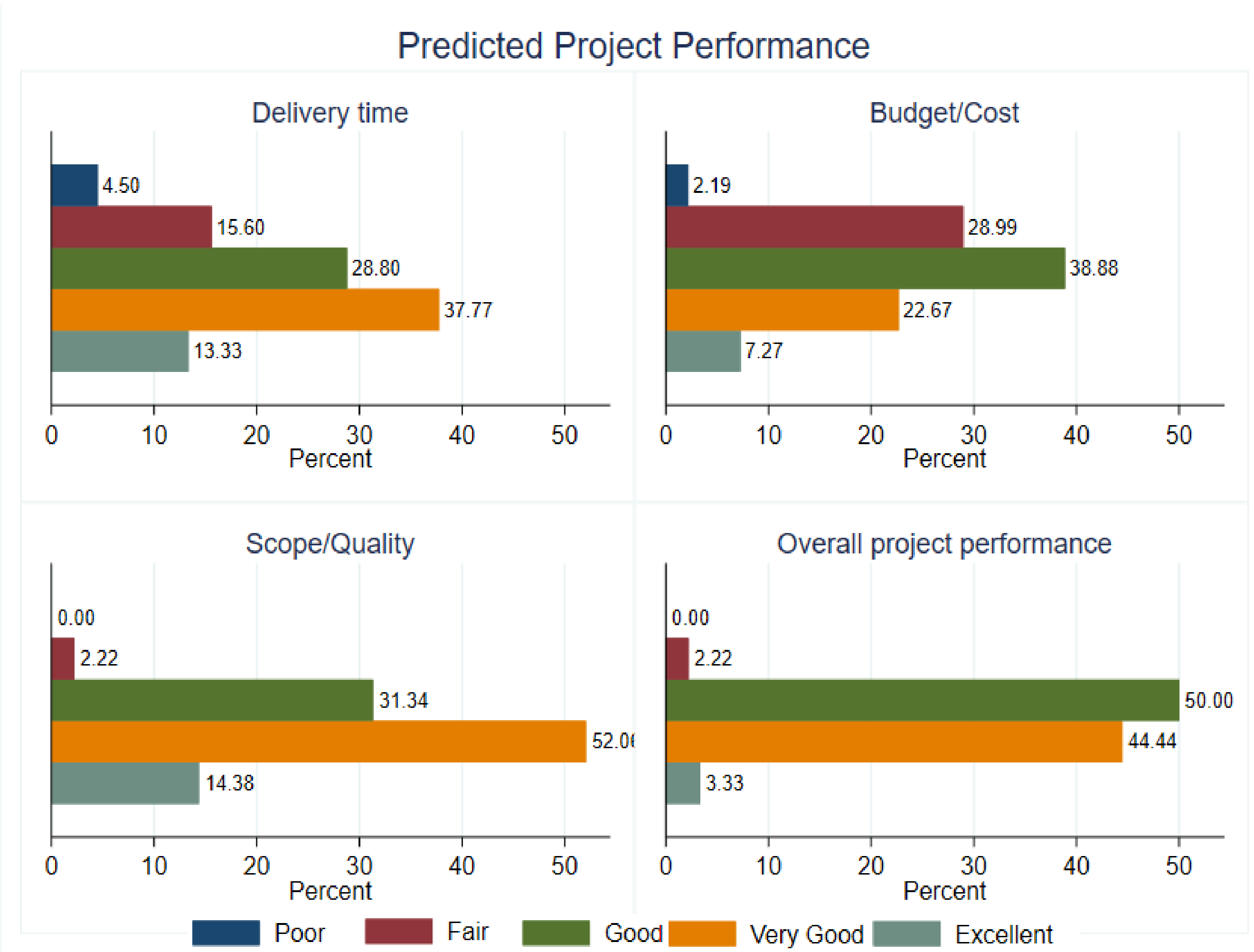

Figure 10- Predicted project performances

The marginal probabilities presented in the next figure illustrates how the probabilities of the performances of the construction projects being poor/fair, good, and very good/excellent behave by considering the average values of all the independent variables included in the model. It is clearly indicated quality/scope has a higher marginal probability followed by delivery time and cost/budget while the marginal effect of overall project performance lies in the middle.

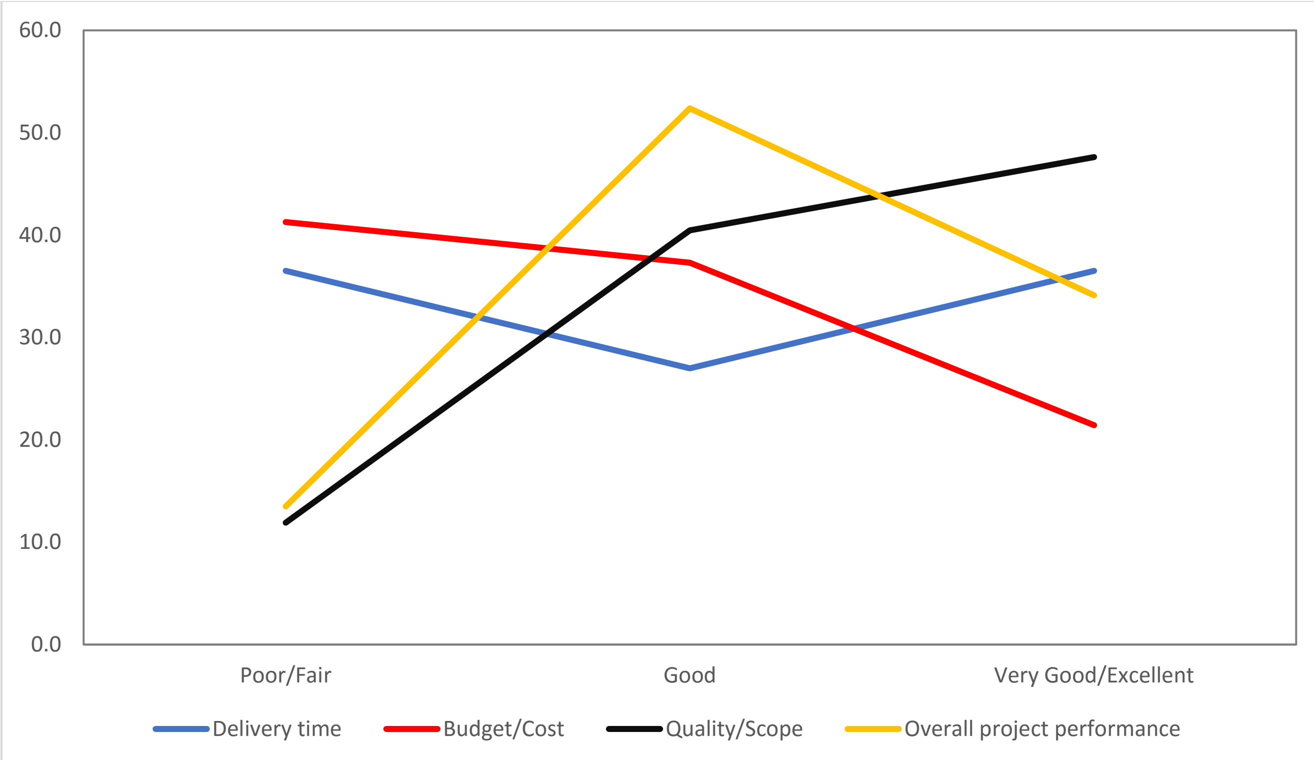

Figure 11- Marginal probabilities

4.6.4 Proportional odds assumption and other model diagnostic tests

The chi-squared score test for the proportional odds assumption was employed to check whether the main assumption of ordinal logit model is satisfied or not. The results of the multiple ordinal logit models are presented and discussed above while the test of proportional odds assumption to each of the respective models is given in the table below. The Stata command 'brant, detail' was used to produce the results in the table. The score test of the proportional odds assumption is found insignificant at 5% level of significance indicating the data all regression models fitted satisfy the proportional odds assumption. The test results reveal that all the variables (p-value > 0.005) were found insignificant i.e., satisfy the proportional odds assumption. These imply that all the analysis under consideration are according to the correct functional form and the results of the models are valid.

Table 9 - Tests of proportional odds assumptions

Regression variables	Test statistic	Delivery time performance	Budget/Cost performance	Quality/Scope performance	Overall project performance
All main variables	Chi2	8.674	9.021	8.261	8.327
	P-value	0.193	0.186	0.184	0.185
PMIS Software	Chi2	1.781	1.852	1.696	1.710
	P-value	0.618	0.643	0.589	0.593
PMIS Information	Chi2	4.205	4.373	4.005	4.037
	P-value	0.242	0.252	0.230	0.232
PMIS Use	Chi2	2.712	2.820	2.583	2.604
	P-value	0.438	0.456	0.417	0.420
PMIS User	Chi2	2.713	2.822	2.584	2.604
	P-value	0.438	0.456	0.417	0.420

To determine whether the fitted models adequately described the observed outcomes, various model diagnostic tests were performed. The main purposes of these tests are to check for any model specification error or violations of assumptions occurred in fitting the models and evaluate the goodness-of-fit of the models fitted. The model diagnostic statistics and tests provided in the table below demonstrate that the ordinal logit models are adequate enough and there are no any violations of assumptions.

Table 10 - Goodness-of-fit and other model diagnostic statistics

Goodness-of-fit statistics	Delivery time performance	Budget/Cost performance	Quality/Scope performance	Overall project performance
Log-likelihood				
Model	-36.000	-54.758	-46.410	-24.491
Intercept-only	-128.065	-119.763	-95.994	-81.446
Chi-square				
Deviance(df=65)	71.999	109.516	92.820	48.982
Wald(df=21)	130.520	191.965	110.478	407.482
p-value	0.000	0.000	0.000	0.000
R2				
McFadden	0.719	0.543	0.517	0.699
McFadden(adjusted)	0.524	0.334	0.267	0.405

McKelvey & Zavoina	0.963	0.854	0.854	0.983
Cox-Snell/ML	0.871	0.764	0.668	0.718
Cragg-Uhler/Nagelkerke	0.924	0.822	0.757	0.858
Count	0.800	0.678	0.756	0.900
Count(adjusted)	0.679	0.473	0.488	0.800
IC				
AIC	121.999	159.516	140.820	96.982
AIC divided by N	1.356	1.772	1.565	1.078
BIC (df=25)	184.494	222.011	200.815	156.978
Hosmer & Lemeshow GOF test				
Chi-square	9.150	7.264	5.490	8.717
p-value	0.330	0.532	0.396	0.271
Link test				
z-value	-1.31	-1.37	-1.7292	-1.918
p-value	0.191	0.171	0.1337	0.08892

4.7 Discussion of results

The system software desirable characteristics of availability, time of response, flexibility, how easy it is to use, how easy it is to query, how easy it is to learning, the ease of intergrating it with other systems and if it is capable of carrying out multiple projects was integral to the production of quality information.

The quality of the IS system employed by an organization has an effect on the quality of the information provided by the system and the entire organization. If the PMIS system used is of high quality then the information that it produces is of high quality leading to the users increased perception of its usefulness, an increase in the satisfaction of the decision makers and an increase in the ability of the upper management to make good decisions. There is a strong direct correlation between the quality of the information generated by a PMIS system with the usage of the system and its effects on the project manager. The quality of the information generated is not a result in itself but has an indirect effect on the performance of the project (DeLone and McLean, 1992).

From the findings, the respondents rated high PMIS tool for project tasks with mean of 5.000 and standard deviation of 0.000. Also the respondents rated high accuracy of the output information with mean of 4.833 and standard deviation of 0.408 on the quality of PMIS information output. Additionally, respondents also rated moderately utilization of PMIS tools for project progress, costing and reporting with the mean 4.800.

However, most of the respondents had rated lowly on the use of planning tool in designing project , costing and budget and resource allocation and mobilization mean 2.500 each and standard deviation of 0.547, 0.547 and 1.048 respectively. This is majorly contributed by the fact that the national government, county government or agency awarding the contractor has developed project budgets, tasks and timelines to be followed by the contractor.

On average, the system software was rated well with mean average of 4.05. This translated that the implementation of PMIS (Project management information system) plays a significant role in the performance of construction tasks. In general, it was observed that the Project Management Information System has an integral function in generating the information requisite for the overall project implementation process.

4.7.1 PMI S Software and project performance

From the findings, the respondents' rated high availability of the system with mean value of 4.000 and standard deviation value of 0.534. Most of the respondents acknowledge that the system availability was always guaranteed though concerns were raised on its susceptibility to various attacks or vulnerabilities associated with online systems.

However, most of the respondents noted that the standalone systems were unable to perform multi-project capacity which was rated low with a mean value of 2.625 and standard deviation value of 0.517. On average, the respondents rated the ease of querying, response time, ease of learning and system integration with a mean value of 3.375 and standard deviation value of 0.517 respectively.

In general, the respondents thought that the system play an integral function in the performance of their tasks. The system helped in tracking of the information required to monitor these projects progress and retrieve key baseline project information for project evaluation. These findings are supported by the studies done earlier indicating that conventional project management systems give textual, graphical and network schedule outputs for the purpose of project control and decision making (Ali and Money, 2005).

4.7.2 PMIS Quality of Information and project performance

From the results, the respondents rated accuracy of the output information generated by the software as the highest with mean value of 4.833 and standard deviation value of 0.408. This informed the fact that the output information was easily accessible and suitable for project activities. However, most of the respondents noted that comprehensiveness of the information was low with mean value of 3.500 and standard deviation value of 0.547. This is as a result of the low magnitude of projects been undertaken and also the fact that systems deployed were not sophisticated but common project management information systems in the market.

On average, the respondents rated the availability, relevance, consistency and reliability of the information. In general, the respondents' felt that the accessibility of quality information assisted in decision making and tasks that were essential in the efficient management of project processes. This research projects finding concurs with the assertion that there is a strong relationship between the quality of the information generated by a PMIS and the technological and support service features of the system which is a good indicator of the quality of the system. The assertion that there is a strong correlation between the quality of the information produced and the quality of the system (Grla et al., 2010).

4.7.3 PMSI Project Management Information System Use and project performance

From the results the use of formulation and appraisal, planning function, controlling function, monitoring function, evaluating function and reporting function tools were found to be an integral part of project process management. It assisted the project managers to ameliorate their execution of various project activities and their overall project performance.

These findings are collaborated by the studies done by (Ali and Money, 2005) whose study established that there is as strong correlation between the the usage of PMIS by project managers and their decision-making styles. These studies found that the usage of the information generated by PMIS by project managers was a determined by the level of usage of the PMIS tools that plan, monitor, control, evaluate and report on the project.

Tools that were rated high in accomplish project process included: feasibility study, risk planning, cost control, overview of project implementation status, project tasks and utilization of project resources. Those tools that were rated lowly were: need analysis, project parameter identification, designing project, costing, budget and resource allocation, mobilization, issues management, status of project timelines, project scheduling and lastly project costing.

4.7.4 PMIS User and project performance in the construction industry

From the results, the respondents' rated moderately the perceived usefulness of the system with mean value of 4.400 and standard deviation value of 0.547. It was based on the fact the project management system provided an improved manner of managing project processes. This led to improved decision making as a result of quality information that facilitates decision making being available promptly.

These findings concur with the studies which found that system should be good and user friendly considering the how easy it is to modify the data and generate reports, the printout quality produced, the screen consistency and how much learning a user has to do in order to be able to operate the system (Liberatore and Pollack-Johnson, 2003).

The other PMIS aspects of user satisfaction, perception of ease of use, user competency and purpose of usage were rated low. User competency and intention to utilize the system was found to be important in achieving the intended project objectives. These findings also concur with the studies which affirm that when a manager increases their competence then they are able to utilize the knowledge available to them to manage their projects effectively and efficiently (Light et al., 2005).

Chapter Five

5. Conclusion and recommendation

5.1 Summary of findings

The study has first attempted to examine the practice of project information management system among public and private construction projects in Ethiopia. It has shown that, based on the survey results, about 71% of construction enterprises use project management information system for at least one purpose. The use of PMIS for the different project functions include 20.6% for project formulation and appraisal function; 71% for planning function; 60% for reporting function and 27 purpose for evaluating function.

The assessment of the quality of project management information system software, information, use and user indicated that there are several problems regarding quality unlike the reasonable degree of PMIS use in general. Several parameters were used to determine an estimate of the quality of these PMIS dimensions. The average quality of PMIS software, information, use and user were estimated to be about 67%, 64%, 54% and 69% respectively based on the rating of the different parameters.

Regarding how the performance of projects influenced by the use of PMIS, 74, 68 and 66 percent of the survey respondents respectively indicated that by implementing the right PMIS, performance of projects with respect to meeting timeline, respecting budget and meeting quality objective could be increased reasonably.

To investigate the influence of quality of PMIS information, use and user on the performance of construction project, ordinal logistic regression models were used for each dimensions of project performance (meeting deadline, budget, scope and overall project performance), which helped us produced interesting results.

The study also finds out that the use of project management information system as well as the quality of PMIS software, information, use and user have all statistically significant association with project delivery time, budget/cost, quality/scope and overall project performance. Both the results of bivariate and multivariate analysis depict that PMIS has greater impact on project delivery time performance followed by project quality and budget. The ordinal regression results showed that PMIS quality have some positive and significant impact on the overall project performances with logs of odds of 6.12, 2.78, 0.52 and 0.76 respectively for system software, quality information PMIS use and PMIS user.

5.2 Conclusions

This research study primarily aimed to analyze the impact of implementating Project Management Information System (PMIS) on project performance in the construction sector of Ethiopia. For that purpose target population were identified and necessary data were collected using appropriating survey methodologies. The main types of data collecte focused on whether the selected construction company is using anyproject management system, the characteristics of the system being used including the quality of the system with respect to software, data, use and user. In addition, data related to the performance of projects acomplished by the enterprises over the last five years as well as information regarding the characteristics of the respondents and enterprises were collected. The collected data were cleaned and descriptive and inferential analysis were carried on using Stata software packages. To analyze the impact of PMIS on project performance, ordinal logistic regressions were fitted using the ratings of project performances in terms of delivery time, cost/budget, scope and overall project performances as dependent variables while the quality of PMIS software, information, use and user as the main explanatory variables while the characteristics of respondents and enterprises were included in the regression as control variables. On the other had, in order to understand the determinants of PMIS use, we have fitted a binary logit model using PMIS use as dependent variable. The study has come up with important finding as indicated in the above section. However, despite the limitations of the study as described below, the following conclusion can be derived based on the results obtained from the descriptive inferential analysis conducted in the study.

- Despite the limitations, it can be concluded that a reasonable number of construction enterprises in Ethiopia have implmented some sort of project management information system in order to manage different types of project functions.
- Among those enterprises which are using PMIS, the main project fuctions are project planning follwed by reporting functions while the use of PMIS for project formulation and appraisal as well as evalting functions is very limited.
- The main types of PMIS software used by the enterprises is MS-Project followed by Primavera while there are aslo companies which use software developed or customized by the companies

or use ERP (enerprise resource planning) sotware which primarly developed for other management functions.

- The use of PMIS in the construction companies is affected by the follwing factors: grade of the enterprise, number of employees, number of projects projects under construction, age of the enterprise in the business. On the other hand, the amount of capital expenditure is not a determinant of PMIS use.
- This study has found that the usage of PMIS was imperative to most project managers and supervisors and construction functional managers at the study found that there is a need for continuous updating and challenging of PMIS success models. In addition, they have the understanding of the positive influences of PMIS on project perfromance.
- Implementation of PMIS has significant impact on the performance of construction projects in general having a positive impact on all project dimesnions such as delivery time, budget/cost, and quality/scope despite the fact that the impact is much higher for project delivery time than other project dimesions. Therfore, we can safely conclude that using PMIS to manage construction projects significanlty improves their performances irrespective of the type of system, software or quality.
- The quality of PMIS software, information, use and user are also very important in analyzing the impact of PMIS on performance of projects which implies that in line with introducing PMIS in a construction company, proper emphasis should be given regarding, for example, the choice of software, nature of the information generated, the way the system is used as well as the competencies of the users of the system.
- From the research study, it was also noted that the ability of the system user to use the system in their project management activities is more important than having a complex system. It means that the usage of PMIS has a substantial impact to the overall project performance.

5.3 Recommendations

The major recommendations coming out from this research include

- Implementation of project management information system has undoubtly positive impact on the performance of construction projects in Ethiopia. Hence, utilizing any kind of information system is recommended.
- Enterprise should understand the meaning and impacts of the different dimensions of project management information system – software, information, use and user in implementing the right type of information system for their projects.
- Among the different project performance dimensions – time, cost, and scope, project management information system has greater impact on the delivery time dimension followed by scope and cost
- How satisfying the expectations of the stakeholders needs be considered as a measure of project success especially in construction industry.
- Assess the causation effects of Project Management Information Systems in prompt decision making
- Evaluate the influence of quality information in provision of predictive management capabilities in the construction sector.

5.4 Limitation of the Study

Despite the fact that the study has attempted to produce some evidences in the relationship between project performance and project management information system, it has also certain limitations. Some of these limitations are

1. The results are based on a cross-sectional survey conducted at one time point, which might not be adequate to trust the results produced. Cross-checking the results with other sources of data could be interesting. The use of panel data and/or complimenting the evidence generated with a kind of qualitative research would increase the validity of the outcome of the research.
2. The economic situation of the construction sector during the survey was unfavorable due to the country's political situation and hence, the respondents were somehow pessimistic in giving certain response

3. The response rate of the survey was low as compared to similar surveys due to various reasons. One of the reasons for the low response rate is that the online data collection approach was not favorable to certain respondents due to the nature of their work.
4. Lack of adequate resource for the research could also be taken as important limitation in this research as increasing sample size or incorporating additional research designs require much more resource both in terms of time and cost.
5. The expectations of stakeholders on how their needs are satisfied were not considered as a measure project success as the survey only targets construction companies.

5.5 Future Research

The study attempted to produce some evidences toward the impact of implementing project management information system on construction projects performance in Ethiopia. However, future studies related to the topic could be conducted to produce far better results and compliment the limitations faced in this study. The follwing are some of the areas future researches should look into.

1. Carry out similar research with the use of more robust data from administrative and other sources instead of relying on people's subjective response as well as using data collected in more than one time point.
2. As the interest of stakeholder is very important, considering how projects are satisfying the expectations of the stakeholders' needs be considered in a measure of project success especially in construction industry.
3. Project performances are highly associated with decision making. Hence, future research should consider the assessment of the causation effects of project Management Information Systems in making prompt decision.
4. Evaluating the impact of quality information in providing predictive management capabilities in the construction sector.

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7. Appendices

7.1 Questionnaire

Impact of PMIS on Project Performance: the case of construction projects in Ethiopia

This survey is prepared for the purpose of collecting data to study the impact of project management information system on project performance in Ethiopia by using construction enterprises as a case study. Note that all the information aquired will only be used for academic perposes, and confidentiality of any response is gurantteed. We would like to thank you for all the information you provide. Please click next to start the survey.

1. **Email address** *

____

Section 1: General Information

This section gathers some important information about the respondent.

2. **1.1 Age of respondent**

Mark only one oval.

- ⬭ 18-30 years
- ⬭ 31-40 years
- ⬭ 41-50 years
- ⬭ over 50 years

3. **1.2 Gender**

Mark only one oval.

- ⬭ Male
- ⬭ Female

4. **1.3 Martial status**

Mark only one oval.

- ⬭ Single
- ⬭ Married
- ⬭ Other

5. **1.4 Education**

Mark only one oval.

- ⬭ Masters and above
- ⬭ Undergaduate degree (BSc/BA)
- ⬭ Dioploma including TVET
- ⬭ High School complete
- ⬭ Below High School

6. **1.5 Your position in the enterprise**
Mark only one oval.

- ◯ Senior management
- ◯ Functional manager
- ◯ Project manager
- ◯ Supervisor
- ◯ Other: ____________________

7. **1.6 For how long have you been working in this enterprise (in years)?**

____

8. **1.7 For how long have you been working in this position (in years)?**

____

Section 2: Organization Profile

The section focuses on collecting some information regarding the enterprise you are currently working in.It is possible to refer to documents or ask some information from colleagues.

9. **2.1 What is the Grade of the enterprise? [1-10]**
Mark only one oval.

1	2	3	4	5	6	7	8	9	10
◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

10. **2.2 Year of establishment.**

____

11. **2.3 Total initial investment amount (ETB)**

____

12. **2.4 Total capital currently (ETB)**

____

13. **2.5 How many employees does the enterprise employ in a typical month?**

____

14. **2.6 How many projects the enterprise has successfully completed so far?**

____

15. **2.7 Total number of construction projects currently under implementation.**

____

16. **2.8 Please indicate the specific types of construction projects currently running and completed since 2014**

Mark only one oval per row.

	0	1-5	5-10	>10
Publicly owned - Roads	○	○	○	○
Publicly owned - Buildings	○	○	○	○
Publicly owned - Other types	○	○	○	○
Privately owned - Roads	○	○	○	○
Privately owned - Buildings	○	○	○	○
Privately owned - Other types	○	○	○	○

17. **2.9 What is the most frequently faced challenge in the construction sector of Ethiopia? (Multiple selection)**

Check all that apply.

- [ ] Poor planning
- [ ] Lack of adequate information system
- [ ] Skill limitation
- [ ] Unrealistic deadlines
- [ ] Scope creep
- [ ] Poor or limited risk management
- [ ] Unrealistic cost estimation
- [ ] Factors related with government policy or bureaucracy
- [ ] Other: ____________________

Section 3: Project Management Information System

The following questions are related with the use of project management information system in your enterprise. Please respond to each of the questions carefully by relating them with the experience of the enterprise.

18. **3.1 Have you ever used a specialized project management software for any of your projects?**

Mark only one oval.

- ○ Yes
- ○ No

19. **3.2 If yes to Q3.1, how often do you use such software?**

Mark only one oval.

- ○ For few projects
- ○ For some projects
- ○ For most projects
- ○ For all projects

20. **3.3 If yes to Q3.1, for what purpose of the different project functions do you use the software?**

Check all that apply.

- [ ] Formulation and appraisal function
- [ ] Planning function
- [ ] Controlling function
- [ ] Reporting function
- [ ] Monitoring function
- [ ] Evaluating function
- [ ] Other: ____________________

21. **3.4 What kind of PMIS software do you use for your projects?**

Check all that apply.

	Formulation & appraisal	Planning	Controlling	Reporting	Monitoring	Evaluating	Other function
COMFAR	☐	☐	☐	☐	☐	☐	☐
MS Project	☐	☐	☐	☐	☐	☐	☐
Primavera	☐	☐	☐	☐	☐	☐	☐
Spectrum	☐	☐	☐	☐	☐	☐	☐
Buildertrend	☐	☐	☐	☐	☐	☐	☐
ERP software susch as SAP, Agresso, etc	☐	☐	☐	☐	☐	☐	☐
Own software	☐	☐	☐	☐	☐	☐	☐
Other	☐	☐	☐	☐	☐	☐	☐

22. **3.5 In your opinion, how would you rate the quality of PMIS software in your enterprise in the following areas? Please tick**

Mark only one oval per row.

	Poor	Fair	Good	Very Good	Excellent
Ease of use	◯	◯	◯	◯	◯
Flexibility	◯	◯	◯	◯	◯
Availability	◯	◯	◯	◯	◯
Ease of querying	◯	◯	◯	◯	◯
Response time	◯	◯	◯	◯	◯
Ease of learning	◯	◯	◯	◯	◯
System integration	◯	◯	◯	◯	◯
Multi-project capacity	◯	◯	◯	◯	◯

23. **3.6 In your opinion, how would you evaluate the quality of project information produced in project implementation? Please tick.**

Mark only one oval per row.

	Poor	Fair	Good	Very Good	Excellent
Comprehensivenss	◯	◯	◯	◯	◯
Accuracy	◯	◯	◯	◯	◯
Availability	◯	◯	◯	◯	◯
Relevance	◯	◯	◯	◯	◯
Consistency	◯	◯	◯	◯	◯
Reliability	◯	◯	◯	◯	◯

24. **3.7a In your opinion, how often are the following project formulation and appraisal functions performed using PMIS tool? Please tick.**

Mark only one oval per row.

	Never	Rarely	Occasional	Often	Very Often
Need analysis	◯	◯	◯	◯	◯
Feasibility study	◯	◯	◯	◯	◯
Investment appraisal	◯	◯	◯	◯	◯
Project parameters	◯	◯	◯	◯	◯
Identification	◯	◯	◯	◯	◯

25. **3.7b In your opinion, how often are the following project planning functions performed using PMIS tool? Please tick.**

Mark only one oval per row.

	Never	Rarely	Occasional	Often	Very often
Designing project	◯	◯	◯	◯	◯
Resource allocation & mobilization	◯	◯	◯	◯	◯
Overall scheduling	◯	◯	◯	◯	◯
Costing & budgeting	◯	◯	◯	◯	◯
Quality mangement	◯	◯	◯	◯	◯
Risk planning	◯	◯	◯	◯	◯

26. **3.7c In your opinion, how often are the following project controlling functions performed using PMIS tool? Please tick.**

Mark only one oval per row.

	Never	Rarely	Occasional	Often	Very often
Resource control	◯	◯	◯	◯	◯
Cost control	◯	◯	◯	◯	◯
Progress control	◯	◯	◯	◯	◯
Issues management	◯	◯	◯	◯	◯
Quality control	◯	◯	◯	◯	◯

27. **3.7d In your opinion, how often are the following project reporting functions performed using PMIS tool? Please tick.**

Mark only one oval per row.

	Never	Rarely	Occasional	Often	Very often
An overview of project	⬭	⬭	⬭	⬭	⬭
Status of project resource utilization	⬭	⬭	⬭	⬭	⬭
Overview of budget and cost overruns	⬭	⬭	⬭	⬭	⬭
Status of project timelines	⬭	⬭	⬭	⬭	⬭
Status of project achievements	⬭	⬭	⬭	⬭	⬭

28. **3.7e In your opinion, how often are the following project monitoring functions performed using PMIS tool? Please tick.**

Mark only one oval per row.

	Never	Rarely	Occasional	Often	Very often
Project reports	⬭	⬭	⬭	⬭	⬭
Project tasks	⬭	⬭	⬭	⬭	⬭
Project schedule	⬭	⬭	⬭	⬭	⬭
Project progress	⬭	⬭	⬭	⬭	⬭

29. **3.7f In your opinion, how often are the following project evaluating functions performed using PMIS tool? Please tick.**

Mark only one oval per row.

	Never	Rarely	Occasional	Often	very often
Project costing	⬭	⬭	⬭	⬭	⬭
Project schedule variance	⬭	⬭	⬭	⬭	⬭
Utilization of project resource	⬭	⬭	⬭	⬭	⬭
Tracking the project tasks	⬭	⬭	⬭	⬭	⬭
Tracking project performance	⬭	⬭	⬭	⬭	⬭

30. **3.8 In your opinion, do you agree that PMIS user has influence project performance in the following aspects?**

Mark only one oval per row.

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
User satisfaction	⬭	⬭	⬭	⬭	⬭
Perceived usefulness	⬭	⬭	⬭	⬭	⬭
Perceived ease of use	⬭	⬭	⬭	⬭	⬭
User competency	⬭	⬭	⬭	⬭	⬭
Intention of use	⬭	⬭	⬭	⬭	⬭

31. **3.9 How would you rate the contribution of PMIS in general on specific project performance in the following areas?**

Mark only one oval per row.

	Very low contribution	Low contribution	Moderate contribution	High contribution	Very high contribution
Meeting timeline	⬭	⬭	⬭	⬭	⬭
Respecting budgets	⬭	⬭	⬭	⬭	⬭
Meeting quality and objectives	⬭	⬭	⬭	⬭	⬭

32. **3.10 What do you think about the main challenges of using PMIS in the construction sector from Ethiopian context?**

Check all that apply.

- ☐ Software related
- ☐ System related
- ☐ User related
- ☐ Information/Data related
- ☐ External factor
- ☐ Other: ____________________

Skip to question 32.

Section 4: Project Performance

Here, we would like to ask you question related with the performance of projects handled by your enterprise.

33. **4.1 How do you rate the performance of projects implemented by your enterprise (both past and existing projects) based on the following parameters?**

Mark only one oval per row.

	Poor	Fair	Good	Very Good	Excellent
Delivery time	⬭	⬭	⬭	⬭	⬭
Budget/Cost	⬭	⬭	⬭	⬭	⬭
Quality/Scope	⬭	⬭	⬭	⬭	⬭
Overall project performance	⬭	⬭	⬭	⬭	⬭

34. **4.2 What percent of all projects contracted or assigned to your enterprise successfully completed so far**

____

35. **4.3 Do you believe that the use of PMIS have significant role on performance of projects from your enterprise perspective?**

Mark only one oval.

- ⬭ Definately, yes
- ⬭ To some extent, yes
- ⬭ Not sure
- ⬭ No significant impact

Thank you for your participation in the survey.

7.2 Stata Codes used for data analysis

```
*-----------------------------------------------------------------------

* PMIS Survey data management and analysis Stata codes  @ Samuel March 202

cd "D:\Sam\My courses\Project Management\MA Thesis\Data Collection"

import excel "GSheet_Download.xlsx", sheet("Copy of Form Responses 1") firstrow

*Age
replace C="1" if C=="18-30 years"
replace C="2" if C=="31-40 years"
replace C="3" if C=="41-50 years"
replace C="4" if C=="over 50 years"
destring C, replace
la def age 1 "18-30 years" 2 "18-30 years" 3 "31-40 years" 4 "over 50 years"
la val C age

*Sex
replace D="1" if D=="Male"
replace D="2" if D=="Female"
la def sex 1 "Male" 2 "Female"
destring D, replace
la val D sex

*Martial ststus
replace E="1" if E=="Single"
replace E="2" if E=="Married"
replace E="3" if E=="Other"
la def ms 1 "Single" 2 "Married" 3 "Other"
destring E, replace
la val E ms

*Educ
replace F="1" if F=="Masters and above"
replace F="2" if F=="Undergaduate degree (BSc/BA)"
replace F="3" if F==" Dioploma including TVET"
replace F="4" if F=="Below High School"
la def educ 1 "Masters and above" 2 "Undergaduate degree (BSc/BA)" 3 "Dioploma including TVET" 4 "High School and below"
destring F, replace
la val F educ

*Position
replace G="1" if G=="Senior management"
replace G="2" if G=="Functional manager"
replace G="3" if G=="Project manager"
replace G="4" if G=="Supervisor"
replace G="5" if G=="Office Engineer" | G== "Office engineer " | G=="Super Intendent" | G=="Civil Engineer"
la def pos 1 "Senior Management" 2 "Functional Manager" 3 "Project Manager" 4 "Supervisor" 5 "Other (Eng/Off Eng/Sup Int/ etc)"
destring G, replace
la val G pos

*No of projects
la def numproj 1 "No proj" 2 "1-5" 3 "5-10" 4 ">10"
foreach x of var Q- V {
    replace `x' = "1" if `x' == "0" | `x' == "Less than 2"
    replace `x' = "2" if `x' == "1-5" | `x'=="Between 3 and 5"
    replace `x' = "3" if `x' == "5-10"
    replace `x' = "4" if `x' == ">10"
    destring `x', replace
    la val `x' numproj
```

```
}

*PM challenges
foreach x of var W- AE {
    replace `x' = trim(`x')
    replace `x' = "1" if `x' == "Poor planning"
    replace `x' = "2" if `x' == "Lack of adequate information system"
    replace `x' = "3" if `x' == "Skill limitation"
    replace `x' = "4" if `x' == "Unrealistic deadlines"
    replace `x' = "5" if `x' == "Scope creep"
    replace `x' = "6" if `x' == "Poor or limited risk management"
    replace `x' = "7" if `x' == "Unrealistic cost estimation"
    replace `x' = "8" if `x' == "Factors related with government policy or bureaucracy"
    replace `x' = "9" if `x' == "Other factor"
    destring `x', replace
    la val `x' chall
}

*PMIS use
la def yn 1 "Yes" 2 "No"
replace AF = "1" if AF == "Yes"
replace AF = "2" if AF == "No"
destring AF, replace
la val AF yn

*PMIS use frequency
replace AG = "1" if AG == "For few projects"
replace AG = "2" if AG == "For some projects"
replace AG = "3" if AG == "For most projects"
replace AG = "4" if AG == "For all projects"
destring AG, replace
la def pmis 1 "For few projects" 2 "For some projects" 3 "For most projects" 4 "For all projects"
la val AG pmis

*PMIS use where
la def  func 1  "Formulation and appraisal function" 2  "Planning function" ///
   3  "Controlling function" 4  "Reporting function" 5   "Monitoring function"  ///
   6  "Evaluating function"  7  "Other", modify

foreach x of var AH-AN {
    replace `x' = trim(`x')
    replace `x'="1" if `x' == "Formulation and appraisal function"
    replace `x'="2" if `x' == "Planning function"
    replace `x'="3" if `x' == "Controlling function"
    replace `x'="4" if `x' == "Reporting function"
    replace `x'="5" if `x' == "Monitoring function"
    replace `x'="6" if `x' == "Evaluating function"
    replace `x'="7" if `x' == "Other"
    destring `x', replace
    la val `x' func
}

la def y 1 "Poor" 2 "Fair" 3 "Good" 4 "Very Good" 5 "Excellent", modify
la def often 1 "Never" 2 "Rarely" 3 "Occasional" 4 "Often" 5 "Very often", modify
la def agree 1 "Strongly disagree" 2 "Disagree" 3 "Neither disagree nor agree" ///
             4 "Agree" 5 "Strongly Agree", modify
la def contr 1 "Very low contribution" 2 "Low contribution" 3 "Moderate contribution" ///
             4 "High contribution" 5 "Very high contribution", modify
la def usec 1 "Software related" 2 "System related" 3 "User related" 4 "Information/Data related" ///
            5 "External factor" 6 "Lack of awareness", modify
la def imp 1 "Definately, yes" 2 "To some extent, yes" 3 "Not sure" 4 "No significant impact"

*Rating
```

```
foreach x of var AW-BJ {
    replace `x' = "1" if `x' == "Poor"
    replace `x' = "2" if `x' == "Fair"
    replace `x' = "3" if `x' == "Good"
    replace `x' = "4" if `x' == "Very Good"
    replace `x' = "5" if `x' == "Excellent"
    destring `x', replace
    la val `x' y
}

*Use frequency
foreach x of var  BK- CN {
    replace `x' = "1" if `x' == "Never"
    replace `x' = "2" if `x' == "Rarely"
    replace `x' = "3" if `x' == "Occasional"
    replace `x' = "4" if `x' == "Often"
    replace `x' = "5" if `x' == "Very Often" | `x' == "Very often" | `x' == "very often"
    destring `x', replace
    la val `x' often
}

*Agree/disagree
foreach x of var  CO -CS {
    replace `x' = "1" if `x' == "Strongly disagree"
    replace `x' = "2" if `x' == "Disagree"
    replace `x' = "3" if `x' == "Neither disagree nor agree"
    replace `x' = "4" if `x' == "Agree"
    replace `x' = "5" if `x' == "Strongly agree"
    destring `x', replace
    la val `x' agree
}

*PMIS contribution
foreach x of var  CT -CV {
    replace `x' = "1" if `x' == "Very low contribution"
    replace `x' = "2" if `x' == "Low contribution"
    replace `x' = "3" if `x' == "Moderate contribution"
    replace `x' = "4" if `x' == "High contribution"
    replace `x' = "5" if `x' == "Very high contribution"
    destring `x', replace
    la val `x' contr
}

*PMIS challenges
foreach x of var CX-DA {
    replace `x' = trim(`x')
    replace `x' = "2" if `x'=="System related"
    replace `x' = "3" if `x'=="User related"
    replace `x' = "4" if `x'=="Information/Data related"
    replace `x' = "5" if `x'=="External factor"
    replace `x' = "6" if `x'=="Lack of awareness"
    destring `x', replace
    la val `x' usec
}

*Project performance
foreach x of var DC-DF {
    replace `x' = "1" if `x' == "Poor"
    replace `x' = "2" if `x' == "Fair"
    replace `x' = "3" if `x' == "Good"
    replace `x' = "4" if `x' == "Very Good"
    replace `x' = "5" if `x' == "Excellent"
    destring `x', replace
```

```
    la val `x' y
}

*PMIS recommendation
replace DH = "1" if DH=="Definately, yes"
replace DH = "2" if DH=="To some extent, yes"
replace DH = "3" if DH=="Not sure"
replace DH = "4" if DH=="No significant impact"
replace DH = "1" if DH=="Yes"
destring DH, replace
la val DH imp

*Edit
egen DF2 = rowmean(DC DE DF)
replace DF2=round(DF2)
replace DF2=4 if DF2==5
replace DF=DF2
drop DF2

gen age=2020-K

gen id=_n

egen software = rowmean(AW-BD)
egen info = rowmean(BE-BJ)
egen use = rowmean(BK-CN)
egen user = rowmean(CO-CS)

recode H (0/2 = 1 "Less than 2 years") (2.1/5 = 2 "2-5 years") (5.1/10 = 3 "5-10") ///
       (10.1/20=4 ">10 years"), gen(exp)

recode age (0/5 = 1 "< 5 years") (5.1/11 = 2 "5-10 years") (10.1/15 = 3 "10-15") ///
       (15.1/20=4 "15-20 years") (20.1/30 = 5 "> 20 years"), gen(ent_age)

label define ent_age 1 "< 5 years" 2 "5-10 years" 3 "10-15 years" 4 "15-20 years" ///
      5 "> 20 years", replace

save PMF_Survey_Raw_Data, replace


**********************Descriptive analysis*********************************
use PMF_Survey_Raw_Data, clear

preserve
    gen id=_n
    keep id BE-BJ
    rename (BE-BJ) (sf1 sf2 sf3 sf4 sf5 sf6)
    reshape long sf@, i(id) j(r)
    collapse (mean) rate1-rate5, by(r)
restore

preserve

foreach x of var C D E F G {
    graph pie , over(`x') plabel(_all percent, color(yellow)) legend(rows(1)) ///
      pie(1, color(64 0 0)) pie(2, color(128 0 0)) ///
      pie(3, color(192 0 0)) pie(4, color(255 0 0)) ///
      name(g_`x', replace) title("`x'")
}

gr hbar, over(exp) scheme(s1color) ytitle("Percent") title("Experience") name("Exp")

gr hbar, over(ent_age) scheme(s1color) ytitle("Percent") ///
```

```
        title("Year since establishment") name("year", replace)

*IRT model
alpha DC DD DE DF, item std detail

irt rsm DC DD DE DF

irtgraph iif DC DD DE DF, scheme(s1color)

irtgraph icc (DC, lcolor(red)) (DD, lpattern(dash)) (DE, lcolor(green) ///
         pattern(dash)) (DF, lcolor(green)), range(-5 5) xlabel(-5 -2.41 0 1.65 5)///
         legend(off) lcolor(red) scheme(s1color)

*************PMIS use and project performance ologit model**************

gen pmisuse = AF==1

tab D, gen(ressex)
tab C, gen(resage)
tab F, gen(reseduc)
tab G, gen(respos)

*ANOVA test
foreach x of var software info use user {

    foreach C of var DC DD DE DF {

        anova `x' `C'
    }
}

*******logistic regression on the determinants of PMIS use

//probit pmisuse ressex2 resage2 resage3 reseduc2 reseduc3 respos2 respos4 respos5 exp O P N L M,
robust

probit pmisuse J M N age O P ressex2 resage2-resage4 reseduc2-reseduc4 respos2-respos5 H, robust

estat gof, group(20)

foreach x of var DC DD DE DF {

    tabstat pmisuse J M N O P ent_age ressex2 resage2-resage4 reseduc2-reseduc4 respos2-respos5 H, by
(`x') stat(mean)

    oprobit `x' pmisuse J M N O P ent_age ressex2 resage2-resage4 reseduc2-reseduc4 respos2-respos5 H
, robust

    est store use`x'
}

esttab use* using "reg_use.csv", replace

*PMIS quality and project performance ologit model

foreach x of var DC DD DE DF {

    tabstat software info use user, by(`x') stat(mean)

    oprobit `x' software info use user J M N O P ent_age ressex2 resage2-resage4 ///
            reseduc2-reseduc4 respos2-respos5 H, robust

    est store qual`x'
```

```
    margins, at(software =(1(1)3))

    margins, at(info =(1(1)3))

    margins, at(use =(1(1)3))

    margins, at(user =(1(1)3))

    linktest

    fitstat

}

esttab qual* using "reg_qual.csv", replace

est stat use*
estat ic use*
est stat qual*
estat ic use*

foreach x of var DC DD DE DF {
    graph hbar (mean) p1`x' (mean) p2`x' (mean) p3`x' (mean) p4`x' (mean) p5`x', ///
    blabel(bar, format(%12.2f)) ytitle(Percent) scheme(s1color)  ///
    legend(order(1 "Poor" 2 "Fair" 3 "Good" 4 "Very Good" 5 "Excellent"))
    gr rename Graph prob`x', replace
}
graph combine probDC probDD probDE probDF, ycommon xcommon

*-------------------------------------End-------------------------------------
```