COST MONITORING AND CONTROLLING PRACTICES OF CONSTRUCTION COMPANIES IN SRI LANKA

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DECLARATION

I hereby certify that this dissertation does not incorporate any material without the acknowledgement of the author of any such material previously submitted for a degree or diploma in any university to the best of my knowledge and I believe it does not contain any material previously published, written or orally communicated by another person except where due reference is made in the text.

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ABSTRACT

The wealth of any nation is gauged by its performance in infrastructure provision through its construction industry. The construction industry is large, volatile, and requires tremendous capital outlays (Kaliba, Mundia & Kanyuka, 2008).

Cost is a comprehensive index, which is not only closely related to the efficiency and competitiveness of an enterprise, but also reflects the superiority and inferiority of its management in various aspects. Cost control is the main means of reducing the cost of products and it serves as the precondition for the enhancement of estimation and economic returns of the business. Cost monitoring concepts have been in the international construction companies for many years. Hence, it needs to analyze the Sri Lankan context of cost monitoring in construction companies.

The main objective of this research work is to discover the current cost monitoring practices in Sri Lankan construction companies, find out the drawbacks of existing CMSs, professional's adaptation to the ICMSs and other affective characteristics related to the implementation of an automated CMS and to give some recommendation to implement an enhanced Project Management System in construction firms, in which cost management, planning and control can be gradually integrated, in order to overcome the existing limitations of the current cost monitoring systems.

This research is based on the literature review and the data collected through questionnaire surveys and interviews among 57 professionals in the construction companies in Sri Lanka. With the findings of this research, it is expected to guide construction professionals towards enhancing the current cost monitoring systems in order to become more proactive, and be able to deal with the dynamic, uncertain and complex construction environment that exists in most of the construction projects in Sri Lanka.

Key words: Cost, Cost Monitoring Systems, Projects, Integrated Cost Monitoring Systems (ICMS), Performance Indicators, Construction Industry.

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ABBREVIATIONS

ABC	-	Activity Based Costing
CMS	-	Cost Monitoring System
EMS	-	Enterprise Management System
ERP	-	Enterprise Resource Planning
EVM	-	Earned Value Management
ICMS	-	Integrated Cost Management System
IMA	-	Institute of Management Accountants
KPI	-	Key Performance Indicators
NPV	-	Net Present Value
PCM	-	Project Cost Management
PM	-	Project Manager
ROI	-	Return On Investment
SPI	-	Schedule Performance Index
SV	-	Schedule Variance
WBS	-	Work Breakdown Structure

Chapter 1
Introduction

1.1 Background

Construction industry constitutes a major component of the national economy in any developing country, since it means that much of the national budget on infrastructure development is channeled to construction projects to fulfill the growing population needs. There was a considerable effect of world economic crisis during the last few years to the Sri Lankan construction industry because of significant changes in both global and national economies which directly influenced the construction sector. Nevertheless, now there are signs of a construction boom in the country after the 30 year war.

Usually construction companies face various difficulties because most of the construction projects are very complex and full of challenges. As many unexpected issues affect the project cost and time over runs many technologies and methods have developed for successful monitoring and controlling to lead the project towards success. With the growing of marketing competitiveness, it is more and more critical in time and budget control of each project for sustainable development of the construction companies. So, most of the organizations in Sri Lanka, and for that matter in the entire world commonly attempt to adopt technological innovations to improve upon their current level of effectiveness. The very rapid growth of the automation and integrated management systems over the last several decades attests to the widespread prevalence and rapid speed of such adoption patterns. Implementation of such automated systems eventually enhances the productivity as well as the efficiency of the management systems.

Proper Cost Monitoring System (CMS) is a process which could guide the construction companies towards high competitiveness while reducing redundant cost during construction. Since, there must be a significant consideration on cost monitoring as well as other processes like planning, utilization of plant, machinery and manpower, coordination and execution of works. Costing procedure has to be well defined and it should be able to provide facilities to produce necessary data output to analyze the status of the project for site management as well as the top management of the company.

A comprehensive guideline for the Integrated Cost Management System (ICMS) has been provided by the Institute of Management Accountant (IMA) and Arthur Anderson LLP through the Management Accounting Statement No. 4MM, March 2000. It is stated that the Integration of information is essential if an organization's resources are to be deployed optimally. Integration provides the basis for robust decision analysis because it supports the incorporation of multiple perspectives. Whether an organization is just beginning its journey towards the implementation of new cost management models or has put many of them in place, the need to integrate information and management systems remains the same. Meeting this need is the objective of the integrated cost management system (ICMS) framework (IMA.Statement-4MM 2000).

Despite most of the companies in banking, manufacturing, trading and services sectors using the integrated systems, identifying the usage of integrated systems in the construction companies is comparatively low in Sri Lanka. When considering the complexity and dynamic working environment of construction projects there must be a well implemented effective proper cost monitoring and controlling system in any construction project in order to identify the actual return on investment (ROI) to the organization. In addition to that the CMS helps to measure the past and current performance of the projects and to make appropriate management decisions while evaluating expected outcomes in the future. This research is to examine the current cost monitoring practices of the construction companies in Sri Lanka while assessing the performance of the current CMSs and to identify the factors which influence both implementation and non-implementation of ICMSs in construction companies.

1.2 The research problem

The importance of having a well implemented proper CMS in the organizations is emphasized by many researchers, professionals and the professional institutions. To fulfill the specific requirements of organizations customized ICMSs are used by various companies all around the world in order to enhance their management systems. Even though most of the companies are using the integrated systems in other sectors, it was identified through the preliminary interviews and investigations that the usage of integrated systems in the construction companies is comparatively low in Sri Lanka. Therefore, there would be many reasons for the non-implementation of ICMS in

construction companies in Sri Lanka. The problem based for this research is "Why the Sri Lankan construction companies are still lagging behind the usage of new management technology and ICMSs in projects?"

1.3 Research objectives

Main objectives of this research are to;

1. examine the current cost monitoring practices used in the construction projects.
2. examine the personal characteristics of professionals in construction companies and other possible constraints which are affecting the implementation of ICMS in construction projects.

1.4 Significance of the study

Construction industry is playing a major role is leading a country towards the development since the necessary infrastructure must be developed in order to facilitate the growing population needs, thereby, enhancing the efficiency and the productivity of the construction processes are reducing wastage and over expenditure of the construction organizations as well as national wealth. Since construction is one of the highly competitive and high-risk businesses in Sri Lanka, the traditional methods and strategies adopted by the companies to survive and to maintain the competitive edge would not be effective in the long- run, as, new challenges emerge day by day making these existing strategies less effective to remain in business.

Therefore, construction companies need to explore and derive strategically important and innovative systems and approaches that would guarantee long-term competitiveness. Hence, exploration of new concepts and philosophies that can improve the existing systems and processes of companies is very vital for business success. Now it has become an essential requirement to examine the current practices of cost Monitoring and controlling, drawbacks of the existing systems, and identify the constraints towards the implementation of ICMSs in construction projects in Sri Lanka.

1.5 Methodology

Initially a comprehensive literature review was conducted to study the related previous researches by both Sri Lankan and international researchers, to understand the concepts, principles of CMSs, various applications of CMSs in different industries and the various enterprise management systems (EMS) and their applications in the construction companies. Secondly a structured questionnaire has been distributed among 100 professionals including project managers, quantity surveyors, senior Engineers, directors, and owners of companies in the construction industry in order to gather the information on following areas.

- Existing cost monitoring systems and outcomes
- Performance of the existing cost monitoring systems
- Professional's understanding and views on ICMSs
- Organizational requirements and support for implementation of ICMSs
- Probable reasons behind the non-implementation of ICMSs

There is a detailed demonstration of the research methodology in Chapter 03 and the method of analyzing the collected data is described in Chapter 04.

1.6 Limitations of the research

Only the senior management personnel in construction companies have been selected as the respondents for this research for evaluations. Even though there are several project management areas, the cost management process of the companies are taken in to consideration for the evaluation, since it is one of the most critical processes needed to deliver a successful project.

1.7 Main findings

Features of the current cost monitoring systems, personal characteristics of the professionals in the construction companies, user adaptation and the specific requirements of the organizations and other possible constraints towards the implementation of ICMS in construction projects have been examined through this research.

1.8 Guide to the report

Chapter 01 - Introduction

This chapter describes the background, the importance and benefits of the ICMSs, problem definition, objectives and the basic guidelines of the research.

Chapter 02 – Literature review

The basic principles of cost monitoring, history of the development of the ICMS, the accepted guidelines of the ICMS, the means of performance measurement of the projects and views, experiences and the recommendations of the previous researchers have been discussed in depth in this chapter.

Chapter 03 – Research methodology

The method of data collection and the way of analyzing data have been elaborated in this chapter.

Chapter 04 – Analysis and discussion

Calculations and the analyzed data are included in this chapter. Results and the most of the findings themselves are illustrated in graphical form in this chapter.

Chapter 05 – Conclusion and recommendation

The research findings are concluded and stated some the recommendations to enhance the existing CMSs and to further researches in this chapter.

Chapter 2

Literature review

2.1 General

An extensive literature survey was conducted and the basic principles of cost monitoring, history of the development of the cost monitoring practices have been examined by referring various publications. Information about traditional methods of cost monitoring was gathered about the features and specially examined the performance indicators of the projects. In addition to that new methods and technologies available for cost monitoring in projects have been explored and specially focused on ICMS and its' benefits. Furthermore the accepted guidelines of the ICMSs, the means of performance measurement of the projects and possible outcomes expected also were discussed in detail. Following key areas have been explored in the literature review of this research.

- Importance of having an effective and efficient CMS
- Cost management processes
- Cost management techniques
- Uses and benefits of the ICMSs
- Performance indicators of projects

In addition to that views, experiences and the recommendations made by the previous researchers have been discussed in depth in this chapter.

2.2 History and background

Despite the environmental, managerial and technological changes that have occurred in the last few decades, existing cost management systems tend to be very similar to the ones that have been used since the mid-twenties (Johnson and Kaplan, 1993). In the face of all these changes, traditional cost account information has become mostly irrelevant and even dangerous for managerial purposes (Ploss, 1999).

According to Johnson and Kaplan (1993) such information tends to be too late, too aggregated and too distorted to be relevant for production management, since they are generated mostly to satisfy fiscal and financial needs.

As previous researches identified, the drawbacks of the traditional cost management systems have three important consequences.

Firstly, these systems cannot provide accurate product cost: costs are distributed to products in a simplistic and arbitrary way that usually does not represent the real demand imposed by each product on the company's resources (Ostrenga,1998).

Secondly, such systems fail to stimulate decisions that can affect the overall production result. Managers are sometimes encouraged to accomplish short term goals by reducing expenses with training and investments, or even by increasing the level of inventory (Ostrenga, 1998). Although effective in the short term, these decisions can seriously affect future results (Goldratt and Cox, 1989).

Finally, the information provided by traditional cost management systems is considerably lesser in the assisting of managers in their effort to improve production performance. Poor transparency allied with the lack of promptitude makes cost information ineffective to help the identification and elimination of waste.

Particularly in the construction industry, the existing gap between the available cost information and the goals set to the business is pointed as being one of the main faults of traditional cost management systems (Kim, 2002). Often construction cost control consists basically of monitoring actual performance against cost estimates and identifying variances. As a result, traditional cost control systems have been much more useful to manage contracts rather than production (Howell and Ballard, 1996). Over the last 15 years, cost management practices have been revolutionized. Spurred on by the criticisms voiced by Thomas Johnson and Robert Kaplan in their publications relevance Lost, the rise and fall of management accounting, accounting practitioners and academics have joined forces to create new forms of cost management that provide decision-relevant information (IMA.Statement-4MM, 2000).

Beginning with activity-based costing in the late 1980s, the list of new cost management techniques has grown to include activity-based management, activity-based budgeting, target cost management, life cycle costing, capacity cost management, investment management and strategic cost management, to name just a few. Efforts have also been made to link cost management to other key performance metrics, creating integrated performance management systems (IMA.Statement-4MM, 2000).

2.3 Importance of having an effective and efficient CMS

A project evaluation and control system measures the project progress and the performance against a project plan to ensure that the project is completed on time, within the budget, and to the satisfaction of the customer. A good project evaluation and control system should also provide project managers with advance warning of potential problems before it is too late to correct them. Without these systems, projects proceed aimlessly with very little oversight, without a clear understanding of status, and without a well-thought-out action plan to bring the project back on track in the event of obvious disruptions (Venkataraman and Pinto, 2008).

Cost planning and control is defined in this study as a managerial process that must be performed in all project phases, involving different sectors and other processes of construction. Its main objective is to generate cost information to support decision making related to construction management in order to reach the goals set for the business, including decisions related to procurement, finance, profitability, timing and quality. Uncertainty, variability, interdependence and complexity play a key role in the construction environment, and a major challenge for production management systems is to eliminate or to reduce the impact of these characteristics (Koskela, 2000). Moreover, the uncertainty related to the financial environment must also be considered, regarding the significant amount of capital required by construction projects (Barbosa and Pimentel, 2001).

Usually cost monitoring practices in the construction companies differ from other companies, since the product of the construction companies is unique and most of the production takes place in a temporary environment, which is highly vulnerable to the weather conditions. Thus, substantial changes of the product and changing construction processes often occur during the production phase in most of the construction projects. Therefore it is vital to predict, identify and consider all the factors which can contribute to the success of the project.

Hence, it is very important to have a comprehensive CMS for construction projects which includes all major and minor contributory factors. This means that cost management

models developed for other industries in which processes are repetitive and relatively stable cannot be easily adapted to construction projects.

According to Koskela (2000) management systems in construction tend to be ineffective due to the fact that the nature of the production processes involved is not properly taken into consideration. The same author suggests that a major underlying cause of the ineffectiveness of production management is the fact that production is viewed as a transformation process, without explicitly considering the non-value-adding activities, which tend to be neglected in production control despite their high impact in terms of cost. In fact, both cost estimates and production plans for construction projects are typically segmented in items that represent only value-adding activities (Koskela, 2000).

In the case of cost estimating, the information produced has the additional drawback that it is remotely related to the way costs are incurred. Most cost methods adopted in the industry are strongly based on the standard cost method, and tend to associate each cost item to a finished element, e.g. walls (m^2), reinforced concrete components (m^3), windows (units), obtained from design drawings (Koskela, 2000). This makes it difficult to examine accurately the effect of design changes in production costs. Moreover, although time is a factor of major importance in construction costs, traditional cost estimation methods do not offer any reliable guidance for assessing the impact of production duration on project costs (Kakaand Price, 1991).

Horngreen, Foster,and Srikant (1990) argue that cost management must not be isolated from other managerial functions, and should play a key role in the implementation of the company strategies. Kim (2002) suggests that cost management systems should involve a set of processes required to ensure that a construction project is completed within the approved budget, including cost estimating, cost control and cost projection. Navon (1995) points out that the proper consideration of the interaction between cost and time in construction projects depend on the integration of cost management systems to production management. Therefore, cost management systems in construction must be dynamic, proactive and able to support different decision-making processes, in order to protect the business from the harmful effects of uncertainty. Their main objective should be to generate information to support decision making, mainly concerned with cost reduction, value addition and financial management.

2.4 Cost management processes

Venkataraman, Rayand Pinto (2008) emphasized the cost management process as "To correctly and accurately measure and evaluate project performance, four essential elements must be in place." That process includes,

- setting a baseline plan
- measuring progress and performance
- comparing actual performance against plan
- taking corrective action

2.4.1 Establishing a project baseline plan

The project baseline plan provides the essential features for measuring performance. It begins with an accurate work breakdown structures (WBS), which establishes all the work packages and tasks associated with the project, assigns the personnel responsible for them, and creates a hierarchical representation of the project from the highest level down. To create the project baseline plan, the project team lays out each of the discrete tasks from the WBS onto a project network diagram, and time-phases all work, resources, and budgets.

2.4.2 Measuring and Monitoring Progress and Performance

Accurate mechanisms for project measurement are essential prerequisites for effective control systems. The first step in creating them is to establish a control system that measures the ongoing status of various project activities in real time and provides project managers with relevant information promptly. The second step is to determine what should be measured. There are both quantitative and qualitative measures for monitoring project progress and integrating quantitative measures like time and cost into the control system is relatively easy. On the other hand, qualitative measures like customer satisfaction with product functionality and technical specification can be determined only through on-site inspection or actual use.

When it comes to quantitative measurement, evaluating project performance relative to time can be as simple as answering questions like, "Is the critical path early, late or still

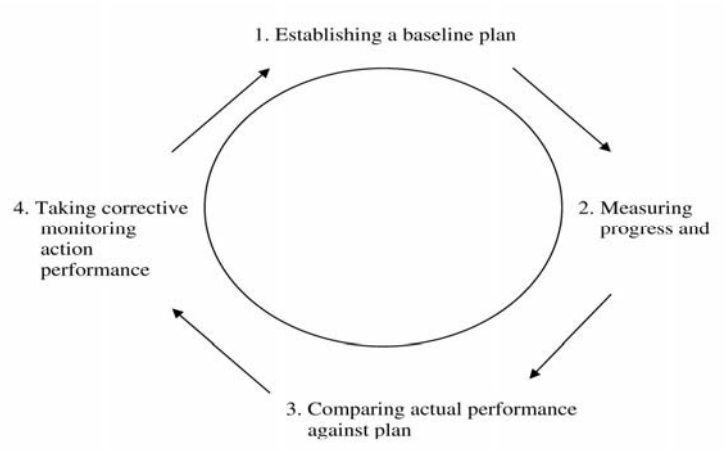
on schedule?" or, "Is there a reduction in the slack of noncritical paths?". Measuring project performance against budget (e.g., dollars, units in place, labor hours) is more difficult. In these cases, a form of project measurement known as earned value management (EVM) can provide a realistic estimate of project performance against a time-phased budget.

2.4.3 Comparing actual performance against plan

Given that actual project performance is rarely in accordance with the original baseline plan, the next step is to compare the plan and performance for measuring deviations. This analysis is sometimes referred to as "gap" analysis and this is essential for determining current project status. As a rule, the smaller the deviation between the baseline plan and actual performance, the easier it is to take corrective action.

2.4.4 Taking remedial actions

In cases where the deviations between the plan and actual performance are large and obvious, some form of corrective action is necessary to bring the project back on track. In some cases, the action may be relatively minor; in others, it may require serious and significant remedial steps. In situations where conditions or project scope have changed, the original baseline plan may have to be revised. Finally, it is important to note that this monitoring and control process is not a one-time fix, but is a continuous cycle of goal setting, measuring, correcting, improving, and re measuring as illustrated in Figure 2.1.



(Venkataraman and Pinto, 2008)

Figure 2.1: The Project control processes

2.5 Cost management techniques

Despite various cost management techniques practiced by various organizations three main cost management techniques are taken in to consideration for this study which have been identified in the literature as potentially helpful for improving cost management in construction.

- Operational cost estimating
- S-curves
- Target costing

2.5.1 Operational cost estimating

The idea of using an operational approach for cost estimating is not new. Skoyles (1965) discussed a radical change in traditional cost estimating methods that had been proposed in the U.K., in which a very detailed estimate of the project was produced based on the early definition of construction methods. This approach was not successful because it was considered to be too time consuming and also due to the lack of knowledge on production methods by cost estimating professionals.

It seems the main difficulty for implementing such an approach was that the high level of uncertainty and variability that exist in construction at the early project stages was neglected. Barnes (1977) proposed a less radical approach to operational cost estimating for construction projects, suggesting the use of different cost drivers for estimating the cost of resources, which were classified into fixed, quantity based, time-based, and price-based.

Activity-Based Costing (ABC) is a costing method that has been recently adopted in many industrial and service firms as a method to improve cost management in complex production systems. It is basically a two-stage approach for allocating indirect costs to products based on cost drivers of various levels (Kaplanand Cooper, 1998). In the first stage, resource costs (labour, equipment and power) are assigned to those activities performed in the organization. During the second stage, activities costs are assigned to the cost objects based on selected cost drivers (e.g., machine set-up, quality inspection and material handling activities), which express a causal relationship between the activity

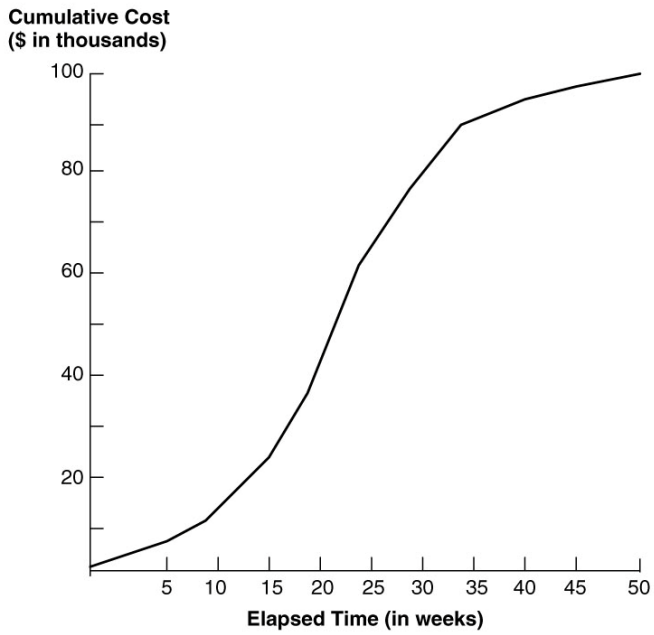
demand and the cost object considered (Ostrenga, 1998). Besides the fact that ABC allows to directly trace manufacturing costs to products, it is also possible to determine the costs related to product families, services and clients.

The information produced by ABC systems can potentially increase process transparency, providing guidance to identify non-value-adding activities (Marchesan and Formoso, 2001). Notwithstanding the benefits of its application, ABC presents some drawbacks when compared to traditional cost systems. Perhaps, the most important one is the large amount of data usually needed in ABC systems. Indeed, according to Krieger (1997) the excessive level of detail is a major cause of unsuccessful ABC implementations.

This problem can be even worse in unstable and complex production systems, such as those observed in the construction industry (Marchesanand Formoso, 2001). The idea of using operational cost estimating in this research is to keep production into perspective during the estimating process. Thus, costs of non-value activities can be identified and estimated to some extent. Moreover, the changes (i.e., design, production planning) that might occur after the initial cost estimate due to the uncertainty of the construction environment may be taken into consideration.

2.5.2 Cash flow S-curves

The S-curve is a fairly simple technique that presents graphically the project cash flow. It can be used to forecast and control the use of resources throughout a project (Kim and Ballard, 2001). S-curves can be used for simulating different scenarios, considering time and cost deviations, and also for summarizing key information for supporting decision making in different sectors of a firm (Nealeand Neale, 1989). Due to its simplicity, they can be used a visual device for displaying information that is quickly understood in the working environment.



(Venkataraman and Pinto, 2008)

Figure 2.2: Project S - curve

Although S-curves do not solve problems concerning limitations in cost estimating (Bazarra, Back and Mata, 2000), this tool is very useful for supporting production management since it can be used for integrating information from production plans and cost estimates (Kimand Ballard, 2000).

S-curves are often used as both a cost and time control tool, by applying the earned value method (EVM). Kimand Ballard (2000) defined EVM as a project control technique that provides a quantitative measure of work performance: project progress is measured against an earnings plan. The entire project is divided into the various types of work required, each with their own budget unit rates, with 100% corresponding to their aggregated budgets. It involves a crediting of budget dollars or labour hours as scheduled work is performed.

However, this technique has been criticized by Kimand Ballard (2000), because EVM is an effective tool only under the limiting assumption that every activity or cost account is independent. According to them, activities should be considered as being dependent. Also, the authors point out that the work sequence can be manipulated by managers, releasing work assignment to the field, that are not shielded from uncertainty. A further

problem cited by Kimand Ballard (2000) is that with the objective of making cost variance positive, managers may try to decrease the actual cost of work performed as much as possible. The overload resulting from reduced capacity can make work flow less reliable, which in turn can impact the performance of downstream production units.

2.5.3 Target costing

Target costing has been widely used by some leading industrial companies with the main objective of reducing the final cost of the product in order to obtain the expected profitability while ensuring satisfactory quality levels (Maskell and Baggaley, 2003). It can be described as a structured way of establishing the cost and quality that must be achieved in the development of a product in order to reach the desired profitability (Cooper, 1995).

Target costing can be divided into two main steps. Firstly, a cost target should be established for the product, by subtracting the product's desired profit margin from its expected selling price.

Secondly, the target cost of the product is distributed to its components, materials or systems (Cooper,1995). Differently from traditional cost estimating processes, cost is regarded as an input and not as an outcome of the design process.

By setting target costs based on market-driven selling prices, target costing transmits the cost pressure that is placed on the firm by the marketplace to everyone involved in the process of product design (Cooper and Slagmulder, 1997). While target costing is focused in cost reduction during the design process, a similar technique, named kaizen costing, has been used during the production phase, with the main objective of reducing costs in order to achieve a pre-established target cost (Monden, 1999).

However, as in most construction projects since there is an overlap between the design and the production phases, this study proposes the use of target costing in the production phase, in construction companies which also get involved in the product development process.

2.6 Uses and benefits of the ICMS

Integration of information is essential if an organization's resources are to be deployed optimally. Integration provides the basis for robust decision analysis because it supports the incorporation of multiple perspectives. Whether an organization is just beginning its journey toward the implementation of new cost management models or has put many of them in place, the need to integrate information and management systems remains the same. Meeting this need is the objective of the integrated cost management system (ICMS) framework (IMA.Statement-4MM 2000).

As a result of the rapid development of the Information Technology many organizations implement various automated systems in order to enhance the existing management systems in an effective and efficient manner. The ICMS framework can be used in conjunction with other management techniques such as total quality management, quality function deployment and electronic commerce. Despite most of the construction projects being too complex ICMS can be implemented in any organization after customizing as per the specific requirements since it has broad applications.IMA.Statement-4MM of 2000states that the various uses and the benefits of the ICMS and the information provided by the ICMS framework can be used to,

- identify optimal customer/market segments
- improve the profitability of key products
- support improved decision making
- reduce miscommunication
- optimize the organization's profitability
- increase process effectiveness
- integrate financial and nonfinancial metrics
- improve competitive position
- facilitate strategic marketing and operational decisions to support rapid response to changing conditions
- provide the means to integrate activities and outcomes across processes and entities in the value chain

In addition to that the implementation of the ICMS framework helps a company in the following ways too;

- Anticipate and react to environmental changes before an organization is affected by them, thus avoiding problems before they occur rather than correcting them after they happen;
- Continually improve the operations and not merely seek a temporary equilibrium;
- Create an external focus on customer requirements and competitive threats so that customer requirements drive the organization;
- Systematically relate all elements, internal and external, so problems are solved holistically rather than incrementally through cross-functional integration; this facilitates the problem being viewed and solved as a whole by building long-term relations with the suppliers and other members of the extended enterprise
- Optimize profits by ensuring that resources remain focused on value activities, that waste is identified and removed, and that process improvements result in reductions in non value-added efforts
- Link individual, group, and organizational incentives to ensure that everyone in the organization understands and is motivated to achieve strategic and operational objectives
- Communicate across all levels, all processes, and all units the needs of the customer, results achieved, problems encountered and solved, and remaining challenges to be met

Professional's engaged in construction projects having a sufficient knowledge of above factors and information is a vital requirement for the effective implementation of an ICMS in construction projects. Therefore, these factors are taken in to consideration for preparing the research questionnaire in order to measure the knowledge levels of the professionals on ICMS.

2.7 Performance indicators of projects

Scuderi and Oltman (2007) pointed out the necessity of a good project management system as "A requirement of good project management is a control system, a way of measuring progress and assessing health. Furthermore they described the main features of

any project management system and the main processes need to be implemented. "A project monitoring system involves determining what data to collect; how, when and who will collect the data; analysis of the data; and reporting current progress." The most common controls in project management focus on the cost and schedule aspects of the cost- schedule-quality equilibrium (the three key variables in project management), generating project indicators that focus on these two areas (Scuderiand Oltman, 2007).

The specific indicators are required to measure the past performance, current status and the predict performance against the base plane of any project so that project manager could make prompt decisions in order to keep smooth run of the project.

2.7.1 Indicator types

Verzuh (2005) describes two traditional metrics: schedule variance (SV) and schedule performance index (SPI) metrics. These are lagging indicators of performance, with significant delays due to administrative overhead (e.g., data gathering, compilation, and analysis lead times). On larger projects, the performance snapshots given by SV and SPI can be weeks out of date and allow any problems to become worse before corrective action would be taken. As with SV and SPI, most traditional project management indicators are lagging (e.g. days lost due to injuries). They inform the project manager of where the project has been or how the project was doing in the past. Other indicators are current indicators, highlighting where the project is (e.g. costs incurred to date) (Scuderiand Oltman, 2007).

Lagging and current indicators inform the project manager (PM) of what has happened but not what is or what will be occurring. Most common project indicators focus on actual-to-planned dates or schedule-to-cost comparison metrics. While knowing the rate at which money has been spent is useful, it does not indicate whether the work is being done correctly (Scuderi and Oltman, 2007).

These two types of indicators, while useful, do not help the PM predict the future, to know what areas are likely to become troublesome or when a project will be complete. Traditional indicators are not generally indicators of quality but instead focus on the cost and schedule aspects of a project, ignoring quality as hard to measure and less relevant.

Leading indicators are needed for a PM to assess all three project aspects properly, including leading indicators of quality (Scuderi and Oltman, 2007)

2.7.2 Key performance indicators (KPI)

Many researchers have identified and emphasized various KPIs in order to measure the health of construction projects. As highlighted by Takim and Akintoye (2002) construction project development involves numerous parties, various processes, different phases and stages of work and a great deal of input from both the public and private sectors, with the major aim being to bring the project to a successful conclusion. The level of success in carrying out construction project development activities is depend heavily on the quality of the managerial, financial, technical and organizational performance of the respective parties, while taking into consideration the associated risk management, the business environment, and economic and political stability.

In relation to this, the UK working groups on Key Performance Indicators (KPIs) have identified ten parameters for benchmarking projects, in order to achieve good performance, in response to Egan's report. These consist of seven project performance indicators, namely: construction cost, construction time, cost predictability, time predictability, defects, client satisfaction with the product and client satisfaction with the service; and three company performance indicators, namely: safety, profitability and productivity. (Takim and Akintoye, 2002)

By considering the fundamental requirement of evaluations of status of a project, it is identified that the followings KPIs can be used to measure the performance of a construction project.

- Construction cost and time
- Cost and Time predictability
- Defects
- Client satisfaction with the product and service
- Safety
- Profitability and Productivity

Since, Cost predictability, Profitability and Productivity directly relate with the CMS of any construction project following factors have been selected to identify the possible outcomes of the existing systems.

Table 2.1: Key performance indicators

KPI	**Area**
Cost predictability	Financial situation
	Inventory
	Manpower and materials utilization
	Machinery utilization
Productivity	Physical work done
Profitability	Comparison with budget
	Effects of inflation and price fluctuation
	Analysis of NPV and ROI
	Analysis of SV and SPI

2.8 Summary

This chapter is discussed the history and background of the cost monitoring systems practiced and identified drawbacks of the traditional cost management systems. In addition to that it is described the importance of having an effective and efficient CMS in construction projects and also identified basic cost management processes such as establishing a project baseline plan measuring and monitoring progress and performance, comparing actual performance against plan and taking remedial actions. Furthermore it is discussed about operational cost estimating, cash flow S-curves and target costing. The uses and benefits of an ICMSs also discussed in this chapter and highlighted the performance indicators of projects while clearly demonstrating the relevant indicator types and Key Performance Indicators (KPI) that can be used to measure the performance of construction projects.

Chapter 3
Research methodology

3.1 General

This chapter is to demonstrate the methodology employed to carry out this research. The framework of the research, the way of selection of population and questionnaire formulation have been discussed in this chapter and also explain the hypothesis, limitations and the findings of past researches which are applicable for this study.

3.2 Framework of the study

Project Cost Management (PCM) includes the processes required to ensure that the project is completed within the approved budget. These processes interact with each other and with the processes in the other project management knowledge areas as well.

Resource planning

Cost estimating

Cost budgeting

Cost control (PMBOK, Chapter 7- Project Cost Management.)

Having a comprehensive CMS is a great help to the Project Manager for smooth and effective monitoring and controlling of the project. As discussed in the chapter 2, this requirement was highlighted by Scuderi and Oltman (2007) and introduced three deferent indicators as lagging indicators, current indicators and leading indicators to measure the performance of any good project management system.

Followings factors relating to the current practices in the Sri Lankan construction companies have been examined through this exercise.

- Existing cost monitoring systems and their outcomes
- Measure the performance level of existing cost monitoring systems
- Professional's understanding and views on ICMS
- Organizational requirements and support on implementation of ICMS
- Probable reasons behind the non-implementation the ICMS

3.3 Research approach

This research is a quantitative study based on the results of a structured questionnaire survey.

3.4 Population of sample

Population of this study represents the project management professionals in the construction companies in Sri Lanka including owners/directors of the companies, project managers, project engineers, senior engineers, and senior quantity surveyors. About 100 questionnaires have been distributed among the professionals in the industry working in the various civil engineering construction projects under several organizations.

3.5 Method of data collection

The relevant information, past data and indicators needed to be considered were identified through the literature review and research data have been collected through interviews and questionnaire survey.

Following areas have been focused for the evaluation.

3.5.1 Personal information

Information related to the age, occupation, gender, educational background and experience in the construction industry and contact details of the professionals of the organizations were collected under this section. In addition to that the necessary data related to the evaluation of the specialization of the engineering discipline, computer literacy and the experience of working with ICMS in current organization or any working environment was also collected.

3.5.2 Organizational information

This section is to collect data on nature, capacity and specialty of the construction companies.

3.5.3 Characteristics of the existing CMSs in the construction projects

As discussed in the literature review cost monitoring is one of the vital roles in project management. Section-3 of the questionnaire is to examine the types of CMS, the software / technology used and outcomes of the current CMS in construction companies in Sri Lanka. Data have been collected for the evaluation of the following areas.

21) Financial situation
22) Physical work done
23) Inventory control
24) Material utilization
25) Machinery utilization
26) Comparison with budget
27) Effects of inflation and price fluctuation
28) Analysis of NPV and ROI
29) Analysis of SV and SPI

The performance level of the existing cost monitoring systems has been measured using three indicators as discussed in the literature review and Section 3.2. The existing management systems have been classified as follows based on their performance levels.

Table 3.1: Indicator types and classification of CMS

	Lagging indicators	**Current indicators**	**Leading indicators**	**Classification of CMS**
1	x	x	x	Highly successful
2	x	x		Successful
3	x	-	-	Partially successful
4	-	-	-	Failure

In addition to that the organizational requirements and support on implementation of ICMS in the construction projects have been evaluated because the selection of the relevant methodology or software usually depends on specific requirements of the organization and the willingness of the top management or owners of the company.

Sometimes professionals are compelled to work with traditional systems despite having the necessary knowledge, awareness and requirement towards implementation of new systems. So this section is to examine the organizational commitment, contribution and requirement and support towards implementation of ICMS. The following factors have been taken in to consideration.

30) Authority to change the existing system
31) Employee's contribution towards the successful execution of CMS
32) Training on CMS for employees
33) Facilities and authority to execute an identical CMS and enhance it to project level
34) Organizational motivation towards enhancing the current CMS
35) Organizational requirement and support for implementing a CMS at project level

3.5.4 Professional's understanding and views on ICMSs

This section is to examine the professional's understanding and views on ICMSs based on the guidelines of the Institute of Management Accountants (IMA), United States of America. The IMA, highlights the "Uses and Benefits of the ICMS Frame Works" through the publication of Statement on Management Accounting, Strategic Cost Management, Implementing Capacity Cost Management System, 2000. It explains the benefits of the implementation of ICMS and the assistance towards enhancing the current management system. This section is to measure the understanding and views on ICMSs by the professionals who are involved with the construction projects in Sri Lanka. The professional's views with related to the following areas have been examined through the questionnaire.

36) Identification of optimal customer / market segments
37) Improvement of the profitability of key products
38) Supports for improved decision making
39) Reduction of miscommunication
40) Optimization of the origination's profitability
41) Increasing the process effectiveness
42) Integrating of financial and non-financial metrics
43) Improving the competitive position

44) Facilitation for strategic marketing and operational decisions
45) Support for rapid response to changing conditions
46) Providing the means to integrate activities and outcomes across processes and entities in the value chain
47) Anticipating and reacting to environmental changes before the organization is affected by them
48) External focus on customer requirements and competitive treats so that customer requirements drive the organization
49) Systematic relations with all elements, internal and external, so that problem solving is holistic rather than incremental through cross functional integration
50) Optimization profits by ensuring that resources remain focused on value activities and that waste is identified and removed
51) Linking individuals, groups, and organizational incentives to ensure that everyone in the organization understands and is motivated to achieve strategic and operational objectives
52) Communication across all levels, all processes, and all units about the needs of the customer, results achieved, problems encountered and solved and the challenges remaining to be met

3.5.5 Reasons for non-implementing of the ICMSs in local construction companies

It was identified that the usage of the ICMS is comparably low in the construction industry than companies in manufacturing, trading, banking and service providing industries during the preliminary investigation and through preliminary interviews. Therefore, this section is to identify the probable reasons for not implementing ICMS in most of the organizations in the construction sector.

53) Capital cost for implementing ICMS
54) Complexity of ICMS
55) Employee's adaptation for ICMS
56) Employee's knowledge on Information Technology
57) Usefulness of ICMS
58) Compatibility of ICMS with the current system
59) Employee's tendency towards use of ICMS
60) Knowledge and interest of owners on implementation of ICMS

3.6 Method of data analysis

Analysis of the collected data has been conducted in the following manner in order to find the performance level of the existing cost monitoring systems, professional's views and understanding of ICMSs and the probable reasons for both implementation and non-implementation of ICMS in the construction projects in construction companies. Section 01 and Section 02 of the questionnaire are to collect demographic information of the respondents and the general information about both projects and the organizations involved in this research.

The collected data was analyzed using Minitab and MS Excel and presented in graphical form. Section 03 of the questionnaire is to find the characteristics of the existing CMSs used in the construction projects and find the employee's contribution for the execution of the CMS. Each possible outcome is getting a score and the performance of the CMS is evaluated as per the total marks obtained.

Table 3.2: Marks allocation for the outcomes of the existing CMSs

Question No	Area	Reports can be produced				
		Lagging indicators		Current indicators	Leading indicators	
		Monthly	At completion	Daily	Next month forecast	None
21	Financial situation	0.5	0.5	1	1	0
22	Physical work done	0.5	0.5	1	1	0
23	Inventory	0.5	0.5	1	1	0
24	Manpower and materials utilization	0.5	0.5	1	1	0
25	Machinery utilization	0.5	0.5	1	1	0
26	Comparison with budget	0.5	0.5	1	1	0
27	Effects of inflation and price fluctuation	0.5	0.5	1	1	0
28	Analysis of NPV and ROI	0.5	0.5	1	1	0
29	Analysis of SV and SPI	0.5	0.5	1	1	0

Reference to the marks obtained for each project, success of the cost monitoring system practiced in that particular project was categorized in to following manner.

Table 3.3: Type of exiting cost monitoring system

Marks range	**Type of the existing CMS**
19 - 27	Highly successful
9 - 18	Successful
1 - 8	Partially successful
0	Failure

Five point Likert scale has been used to define the importance of the various factors which affect the implementation and practicing of ICMS. In addition to that the necessary data was collected through the questionnaire in order to evaluate the demographic characteristics, educational background, knowledge, awareness and views on ICMS of the respondents. Responses to the questionnaire have been evaluated according to the five point Likert scale in the following manner from question No. 30 onwards.

Table 3.4: Five point Likert scale

1	2	3	4	5
Strongly agree	Agree	Don't have a clear idea	Disagree	Strongly disagree
☐	☐	☐	☐	☐

Hypothesis testing is conducted to examine the professional's contribution as well as the organizational support towards implementation of ICMS in the organizations in the construction companies in Sri Lanka. It has been evaluated under three different scenarios.

Table 3.5: Evaluation scenarios

Scenario	Area
01	Professional's views on support / requirement of the organization to execute an ICMS in construction projects
02	Professional's understanding and views on support / benefits of ICMS
03	Probable reasons behind implementation / not implementation of an ICMS in organizations

According to the above scenarios following hypothesis were empirically tested according to the results of the questionnaire survey relating to the construction companies in Sri Lanka.

Table 3.6: Hypothesis (Scenario – 01)

Q. No	Factor	Hypothesis
30	Authority to change	H_0: Organizations provide authority for employees to change the existing CMS
		H_1: Organizations not provide authority for employees to change the existing CMS
31	Employee contribution	H_0: All Employees of the entire organization contribute towards the successful execution of CMS
		H_1: All Employees of the entire organization not contribute towards the successful execution of CMS.
32	Trainings	H_0: The organization conducts necessary trainings for employees on CMS
		H_1: The organization not conduct necessary trainings for employees on CMS
33	Facilities and authorities to execute	H_0 : Organization has provided all necessary facilities and authorities to execute an identical CMS and enhance it in projects
		H_1 : Organization hasn't provided all necessary facilities and authorities to execute an identical CMS and enhance it in projects

34	Encouragement	H_0: Professionals are provided authority and facility to execute identical CMS in projects
		H_1: Professionals are not provided authority and facility to execute identical CMS in projects
35	Organizational requirement and support to implement	H_0: There is neither any organizational requirement nor support to implement a CMS in project level
		H_1: There is an organizational requirement and support to implement a CMS in project level

Table 3.7: Hypothesis (Scenario – 02)

Q. No	Provision	Hypothesis
36	To Identify optimal customer / Market segments	H_0: Professionals believe as ICMS help to identify optimal customer / market segments
		H_1: Professionals not believe as ICMS help to identify optimal customer / market segments
37	To improves the profitability of key products	H_0: Professionals believe as ICMS improves the profitability of key products
		H_1: Professionals believe that as ICMS improves the profitability of key products
38	To make improved decision making	H_0: Professionals believe as the ICMS supports for improved decision making
		H_1: Professionals not believe as the ICMS supports for improved decision making
39	To reduce miscommunication	H_0: Professionals believe that as the ICMS reduces miscommunication
		H_1: Professionals not believe that as the ICMS reduces miscommunication
40	To optimize the origination's profitability	H_0: Professionals believe as the ICMS optimizes the origination's profitability
		H_1: Professionals not believe as the ICMS optimizes the origination's profitability

41	To increase process effectiveness	H_0: Professionals believe as the ICMS increases process effectiveness
		H_1: Professionals believe as the ICMS increases process effectiveness
42	To integrate financial and non-financial metrics	H_0: Professionals believe as the ICMS integrates financial and non-financial metrics
		H_1: Professionals not believe as the ICMS integrates financial and non-financial metrics
43	To improve the competitive position	H_0: Professionals believe as the ICMS improves the competitive position
		H_1: Professionals not believe as the ICMS improves the competitive position
44	To facilitate strategic marketing and operational decisions	H_0: Professionals believe as the ICMS facilitate strategic marketing and operational decisions
		H_1: Professionals not believe as the ICMS facilitate strategic marketing and operational decisions
45	To rapid response to changing conditions	H_0: Professionals believe as the ICMS supports rapid response to changing conditions
		H_1: Professionals not believe as the ICMS supports rapid response to changing conditions
46	Providing the means to integrate activities and outcomes across processes and entities in the value chain	H_0: Professionals believe as the ICMS provides the means to integrate activities and outcomes across processes and entities in the value chain
		H_1: Professionals not believe as the ICMS provides the means to integrate activities and outcomes across processes and entities in the value chain
47	Anticipating and react to environmental changes before an organization is affected by them	H_0: Professionals believe as the helps to anticipate and react to environmental changes before an organization is affected by them
		H_1: Professionals not believe as the helps to anticipate and react to environmental changes before an organization is affected by them

48	Creating an external focus on customer requirement and competitive treats so that customer requirement drive the organization	H_0: Professionals believe as the ICMS creates an external focus on customer requirement and competitive treats so that customer requirement drive the organization
		H_1: Professionals not believe as the ICMS creates an external focus on customer requirement and competitive treats so that customer
49	Creation of systematically relationship of all elements, internal and external	H_0: Professionals believe as the ICMS systematically relates all elements, internal and external, so problems are solved holistically rather than incrementally through cross functional integration
		H_1: Professionals not believe as the ICMS systematically relates all elements, internal and external, so problems are solved holistically rather than incrementally through cross functional integration
50	Optimizing the profits by ensuring that resources remain focused on value activities, that waste is identified and removed	H_0: Professionals believe as the ICMS optimizes profits by ensuring that resources remain focused on value activities, that waste is identified and removed
		H_1: Professionals not believe as the ICMS optimizes profits by ensuring that resources remain focused on value activities, that waste is identified and removed
51	Linking individual, groups, and organizational incentives to ensure that everyone in the organization understands and is motivated to achieve strategic and operational objectives	H_0: Professionals believe as the ICMS links individual, groups, and organizational incentives to ensure that everyone in the organization understands and is motivated to achieve strategic and operational objectives
		H_1: Professionals not believe as the ICMS links individual, groups, and organizational incentives to ensure that everyone in the organization understands and is motivated to achieve strategic and operational objectives

52	Communication across all levels, all process, and all units the needs of the customer, result achieved, problems encountered and solved and remaining challengers to be met	H_0: Professionals believe as the ICMS communicates across all levels, all process, and all units the needs of the customer, result achieved, problems encountered and solved and remaining challengers to be met
		H_1: Professionals not believe as the ICMS communicates across all levels, all process, and all units the needs of the customer, result achieved, problems encountered and solved and remaining challengers to be met

Table 3.8: Hypothesis (Scenario – 03)

Q. No	Factor	Hypothesis
53	Capital Cost	H_0: Professionals believe that The ICMS is not implemented since it is quite expensive
		H_1: Professionals not believe that The ICMS is not implemented since it is quite expensive
54	Complexity	H_0: Professionals believe that The ICMS is not implemented since it is too complex
		H_1: Professionals not believe that The ICMS is not implemented since it is too complex
55	Adoption	H_0: Professionals believe that The ICMS is not implemented since most of the employees cannot be adopted
		H_1: Professionals not believe that The ICMS is not implemented since most of the employees cannot be adopted
56	Employee's knowledge on Information Technology (IT)	H_0 : Professionals believe that The ICMS is not implemented since most employees have less knowledge on IT.
		H_1: Professionals not believe that The ICMS is not implemented since most employees have less knowledge on IT

57	Usefulness	Ho: Professionals believe that The ICMS is not implemented since it is not useful
		H_1: Professionals not believe that The ICMS is not implemented since it is not useful
58	Compatibility with the current system	H_0: Professionals believe that The ICMS is not implemented since it is not compatible with the current system
		H_1: Professionals not believe that The ICMS is not implemented since it is not compatible with the current system
59	Employee's tendency to use	H_0: Professionals believe that The ICMS is not implemented since most of the employees don't like to use it
		H_1: Professionals not believe that The ICMS is not implemented since most of the employees don't like to us it
60	Top management / owner's tendency to implement	H_0: Professionals believe that The ICMS is not implemented since there is less knowledge/ interest of top management / owners on ICMS
		H_1: Professionals not believe that The ICMS is not implemented since there is less knowledge/ interest of top management / owners on ICMS

3.7 Summary

This chapter demonstrated the methodology employed to carry out this research. The framework of the research, the way of selection of population and questionnaire formulation have been discussed. Five different categories have been taken in to consideration for data collecting namely, personal information, organizational information, characteristics of the existing cost monitoring system in the construction projects, professional's understanding and views on ICMSs and probable reasons for non-implementing of the ICMS in local construction companies. The relevant information, past data and indicators needed to be considered were identified through the literature review and the hypothesis, limitations and the findings of past researches which are applicable for this study also discussed in this chapter. In addition to that it is discussed in this chapter about method of data analysis and examined the outcomes of the analysis.

Chapter 4

Analysis and discussion

4.1 General

This Chapter is to analyze and discuss the data obtained through the questionnaire. The data analysis is carried out as demonstrated in Chapter 03 and MS Excel 2010 and Minitab have been used as calculation and analysis tools.

4.2 Distribution of sample and demographic characteristics of respondents

The Questionnaires have been distributed among 100 professionals in the construction industry from various disciplines and technical backgrounds and evaluation of their specialty, age, gender, educational level, years of construction experience, specific involvement with various projects, computer literacy and the experience with ICMS are taken in to consideration in this section.

4.2.1 Distribution of sample

The key professionals in the construction companies including Engineers, Quantity Surveyors, Project Managers, and other Technical staff have been selected as the population for this research and the sample consisted of 57 professionals from both government and non-government organizations.

Table 4.1: Distribution of sample *(Question No. 02)*

Designation category	**Nos**
Engineers	17
Quantity Surveyors	20
Managers	14
Technical Staff	6
Other	0
Total	**57**

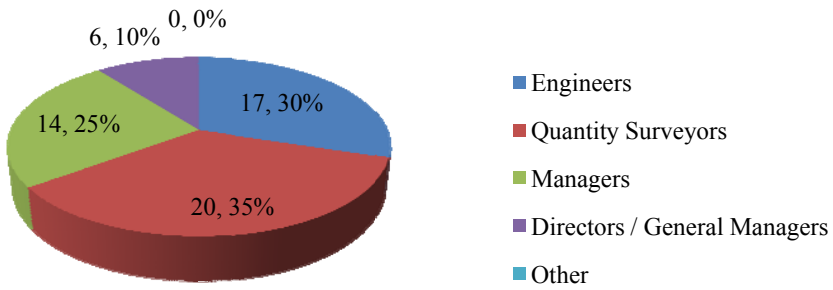


Figure 4.1: Distribution of sample

4.2.2 Demographic characteristics of respondents (Age variation)

Basically management of the organizations have been focused for data collection and age variations of the respondents shown in the Table: 4.2 and the Figure 4.2 Majority of the respondents are between age 26 – 35 and it is equal to 49% of the sample.

Table 4.2: Age variation *(Question No. 02)*

Age category (Years)	**Nos**
18 - 25	0
26 - 35	28
36 - 45	14
46 - 55	9
56 & above	6
Total	**57**

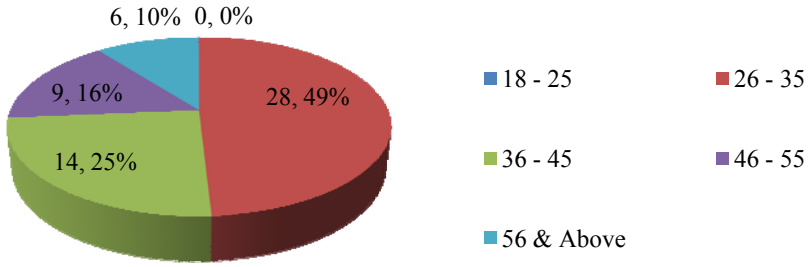


Figure 4.2: Age variation

4.2.3 Demographic characteristics of respondents (Gender variation)

73% of the respondents were male for this research and it was difficult to keep the gender balance, since the less employment of women in the construction industry.

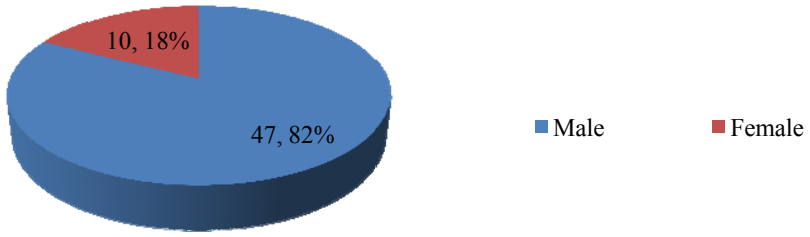


Figure 4.3: Gender variation

4.2.4 Demographic characteristics of respondents (Education level)

Majority (64%) of the participant of this study has at least a basic degree and there are 31% post graduates and 3.5% diploma holders among the responded for the survey.

Table 4.3: Education level *(Question No. 04)*

Education level	**Nos**
GCE A/L	0
Certificate	0
Diploma	4
Graduate	36
Post Graduate	17
Total	**57**

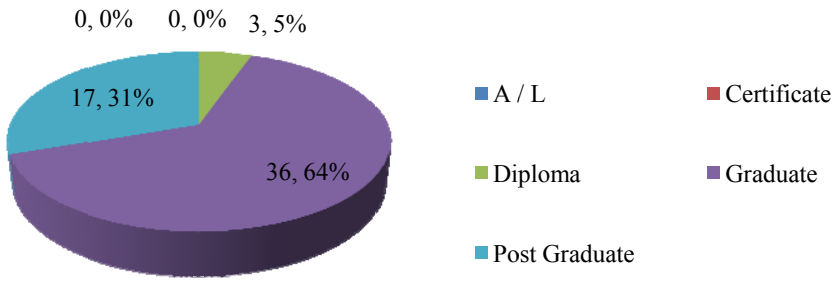


Figure 4.4: Education level

4.2.5 Demographic characteristics of respondents (Construction experience)

Professionals, having different experiences in various disciplines, have participated for this study and their experience in construction industry (in years) shown in the Table 4.4 and Figure 4.5.

Table 4.4: Construction experience *(Question No. 06)*

Construction experience (Years)	**Nos**
0 - 5	14
6 - 10	17
11 - 20	13
21 - 30	9
31 or above	4
Total	**57**

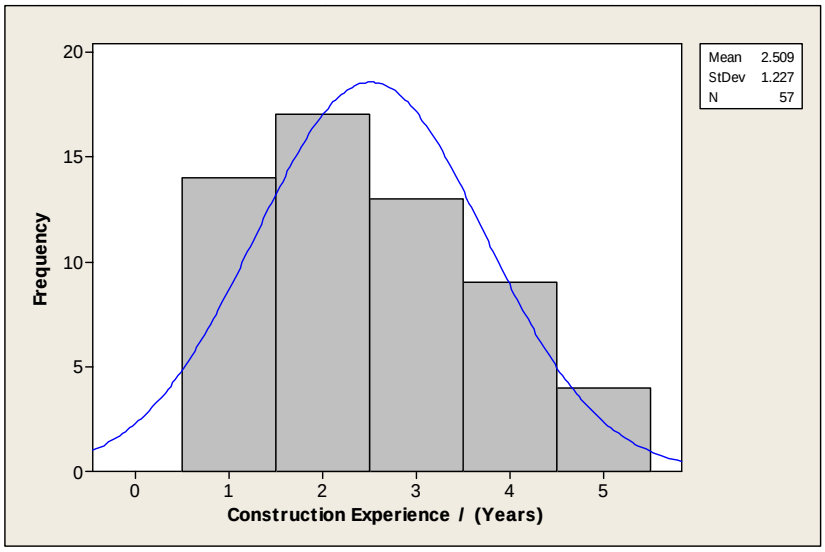


Figure 4.5: Construction experience

4.2.6 Demographic characteristics of respondents (Specialization)

Professionals from the all major areas of the construction industry have been involved in this study and they have specialized experience in construction of buildings, roads, bridges, water supply and drainage system and other related construction work. Distribution of professional's specialty is shown in Figure 4.6.

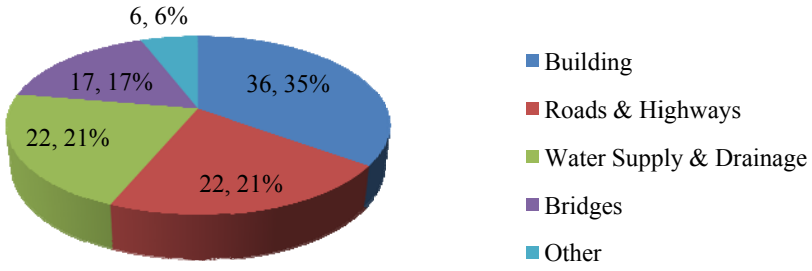


Figure 4.6: Specialization in the construction industry

4.2.7 Demographic characteristics of respondents (Computer literacy)

It can be observed that 52% of the participants were confident as they have good computer literacy and 17% think they have an excellent ability to use computers.

In addition to that the findings of the research have emphasized that all respondents have some level of experience with computers.

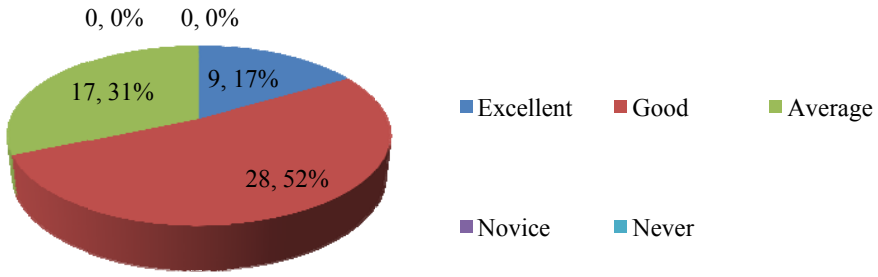


Figure 4.7: Computer literacy

4.2.7 Demographic characteristics of respondents (Experience with ICMS)

Professional's experience with ICMSs and knowledge about ICMSs are key factors which would considerably affect the implementation of ICMSs in any organization. With the findings of the research it is clearly displayed that none of the respondents believe they have excellent experience with ICMSs. That means most of the key personnel in construction organizations are having little knowledge of the benefits and usage of ICMSs

Table 4.5: Experience with ICMS*(Question No. 10)*

Experience with ICMS	**Nos**
Excellent	0
Good	6
Average	31
Novice	3
Never	9
Total	**49**

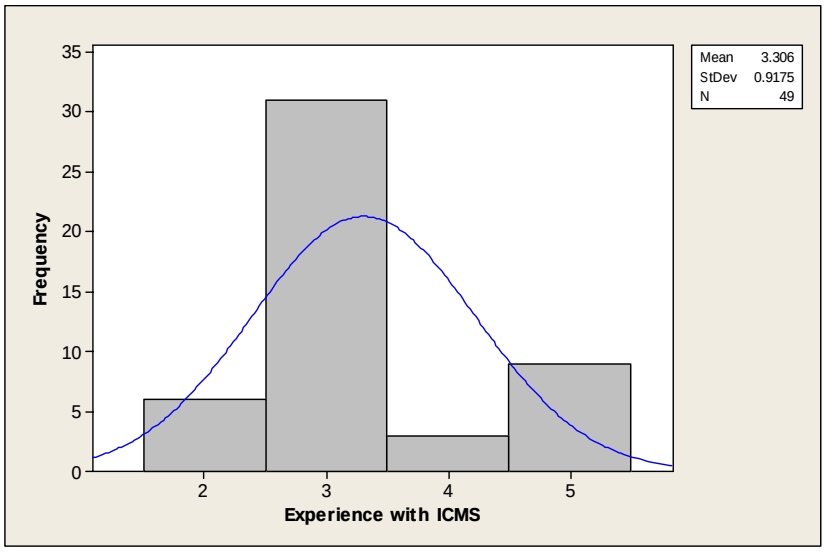


Figure 4.8: Experience with ICMS

4.3 Characteristics of organizations involved for the study

The aim of Section 02 of the questionnaire was to collect foremost important information about the organizations, where the professionals who responded to this exercise worked in. Information about existing Cost Monitoring Systems have been collected related to about 55 projects executed by various construction companies in Sri Lank and there were 75% local construction companies and 25% of foreign companies in the selected sample of this study

Table 4.6: Experience in construction industry *(Question No. 12)*

Experience in construction industry /(Years)	**No of companies**
0 - 5	12
6 - 10	8
11 - 20	13
21 - 30	18
31 above	5
Total	**56**

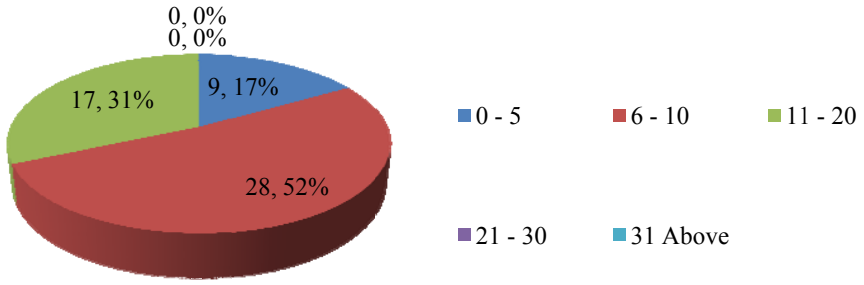


Figure 4.9: Experience in construction industry

4.4 Characteristics of the existing cost monitoring systems

As demonstrated in chapter 3, the performance level of the existing cost monitoring systems has been measured using three indicators. Details of reports, related to the cost monitoring and financial performance of the projects, that can be produced using existing cost monitoring systems of current construction projects have been collected through the questionnaire survey and three main indicators were observed to measure the success of the current systems.

Table 4.7: Outcomes of existing CMSs

Q. No	Area	Reports can be produced				
		Lagging indicators		Current indicators	Leading indicators	
		Monthly	**At completion**	**Daily**	**Next month forecast**	**None**
21	Financial situation	50	11	0	11	3
22	Physical work done	44	9	11	6	3
23	Inventory	17	14	9	3	6
24	Manpower and materials utilization	28	9	25	9	3
25	Machinery utilization	28	9	28	6	3
26	Comparison with budget	42	14	0	3	3
27	Effects of Inflation and price fluctuation	25	14	0	0	17
28	Analysis of NPV and ROI	3	20	0	0	20
29	Analysis of SV and SPI	9	14	0	0	20

With the results obtained through the analysis of the responses to the questions No. 21 to 29 as demonstrated in section 3.5, it is observed that the usage of successful CMS is very low, being only 11%, and there was no comprehensive CMS in any project identified through this research. That means all three indicators (Lagging indicators, Current indicators and Leading indicators) have not been generated by any of the CMSs at once. Partially successful CMSs have been implemented in 89% of projects and various methods have been used in almost all the observed projects for cost monitoring.

Table 4.8: Type of the existing cost monitoring systems

Type of the existing CMSs	**Nos**
Highly successful	0
Successful	6
Partially successful	50
Failure	0

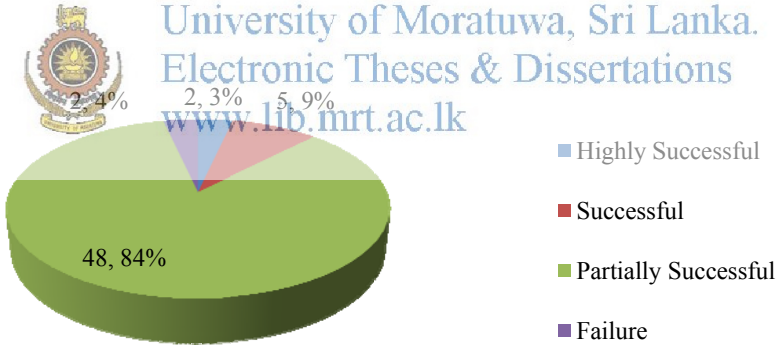


Figure 4.10: Types of the existing cost monitoring systems

With the above results it was essential to examine the probable reasons behind the poor cost monitoring practices in the construction companies and it was observed that a comprehensive ICMS or ERP system have not been used in any of the construction projects. Specially configured software have been used in 23% of the projects and In-house built systems and Microsoft application software have been used in 46% and 19% of projects respectively. Therefore it is obvious that there would be some constraint to employ the ICMS in local construction projects.

Table 4.9: Nature of the existing cost monitoring system

Nature of Existing CMS	**Nos**
In-house built system	22
Microsoft application software	9
Specially configured software	11
Well-developed ICMS	0
None	6
Total	**48**

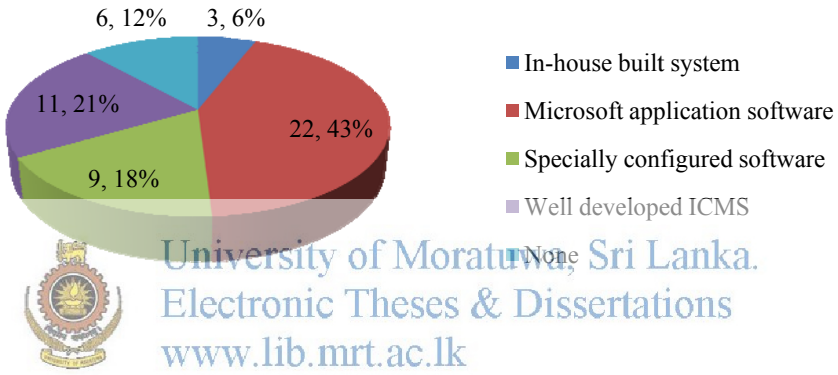


Figure 4.11: Nature of the existing cost monitoring systems

4.5 Organizational contribution to execute and develop the existing CMS

As discussed in Chapter 02, followings are identified as factors that contribute towards implementation of CMS at project level.

- Providing authority to the relevant employees to change the existing CMS
- Active employee contribution to execute a CMS
- Training on CMS
- Providing authority and facility to execute identical CMS in projects if necessary
- Encouragement of employees towards the enhancement of existing CMS
- Organizational requirement to execute CMS at project level

These criteria have been analyzed using hypothesis testing in three different scenarios reference to the data collected under Section 03, Section 04 and Section 05 of the questionnaire.

4.6 Hypothesis analysis

As discussed in Section 3.5, Hypothesis testing has been conducted to examine the professional's contribution as well as the organizational support towards implementation of ICMS in the organizations in the construction companies in Sri Lanka. It has been evaluated under four different scenarios.

Null hypothesis H_0: $t < t_c$

H_1: $t > t_c$

When the t value is greater than t_c (t - Critical) based on a significance level of 5%, that Null Hypothesis was rejected based on the results obtained by the evaluation of responses to Section 03, Section 04 and Section 05 of the questionnaire.

Scenario 01: Organizational contribution to execute and develop the existing CMS

Scenario 02: Understanding of professionals on benefits of ICMS

Scenario 03: Practical difficulties and barriers

4.6.1 Data analysis (Scenario 01)

Table 4.10: Data analysis (Scenario 01)

	Contribution towards a successful CMS	Strongly Agree	Agree	Don't have a clear idea	Disagree	Strongly Disagree	Total (n)	Mean Value ($\bar{x}=\sum fx/\sum f$)	Variance $[\sum f(x-M)^2/\sum f]$	Standard Deviation $\{\sigma_x = [\sqrt{(\sum f(x-M)^2/\sum f)}]\}$	$t = (\bar{x}-M)/(\sigma_x/\sqrt{(n)})$	t - Critical
		1	2	3	4	5		$\bar{x}$	V	σ_x	t	t_c
Q. No.	**Organizational contribution to execute and develop the existing CMS**											
30	There is unique Cost Monitoring System for the entire organization and nobody is allowed to make any changes or any development at project level	6	22	20	0	9	57	2.72	1.38	1.1765	-1.8014	1.6725
31	All Employees of the entire organization contribute towards the successful execution of Cost Monitoring System	11	11	25	6	3	56	2.63	1.18	1.0882	-2.5789	1.6730
32	The organization conducts necessary trainings for employees on Cost Monitoring System	6	11	33	3	3	56	2.75	0.85	0.9195	-2.0346	1.6730
33	I have been provided all necessary facilities and authorities to execute an identical Cost Monitoring System and enhance it in my project	3	22	17	6	9	57	2.93	1.35	1.1628	-0.4556	1.6725
34	I have been encouraged by the organization to enhance the current Cost Monitoring System	6	28	14	0	9	57	2.61	1.42	1.1916	-2.4455	1.6725
35	There is neither any organizational requirement nor support to implement a Cost Monitoring System in project level	0	9	31	6	11	57	3.33	0.94	0.9698	2.5950	1.6725

4.6.2 Hypothesis testing (Scenario 01)

Table 4.11: Hypothesis testing (Scenario 01)

	Approach	Hypothesis	t	t_c	Condition	Decision
30	Authority to change	H_0: Organizations not provide authority for employees to change the existing CMS	-1.8014	1.6725	$t < t_c$	Accept
		H_1: Organizations provide authority for employees to change the existing CMS				Reject
31	Employee contribution	H_0: All Employees of the entire organization contribute towards the successful execution of CMS	-2.5789	1.6730	$t < t_c$	Accept
		H_1: All Employees of the entire organization not contribute towards the successful execution of Cost Monitoring System				Reject
32	Trainings	H_0: The organization conducts necessary trainings for employees on CMS	-2.0346	1.6730	$t < t_c$	Accept
		H_1: The organization not conduct necessary trainings for employees on CMS				Reject
33	Facilities and authorities to execute	H_0 : Organization has provided all necessary facilities and authorities to execute an identical Cost Monitoring System and enhance it in projects	-0.4556	1.6725	$t < t_c$	Accept
		H_1 : Organization hasn't provided all necessary facilities and authorities to execute an identical Cost Monitoring System and enhance it in projects				Reject
34	Encouragement	Ho: Professionals are provided authority and facility to execute identical CMS in projects	-2.4455	1.6725	$t < t_c$	Accept
		H_1: Professionals are not provided authority and facility to execute identical CMS in projects				Reject
35	Organizational requirement and support to implement	H_0: There is neither any organizational requirement nor support to implement a Cost Monitoring System in project level	2.5950	1.6725	$t > t_c$	Reject
		H1: There is an organizational requirement and support to implement a Cost Monitoring System in project level				Accept

4.6.3 Data analysis (Scenario 02)

Table 4.12: Data analysis (Scenario 02)

	Contribution towards a Successful CMS	Strongly Agree	Agree	Don't have a clear idea	Disagree	Strongly Disagree	Total (n)	Mean Value ($\bar{x}=\sum fx/\sum f$)	Variance $[\sum f(x-M)^2/\sum f]$	Standard Deviation $\{\sigma_x = [\sqrt{(\sum f(x-M)^2/\sum f)}]\}$	$t = (\bar{x}-M) / (\sigma_x/\sqrt{(n)})$	t - Critical
		1	2	3	4	5		$\bar{x}$	V	σ_x	t	t_c
Q. No.	**Understanding of professionals on Benefits of ICMS**											
36	The ICMS helps to identify optimal customer / market segments	6	39	3	0	3	51	2.12	0.71	0.8402	-7.5000	1.6759
37	The ICMS improves the profitability of key products	17	31	3	0	0	51	1.73	0.32	0.5685	-16.0116	1.6759
38	The ICMS supports for improved decision making	22	22	3	0	3	50	1.80	1.02	1.0102	-8.4000	1.6766
39	The ICMS reduces miscommunication	3	31	6	0	11	51	2.71	1.65	1.2852	-1.6343	1.6759
40	The ICMS optimizes the origination's profitability	14	28	6	0	3	51	2.02	0.94	0.9693	-7.2229	1.6759
41	The ICMS increases process effectiveness	11	31	3	0	3	48	2.02	0.87	0.9338	-7.2652	1.6779
42	The ICMS integrates financial and non-financial metrics	6	22	17	0	6	51	2.57	1.21	1.1001	-2.8003	1.6759
43	The ICMS improves the competitive position	14	25	9	0	3	51	2.08	0.99	0.9969	-6.6021	1.6759
44	The ICMS facilitate strategic marketing and operational decisions	3	42	3	0	3	51	2.18	0.63	0.7926	-7.4200	1.6759
45	The ICMS supports rapid response to changing conditions	0	36	14	0	0	50	2.28	0.21	0.4536	-11.2250	1.6766

	Contribution towards a successful CMS	Strongly Agree	Agree	Don't have a clear idea	Disagree	Strongly Disagree	Total (n)	Mean Value ($\bar{x}=\sum fx/\sum f$)	Variance $[\sum f(x-\mu)^2/\sum f]$	Standard Deviation $\{\sigma_x = [\sqrt{(\sum f(\bar{x}-\mu)^2/\sum f)}]\}$	$t = (\bar{x}-\mu)/(\sigma_x/\sqrt{(n)})$	t - Critical
		1	2	3	4	5		$\bar{x}$	V	σ_x	t	t_c
46	The ICMS provides the means to integrate activities and outcomes across processes and entities in the value chain	9	22	11	0	9	51	2.57	1.69	1.3001	-2.3696	1.6759
47	The ICMS helps to anticipate and react to environmental changes before an organization is affected by them	14	22	14	0	3	53	2.17	1.03	1.0141	-5.9601	1.6747
48	The ICMS creates an external focus on customer requirement and competitive treats so that customer requirement drive the organization	3	33	14	0	3	53	2.38	0.70	0.8373	-5.4139	1.6747
49	The ICMS systematically relates all elements, internal and external, so problems are solved holistically rather than incrementally through cross functional integration	3	22	11	0	14	50	3.00	1.84	1.3553	0.0000	1.6766
50	The ICMS optimizes profits by ensuring that resources remain focused on value activities, that waste is identified and removed	14	28	9	0	3	54	2.07	0.94	0.9684	-7.0261	1.6741
51	The ICMS links individual, groups, and organizational incentives to ensure that everyone in the organization understands and is motivated to achieve strategic and operational objectives	11	31	9	3	0	54	2.07	0.60	0.7734	-8.7974	1.6741
52	The ICMS Communicates across all levels, all process, and all units the needs of the customer, result achieved, problems encountered and solved and remaining challengers to be met	9	25	11	6	3	54	2.43	1.15	1.0746	-3.9257	1.6741

4.6.4 Hypothesis testing (Scenario 02)

Table 4.13: Hypothesis testing (Scenario 02)

	Support of the ICMS	Hypothesis	t	t_c	Condition	Decision
36	To Identify optimal customer / Market segments	H_0: Professionals believe as ICMS help to identify optimal customer / market segments	-7.5000	1.6759	$t < t_c$	Accept
		H_1: Professionals not believe as ICMS help to identify optimal customer / market segments				Reject
37	To improves the profitability of key products	H_0: Professionals believe that as ICMS improves the profitability of key products	-16.0116	1.6759	$t < t_c$	Accept
		H_1: Professionals believe that as ICMS improves the profitability of key products				Reject
38	To make improved decision making	H_0: The organization conducts necessary trainings for employees on CMS	-8.4000	1.6766	$t < t_c$	Accept
		H_1: The organization not conduct necessary trainings for employees on CMS				Reject
39	To reduce miscommunication	H_0 : Organization has provided all necessary facilities and authorities to execute an identical Cost Monitoring System and enhance it in projects	-1.6343	1.6759	$t < t_c$	Accept
		H_1 : Organization hasn't provided all necessary facilities and authorities to execute an identical Cost Monitoring System and enhance it in projects				Reject
40	To optimize the origination's profitability	Ho: Professionals are provided authority and facility to execute identical CMS in projects	-7.2229	1.6759	$t < t_c$	Accept
		H_1: Professionals are not provided authority and facility to execute identical CMS in projects				Reject

	Approach	Hypothesis	t	t_c	Condition	Decision
41	To increase process effectiveness	H0: Professionals believe as the ICMS increases process effectiveness	-7.2652	1.6779	$t < t_c$	Accept
		H1: Professionals believe as the ICMS increases process effectiveness				Reject
42	To integrate financial and non-financial metrics	H0: Professionals believe as the ICMS integrates financial and non-financial metrics	-2.8003	1.6759	$t < t_c$	Accept
		H1: Professionals not believe as the ICMS integrates financial and non-financial metrics				Reject
43	To improve the competitive position	H0: Professionals believe as the ICMS improves the competitive position	-6.6021	1.6759	$t < t_c$	Accept
		H1: Professionals not believe as the ICMS improves the competitive position				Reject
44	To facilitate strategic marketing and operational decisions	H0: Professionals believe as the ICMS facilitate strategic marketing and operational decisions	-7.4200	1.6759	$t < t_c$	Accept
		H1: Professionals not believe as the ICMS facilitate strategic marketing and operational decisions				Reject
45	To rapid response to changing conditions	H0: Professionals believe as the ICMS supports rapid response to changing conditions	-11.2250	1.6766	$t < t_c$	Accept
		H1: Professionals not believe as the ICMS supports rapid response to changing conditions				Reject
46	Providing the means to integrate activities and outcomes across processes and entities in the value chain	H_0: Organizations provide authority for employees to change the existing CMS	-2.3696	1.6759	$t < t_c$	Accept
		H_1: Organizations not provide authority for employees to change the existing CMS				Reject

	Response of the ICMS	Hypothesis	t	t_c	Condition	Decision
47	Anticipating and react to environmental changes before an organization is affected by them	H_0: All Employees of the entire organization contribute towards the successful execution of CMS	-5.9601	1.6747	$t < t_c$	Accept
		H_1: All Employees of the entire organization not contribute towards the successful execution of Cost Monitoring System				Reject
48	Creating an external focus on customer requirement and competitive treats so that customer requirement drive the organization	H_0: The organization conducts necessary trainings for employees on CMS	-5.4139	1.6747	$t < t_c$	Accept
		H_1: The organization not conduct necessary trainings for employees on CMS				Reject
49	Creation of systematically relationship of all elements, internal and external	H_0 : Organization has provided all necessary facilities and authorities to execute an identical Cost Monitoring System and enhance it in projects	0.0000	1.6766	$t < t_c$	Accept
		H_1 : Organization hasn't provided all necessary facilities and authorities to execute an identical Cost Monitoring System and enhance it in projects				Reject
50	Optimizing the profits by ensuring that resources remain focused on value activities that waste is identified and removed	Ho: Professionals are provided authority and facility to execute identical CMS in projects	-7.0261	1.6741	$t < t_c$	Accept
		H_1: Professionals are not provided authority and facility to execute identical CMS in projects				Reject
51	Linking individual, groups, and organizational incentives to ensure that everyone in the organization understands and is motivated to achieve strategic and operational objectives achieve strategic and operational objectives	H_0: Organizations provide authority for employees to change the existing CMS	-8.7974	1.6741	$t < t_c$	Accept
		H_1: Organizations not provide authority for employees to change the existing CMS				Reject
52	Communication across all levels, all process, and all units the needs of the customer, result achieved, problems encountered and solved and remaining challengers to be met	H_0: All Employees of the entire organization contribute towards the successful execution of CMS	-3.9257	1.6741	$t < t_c$	Accept
		H_1: All Employees of the entire organization not contribute towards the successful execution of Cost Monitoring System				Reject

4.6.5 Data analysis (Scenario 03)

Table 4.14: Data analysis (Scenario 03)

	Contribution towards a successful CMS	Strongly Agree	Agree	Don't have a clear idea	Disagree	Strongly Disagree	Total (n)	Mean Value ($\bar{x}=\sum fx/\sum f$)	Variance $[\sum f(x-M)^2/\sum f]$	Standard Deviation $\{\sigma_x = [\sqrt{(\sum f(x-M)^2/\sum f)}]\}$	$t = (\bar{x}-M) / (\sigma_x/\sqrt{(n)})$	t - Critical
		1	2	3	4	5		$\bar{x}$	V	σ_x	t	t_c
Q No.	**Practical difficulties**											
53	The ICMS is not implemented since it is quite expensive	0	17	25	3	3	48	2.83	0.65	0.8078	-1.4295	1.6779
54	The ICMS is not implemented since it is too complex	0	14	31	0	3	48	2.83	0.52	0.7244	-1.5939	1.6779
55	The ICMS is not implemented since most of the employees cannot be adopted	3	28	17	0	0	48	2.29	0.34	0.5819	-8.4330	1.6779
56	The ICMS is not implemented since most employees have less knowledge on Information Technology (IT)	0	22	22	0	3	47	2.66	0.62	0.7879	-2.9623	1.6787
57	The ICMS is not implemented since it is not useful	0	0	36	9	3	48	3.31	0.35	0.5891	3.6750	1.6779
58	The ICMS is not implemented since it is not compatible with the current system	0	11	33	0	3	47	2.89	0.49	0.6989	-1.0436	1.6787
59	The ICMS is not implemented since most of the employees don't like to us it	0	20	20	6	3	49	2.84	0.76	0.8743	-1.3071	1.6772
60	The ICMS is not implemented since there is less knowledge/ interest of top management / owners on ICMS	6	31	9	3	0	49	2.18	0.53	0.7267	-7.8636	1.6772

4.6.6 Hypothesis testing (Scenario 03)

Table 4.15: Hypothesis testing (Scenario 03)

	Factor	Hypothesis	t	t_c	Condition	Decision
53	Capital Cost	H_0: Professionals believe that The ICMS is not implemented since it is quite expensive	-1.4295	1.6779	$t < t_c$	Accept
		H_1: Professionals not believe that The ICMS is not implemented since it is quite expensive				Reject
54	Complexity	H_0: Professionals believe that The ICMS is not implemented since it is too complex	-1.5939	1.6779	$t < t_c$	Accept
		H_1: Professionals not believe that The ICMS is not implemented since it is too complex				Reject
55	Adoption	H_0: Professionals believe that The ICMS is not implemented since most of the employees cannot be adopted	-8.4330	1.6779	$t < t_c$	Accept
		H_1: Professionals not believe that The ICMS is not implemented since most of the employees cannot be adopted				Reject
56	Employee's knowledge on Information Technology (IT)	H_0 : Professionals believe that The ICMS is not implemented since most employees have less knowledge on Information Technology (IT)	-2.9623	1.6787	$t < t_c$	Accept
		H_1: Professionals not believe that The ICMS is not implemented since most employees have less knowledge on Information Technology (IT)				Reject
57	Usefulness	Ho: Professionals believe that The ICMS is not implemented since it is not useful	3.6750	1.6779	$t > t_c$	Reject
		H_1: Professionals not believe that The ICMS is not implemented since it is not useful				Accept

	Factor	Hypothesis	t	t_c	Condition	Decision
58	Compatibility with the current system	H_0: Professionals believe that The ICMS is not implemented since it is not compatible with the current system	-1.0436	1.6787	$t < t_c$	Accept
		H_1: Professionals not believe that The ICMS is not implemented since it is not compatible with the current system				Reject
59	Employee's tendency to use	H_0: Professionals believe that The ICMS is not implemented since most of the employees don't like to use it	-1.3071	1.6772	$t < t_c$	Accept
		H_1: Professionals not believe that The ICMS is not implemented since most of the employees don't like to us it				Reject
60	Top management / owner's tendency to implement	H_0: Professionals believe that The ICMS is not implemented since there is less knowledge/ interest of top management / owners on ICMS	-7.8636	1.6772	$t < t_c$	Accept
		H_1: Professionals not believe that The ICMS is not implemented since there is less knowledge/ interest of top management / owners on ICMS				Reject

4.7 Discussion of results

4.7.1 Hypothesis analysis (Scenario 01)

With the results of the questionnaire survey it is clearly identified that most of the professionals believe that they are not provided necessary authority to change the existing CMSs at project level and there is lack of training, facilities, authority to execute, and encouragement of top management. But majority of respondents emphasized that there is an organizational requirement and support to implement a CMS at project level to examine the financial situation of projects.

4.7.2 Hypothesis analysis (Scenario 02)

Even though the ICMSs have not been executed in most of the projects, most of the professionals involved in this exercise are aware of the help and positive contribution to identify optimal customer / Market segments, to improve the profitability of key products, to carryout improved decision making and to reduce miscommunication. It can be identified that they have a considerable knowledge of the input of ICMS to optimize the organization's profitability, to increase process effectiveness, to integrate financial and non-financial matrices, to improve the competitive position, to facilitate strategic marketing and operational decisions and for rapid responses to changing conditions.

According to the results obtained through the hypothesis testing it can be identified that professionals believe that ICMS would help providing the means to integrate activities and outcomes across processes and entities in the value chain, formulating a reaction to environmental changes before an organization is affected by them and creating an external focus on customer requirement and competitive treats so that customer requirements drive the organization. The role of ICMS in to create a systematic relationship of all elements, internal and external, optimizing the profits by ensuring that resources remain focused on value activities, that waste is identified and removed, linking individual, groups, and organizational incentives to ensure that everyone in the organization understands and is motivated to achieve strategic and operational objectives. In addition to that they are aware of the use of ICMS for improved communication across all levels, processes and units.

4.7.3 Hypothesis analysis (Scenario 03)

The professionals' views on most of the reasons behind the non-implementation of ICMS at project level have been identified in this section and the high capital cost, complexity and many constraints be adopted of the current systems obstruct the use of ICMS in many projects. In addition to that the employee's knowledge on IT is also identified as an obstruction to implement ICMSs. But most of them believe that even though ICMS is useful there are some compatibility issues with current system and as such the tendency of majority of employees using ICMS is very low. It is identified through this research that the knowledge of the benefits of ICMS among top management and / owners and the tendency to implement ICMSs in their organization is considerably low in the Sri Lankan construction companies.

4.8 Summary

This chapter presented detailed analysis of the factors contributing to implementation of cost monitoring systems in Sri Lankan construction companies. It was found that in general construction professionals possess enough awareness about ICMSs, its' deliverables, and possible contribution for the project success. It was observed that majority of the participants were confident as they have good computer literacy and clearly displayed that none of the respondents believe they have excellent experience with ICMSs. With the results obtained through the analysis it is observed that the usage of successful CMS is very low and there was no comprehensive CMS in any project identified through this research. In general specially configured software, In-house built systems and Microsoft application software have been used in projects. With the results of hypothesis testing is clearly exposed hat professionals are having lack of opportunities and authorities to execute ICMSs in their projects. As per the views of respondents the high capital cost, complexity and many constraints be adopted of the current systems obstruct the use of ICMS in many projects. In addition to that the employee's knowledge on IT is also identified as an obstruction to implement ICMSs. But most of them believe that even though ICMS is useful there are some compatibility issues with current system and as such the tendency of majority of employees using ICMS is very low. It is identified through this research that the knowledge of the benefits of ICMS among top management and / owners and the tendency to implement ICMSs in their organization is considerably low in Sri Lanka.

Chapter 5

Conclusions and recommendations

5.1 Conclusion

Many researchers have emphasized the need of having comprehensive CMS in order to have a smooth run of any construction project. The key component of this research is to identify the various indicators of projects that indicate the past, current and future situations of any project and the usage of these indicators in local construction companies and to examine the current cost practices, constraints and probable reasons for implementation and non-implementation of ICMS in the local market.

When considering the existing cost monitoring systems and outcomes it is observed that there are various CMSs have being implemented in construction projects which basically depend on the organizational requirements and the levels of monitoring. It is clearly exposed through the observation of this research that the performance of the existing cost monitoring systems implemented in most of the construction projects is not at a satisfactory level and need enhancing up to accepted levels. Even though professionals in the construction industry are not having a considerable experience with ICMS, most of them believe that ICMS provide various facilities and benefits for the project managers to execute a project smoothly and effectively while keeping within the budget.

Even though organizational requirements and support on implementation of ICMS are key factors to execute a comprehensive CMS at project level, as per the responses of most of the professionals it can be observed that the support of the top management and the owners of the organizations is considerably low due to various reasons. As revealed in the discussion of results there is a number of probable reasons which have been identified through this study and it is essential to educate the relevant personnel regarding the benefits against the cost that is incurred on implementation of ICMSs.

5.2 Recommendations

The results of this study emphasize the organizational challenges facing project management professionals during the execution of the CMSs. As the implementation of CMS in construction projects requires that wholesome effort of the organizations it is required streamline the processes, making some changes in the organizational structure, developing well-organized training programs, and showing some short term and long term tangible results to the top management. A comprehensive set of procedures coupled with CMS training and necessary tools worked in close coordination with the executive staff and in functional areas, will establish a greater appreciation of CMS by the company as a whole, and help tremendously in the implementation of CMSs in construction organizations in Sri Lanka. Since it is observed that the considerable lack of knowledge on ICMS among construction professionals it is essential to educate them to use ICMS as a systematic approach to the integration and measurement of cost, schedule and scope accomplishments on a construction project providing managers the ability to examine cost data in the context of detailed financial information and critical programs and technical milestones. I believe that it is a vital requirement to include this subject in the course contents of post graduate, graduate, diploma and also in certification courses conducted for technical people about the latest technology and facilities available around us that can be used for project monitoring and competitive estimations and to enhance the employees' adaptation to new systems.

5.3 Recommendations for future researches

The application of ICMS in the construction companies in Sri Lanka is a relatively new phenomenon as none of the organizations use ICMS presently. Further research could be carried out to find the cultural and practical difficulties faced during implementation of ICMSs in construction organizations. In addition to that uses of the outcomes from the current CMSs for the bidding process also need to be examined, because it is essential to have actual cost and norms for at least major activities to improve the competitiveness of any organization. As a first step to identify the real needs of the companies, a comprehensive audit of the situation needs to be conducted. It shall consist of structured and unstructured interviews at each level of employees of the organization and appropriate mechanisms needed to be identified to overcome the environmental and cultural constraints that could arise when introducing the ICMS to the organizations.

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Appendixes

Appendix 1: Questionnaire Letter

Appendix 1: Questionnaire

Questionnaire for a survey on

Cost Monitoring and Controlling Practices of the Construction Industry In Sri Lanka

Conducted By Samantha Weerasinghe & Supervised By Dr. R.U. Halwatura

Master of Science in Construction Project Management, Department of Civil Engineering, University of Moratuwa, Sri Lanka

Dear Sir/Madam,

I am a post graduate student of the Faculty of Engineering, University of Moratuwa conducting a Questionnaire for survey in order to fulfil the a partial requirement of the degree of Master of Science in Construction Project Management. This research has been conducting under the supervision of Dr. R.U. Halwatura, Senior Lecture to the Department of Civil Engineering, University of Moratuwa.

The aim of this research is to examine the current cost monitoring and controlling practices of the construction industry in Sri Lanka and professional understands and views on implementation of Integrated Cost Monitoring Systems (ICMS) in organizations of the constructions industry.

Integrated Cost Monitoring Systems (ICMS)

Integration of information is essential if an organization's resources are to be deployed optimally. Integration provides the basis for robust decision analysis because it supports the incorporation of multiple perspectives. Whether an organization is just beginning its journey toward the implementation of new cost management models or has put many of them in place, the need to integrate information and management systems remains the same. Meeting this need is the objective of the integrated cost management system (ICMS) framework.

(Statement on Management Accounting, Statement Number 4MM, March 2000)
(Institute of Management Accountants, Montvale, United State of America)

This Questionnaire consists of two parts as Part 01 for all professionals and Part 02 for professional who have some knowledge and understanding on ICMS,

Part 01 – Information on personal and organizational details and current cost monitoring practice
Part 02 – Professional's knowledge, understanding and views on ICMS

I hereby guarantee the responses of the questionnaire will be used only for abovementioned purpose and will not be exposed to any third party. The research publications will not contain any personal detail of the respondents. Thanking for your responses and your participation for this research is highly appreciated.

Thank You,
Yours faithfully,

Samantha Weerasinghe
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University of Moratuwa
Sri Lanka

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Appendix 2

Questionnaire for a survey on

Cost Monitoring and Controlling Practices of the Construction Industry In Sri Lanka

Conducted By Samantha Weerasinghe & Supervised By Dr. R.U. Halwatura

Master of Science in Construction Project Management, Department of Civil Engineering, University of Moratuwa, Sri Lanka

Declaration: This questionnaire for a survey is only for research project to the fulfilment of MSc (CPM) and collected data will not be passed on to any third party and used solely for the purpose of the study.

PART 01 – GENERAL INFORMATION

- Optional Fields

SECTION-01 - PERSONAL INFORMATION

1. **Name*** _____
2. **Designation** _____
3. **Age** _____ Years
4. **Gender** ☐Male ☐Female
5. **Education Level**

   ☐A/L ☐ Certificate ☐ Diploma ☐Graduate ☐Post Graduate
6. **Years of experience in the construction industry** _____ Years
7. **Contact Details*** Mobile: Email:
8. **Specialization of construction experience**

   ☐ Building ☐ Roads & Highways ☐ Water Supply & Drainage ☐ Bridges ☐ Other
9. **Computer Literacy**

   ☐ Excellent ☐ Good ☐ Average ☐ Novice ☐ Never
10. **Experience with ICMS in any working environment**

    ☐ Excellent ☐ Good ☐ Average ☐ Novice ☐ Never

SECTION - 02

ORGANIZATIONAL INFORMATION

11. **Name*** _____
12. **Experience in the construction industry /(Years)** _____
13. **Country of Origin** _____
14. **Annual construction Turnover(Last Year) /(Rs.M)** _____
15. **ICTAD Grade (If Applicable)**

		C-1	C-2	C-3	C-4	C-5
a.	Buildings	☐	☐	☐	☐	☐
b.	Roads & Highways	☐	☐	☐	☐	☐
c.	Water Supply & Drainage	☐	☐	☐	☐	☐
d.	Bridges	☐	☐	☐	☐	☐
e.	Other	☐	☐	☐	☐	☐

16. No of Employees		**0 - 5**	**6 - 20**	**21 - 100**	**101 - 500**	**501 over**
f.	Engineers	☐	☐	☐	☐	☐
g.	Quantity Surveyors	☐	☐	☐	☐	☐
h.	Non – Technical Managers	☐	☐	☐	☐	☐
i.	Skilled Workers	☐	☐	☐	☐	☐
j.	Unskilled Workers	☐	☐	☐	☐	☐

SECTION-03:
CHARACTERISTICS OF THE EXISTING COST MONITORING SYSTEM IN YOUR PROJECT

17. Type of the existing cost monitoring system

☐In-house built system

☐Use Microsoft application software

☐Specially configured software

☐Well developed ICMS

☐None

18. Employee participation for the cost monitoring process

	Very High	High	Average	Low	None
Management staff	☐	☐	☐	☐	☐
Cost monitoring unit	☐	☐	☐	☐	☐
Accounting staff	☐	☐	☐	☐	☐
Technical staff	☐	☐	☐	☐	☐
Other staff	☐	☐	☐	☐	☐

19. According to your experience, level of difficulty of overall project Management?

	Very High	High	Average	Low	None
Implementation	☐	☐	☐	☐	☐
Data Collection	☐	☐	☐	☐	☐
Analyzing	☐	☐	☐	☐	☐
Monitoring	☐	☐	☐	☐	☐
Controlling	☐	☐	☐	☐	☐

20. According to your experience, level of difficulty of deferent phases of Cost Monitoring?

	Very High	High	Average	Low	None
Planning	☐	☐	☐	☐	☐
Execution	☐	☐	☐	☐	☐
Monitoring	☐	☐	☐	☐	☐
Analyzing	☐	☐	☐	☐	☐
Controlling	☐	☐	☐	☐	☐

Questionnaire for a survey on

Cost Monitoring and Controlling Practices of the Construction Industry In Sri Lanka

Conducted By Samantha Weerasinghe & Supervised By Dr. R.U. Halwatura

Master of Science in Construction Project Management, Department of Civil Engineering, University of Moratuwa, Sri Lanka

This section is to find the features of the existing method that used in your project in order to analyse the financial situation. Please indicate the possible outcome from your current **Cost Monitoring System (CMS)** used in your project

Question No	Area	Reports can be produced				
		Lagging Indicators		Current Indicators	Leading Indicators	
		Monthly	**At Completion**	**Daily**	**Next month Forecast**	**None**
21.	Financial Situation	☐	☐	☐	☐	☐
22.	Physical Work done	☐	☐	☐	☐	☐
23.	Inventory	☐	☐	☐	☐	☐
24.	Manpower & Materials utilization	☐	☐	☐	☐	☐
25.	Machinery utilization	☐	☐	☐	☐	☐
26.	Comparison with budget	☐	☐	☐	☐	☐
27.	Effects of Inflation & Price Fluctuation	☐	☐	☐	☐	☐
28.	Analysis of NPV & ROI	☐	☐	☐	☐	☐
29.	Analysis of SV & SPI	☐	☐	☐	☐	☐

30. **There is unique Cost Monitoring System for the entire organization & nobody is allowed to make any changes or any development at project level**

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐ Don't have a clear idea

31. **All Employees of the entire organization contribute towards the successful execution of Cost Monitoring System**

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐ Don't have a clear idea

32. **The organization conducts necessary trainings for employees on Cost Monitoring System**

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐ Don't have a clear idea

33. **I have been provided all necessary facilities & authorities to execute an identical Cost Monitoring System & enhance it in my project**

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐ Don't have a clear idea

34. **I have been encouraged by the organization to enhance the current Cost Monitoring System**

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐ Don't have a clear idea

35. **There is neither any organizational requirement nor support to implement a Cost Monitoring System in project level**

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐ Don't have a clear idea

PART 02 – SPECIFIC INFORMATION ON ICMS

SECTION-04:

INDIVIDUAL UNDERSTANDING & VIEWS ON USES AND BENEFITS OF ICMS FRAME WORKS

36. The ICMS helps to identify optimal customer / market segments

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐ Don't have a clear idea

37. The ICMS improves the profitability of key products

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐ Don't have a clear idea

38. The ICMS supports for improved decision making

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐ Don't have a clear idea

39. The ICMS reduces miscommunication

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐ Don't have a clear idea

40. The ICMS optimizes the origination's profitability

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐ Don't have a clear idea

41. The ICMS increases process effectiveness

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐ Don't have a clear idea

42. The ICMS integrates financial & non-financial metrics

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐ Don't have a clear idea

43. The ICMS improves the competitive position

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐ Don't have a clear idea

44. The ICMS facilitate strategic marketing and operational decisions

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐ Don't have a clear idea

45. The ICMS supports rapid response to changing conditions

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐ Don't have a clear idea

46. The ICMS provides the means to integrate activities and outcomes across processes and entities in the value chain

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐ Don't have a clear idea

47. The ICMS helps to anticipate and react to environmental changes before an organization is affected by them

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐ Don't have a clear idea

48. The ICMS creates an external focus on customer requirement and competitive treats so that customer requirement drive the organization

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐ Don't have a clear idea

49. The ICMS systematically relates all elements, internal & external, so problems are solved holistically rather than incrementally through cross functional integration

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐ Don't have a clear idea

50. The ICMS optimizes profits by ensuring that resources remain focused on value activities, that waste is identified and removed

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐ Don't have a clear idea

51. The ICMS links individual, groups, and organizational incentives to ensure that everyone in the organization understands and is motivated to achieve strategic and operational objectives

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐ Don't have a clear idea

52. The ICMS Communicates across all levels, all process, and all units the needs of the customer, result achieved, problems encountered and solved and remaining challengers to be met

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐ Don't have a clear idea

SECTION-05:

PROBABLE REASONS BEHIND NOT IMPLEMENTATION OF AN ICMS IN THE ORGANIZATION

(Please answer for following questions if there isn't an ICMS in your organization)

53. The ICMS is not implemented since it is quite expensive

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐ Don't have a clear idea

54. The ICMS is not implemented since it is too complex

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐ Don't have a clear idea

55. The ICMS is not implemented since most of the employees cannot be adopted

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐ Don't have a clear idea

56. The ICMS is not implemented since most employees have less knowledge on Information Technology (IT)

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐ Don't have a clear idea

57. The ICMS is not implemented since it is not useful

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐ Don't have a clear idea

58. The ICMS is not implemented since it is not compatible with the current system

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐ Don't have a clear idea

59. The ICMS is not implemented since most of the employees don't like to us it

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐ Don't have a clear idea

60. The ICMS is not implemented since there is less knowledge/ interest of top management / owners on ICMS

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree ☐ Don't have a clear idea

Thanking you for your valuable participation