

Effectiveness of Software Applications in Construction Project Management ¹

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Abstract

The construction industry is undergoing increased complexity due to continuous advancements in design and technology. Completing projects within specified timelines and budget constraints poses a significant challenge. In the Sri Lankan context, the demand for efficient management has become more pressing, given the rapid expansion of construction activities. Achieving successful project completion necessitates the involvement of professional project management expertise, and an instrumental tool in this regard is the utilization of project management software. This software aids in streamlining processes, enhancing communication, and ensuring effective resource allocation for improved project outcomes.

The focus of this research was to gather industry experience in applications of construction management software and to assess the difficulties & benefits realized by the industry. The study was conducted in 287 construction companies, the firms registered under ICTAD (Institute for Construction Training and Development) and the grades C1, C2, C3 and C4 were considered. Focuses on three main areas in management and the survey was done through a questionnaire-based interview. Data collected were used to understand the position where construction firms stand in terms of software usage for project management activities in the Sri Lankan construction industry.

According to the study Over 80% of building contractor firms (ICTAD grades C1 to C4) are using MS Project as their project management software tool. Some firms have extended the usage to the MS Project server facility, but it was very limited for a few firms. If the satisfaction levels, irrespective of software usage for those particular areas are also decreased along with the software usage. Around 35% of construction firms in the industry have a plan to develop their software systems in the future. Among them, getting to train the staff has become the 1st place activity and 28% of firms in a place to introduce the latest/ newer versions of software to their firms. Therefore, firms use only the basic and initial features of the project management software and gradually decrease the usage with the complexity of features. Further, need to measure and address the issues, the nonavailability of trained staff through training programs and introducing the latest version of the software.

Keywords: Software application, time, cost, recourses, Project Management

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1. Introduction

The Management of construction projects is a challenging occupation as the environment in which projects are constructed increases in complexity. Such complexity arises from the increasing technological, social and economic forces that impact the process of constructing the world's buildings and infrastructure (Alameri et al., 2021).

All those complex and rapid improvements in design as well as technological disciplines have added new dimensions to the construction industry (Muñoz-La Rivera et al., 2021). The scarcity of essential materials for construction and rapid increase in the cost of labor have led to new techniques in construction technology and management. Further, the continued exploitation of labor in the past has increased workers discontent and new rules and regulations imposed by the governments as well as international organizations have created more obligations on workers facility and welfare (Forcael et al., 2020). Therefore, the importance of systematic planning and programming of works and effective management of construction projects is highlighted more than ever to prevent drudgery and to improve productivity & efficiency.

According to the Annual Survey of the Sri Lankan Construction Industry, the total estimated value of work done by all types of construction activities of the contractors in Sri Lanka was Rs. 316,448. Million 2018-2019. The Highest contribution to this value has been made by the building construction sector. Furthermore, GDP from Construction in Sri Lanka decreased to 185519 LKR Million in the third quarter of 2023 from 187194 LKR Million in the second quarter of 2023 as per the Department of Census & Statistics in Sri Lanka (statistics,2021). The figures show how important the role of construction is in the country and its contribution to its economy. This clearly suggests that enhancing the efficiency and productivity of the construction industry through the adoption of new technologies, coupled with effective management techniques, has the potential to significantly boost the contribution of the sector to the country's economy.

The research was confined to the field of construction management, specifically focusing on the utilization of software in construction management processes. A construction program encompasses various elements, including site investigation, feasibility studies, project reports, planning for the works (including construction methods and the allocation of resources such as labor, materials, equipment, and finances), monitoring work progress during construction, and implementing necessary controls from the planning phase to the completion of the project and its subsequent maintenance. For contractors, it also involves conducting their own investigations and market surveys, participating in bidding processes, and managing the remaining tasks from work planning to project closure.

The entire construction process poses significant challenges, particularly for contracting organizations, making it a complex and sensitive undertaking from initiation to project completion

(Amini et al., 2023). Successful project completion without time and cost overruns requires meticulous attention to initiation, planning, implementation, monitoring and controlling, and closure throughout the project life cycle. Each of these steps involves handling substantial data within tight timeframes, engaging numerous stakeholders, storing data for future reference, manipulating diverse data sets, and ensuring timely and accurate information availability (Couto et al., 2022). Effectively addressing these challenges necessitates the adoption of Information Technology (IT), with a specific focus in this study on project management software. The utilization of software enhances coordination and collaboration among various entities involved in a construction project, such as contractors and consultants, thereby improving communication practices (Mathar et al., 2020). The advantages of employing software include heightened document quality, accelerated work processes, improved financial control and communication, simplified and faster access to shared data, and a reduction in documentation errors (Lalmi et al., 2021).

The construction Industry in Sri Lanka is in a very backward state compared to other developed & some South Asian countries. The underperformance of the construction industry can be attributed to several factors, with the inadequate integration of information technology (IT) being a notable contributor (Manoharan et al., 2023). Other sectors in the economy such as banks, the share market, the apparel industry and financial institutions are using IT in a day to day operations (Wijewardhana et al., 2021).

After 13 years of the above statement, an attempt was made in this study to research the software usage for construction project management by contractor firms in Sri Lanka, involved in the building construction sector and the areas where software can be used to improve productivity.

1.1 Problem statement

The growing complexity in the construction industry, driven by advancements in design and technology, poses a significant challenge in achieving projects without time and cost overruns. In the Sri Lankan context, the demand for efficient management has intensified with the rapid expansion of construction activities. Successful project completion necessitates professional construction project management, and one potential solution to address this challenge is the utilization of project management software. This research aims to investigate the effectiveness of project management software in enhancing the construction project management sector in Sri Lanka.

1.2 Construction project management and use of software tools

The construction industry is becoming more and more complicated due to rapid technological developments. Modern machinery, plants and sophisticated construction methods promote the construction industry (Harris et al., 2021). Also, the involvement of professionals in various

disciplines has vastly increased in the construction industry and influence from parties such as clients, bankers, funding agencies and financial institutions. This focuses on time and cost. Therefore, become more and more important than ever. The contribution is due to new procurement methods, various types of contracts and new management activities innovated and introduced to the construction industry (McNamara & Sepasgozar, 2021). Eventually, the whole pressure will affect one of the main stakeholders of projects. The contractor and staff of management handle the project effectively and efficiently to achieve anticipated time and cost constraints (Arefazar et al., 2022). Proper techniques of management have been adopted to maximize their profits and survival through tight competition. As the best solution, computer software will be one of the most important tools in managing construction projects (Alzoubi, 2022).

The latest construction project management software is available in the market, with some dedicated specifically to project management, ensuring compliance with construction industry requirements for effective and efficient project management, regardless of the project's size or scale (Pinto, 2020). The utilization of these available features depends on factors such as the software's price, system configuration requirements, availability of trained personnel, awareness of the facilities provided in software systems, and available alternatives within the construction industry.

In Sri Lanka, local contractors still manage small and medium construction projects using traditional methods. For instance, progress monitoring is not consistently conducted throughout the project, and even when tracking and monitoring are implemented, efficiency and effectiveness often fall short of satisfactory levels (Santoso & Gallage, 2020). Despite the industry's overall efforts to optimize planning, scheduling, and project control, many projects in Sri Lanka are still experiencing issues such as going out of control, costs exceeding estimates, completion times extending beyond schedules, and owners growing increasingly dissatisfied with project statuses (Wimalasena & Gunatilake, 2018).

This situation suggests that Sri Lankan construction companies are frequently characterized as inefficient performers when assessed against failure criteria related to cost, time, and quality. To address these challenges, the construction industry needs to fully leverage computer technology to maximize profits through improved efficiency and productivity using project management software (Rathnayaka et al., 2023), (Epasinghe et al., 2018).

1.3 Institute for Construction Training and Development (ICTAD)

The Institute for Construction Training and Development (ICTAD) in Sri Lanka assigns grades to construction firms based on their qualifications and capabilities. These grades, namely C1, C2, C3, and C4, indicate the level of competency and capacity of a construction firm to undertake

projects. Here's a general overview of what these grades typically represent: C1 Grade is assigned to large and well-established construction firms. C1 firms are considered competent of handling complex and large-scale projects, C2 Grade is medium-sized and possesses a moderate level of competency. C3 Grade firms are usually smaller and may have limitations in terms of size and complexity of projects. C4 Grade is the lowest grade and is assigned to smaller firms with limited capabilities (LANKA, 2019).

2. Objectives

The main objectives of the research are as follows:

- To evaluate to what extent software is being used in the Construction Industry for Planning, Scheduling and Monitoring.
- To find out the areas where software can be used effectively in Construction Project Planning & Control.
- Find out key areas of Project Management where software application is needed to enhance productivity.

3. Methodology

The study employed a comprehensive methodology centered around the utilization of project management software for various facets such as planning, scheduling, monitoring, and controlling within the construction industry. This includes a study of facilities provided by software & its usage levels by firms in project management activities. The research targeted contractor firms involved in building construction, chosen strategically to reflect the competitive dynamics among local contractors in the sector. Data collection was conducted among 287 companies categorized under different grades (C1, C2, C3, and C4) registered with ICTAD.

The collection process involved structured questionnaire-based interviews to find the activities where firms have achieved higher performance levels through software usage and the extent of software adoption for project management activities within the Sri Lankan construction landscape. Subsequently, a rigorous analysis and interpretation of the gathered data were carried out to derive meaningful conclusions.

3.1 Data collection process

A questionnaire was formulated through the knowledge & information gained from the literature study and was used as the source of collecting particular information for the study from selected 287 companies in the industry. Filling questionnaires through interviews and discussions with various personnel, especially the senior managers with civil engineering backgrounds in construction organizations.

3.2 Selected Group

Only the firms registered in ICTAD grades, C1, C2, C3 and C4 were selected who engaged especially in building constructions, in the year 2010 as the target group & the distribution was as follows;

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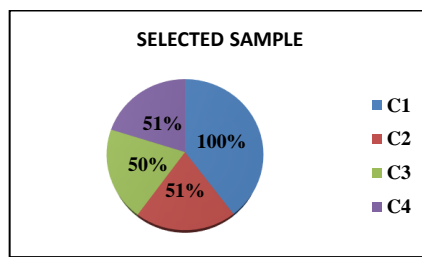
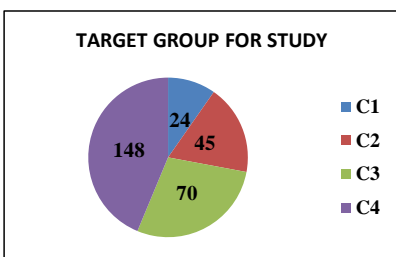


Figure 01: Target Group for the Study

Figure 02: Selected Sample

4.0 Results

Over 80% of building contractor firms (ICTAD grades C1 to C4) are using MS Project as their project management software tool. Some firms have extended the usage to the MS Project server facility, but it was very limited for a few firms. The reasons provided by contractors for software usage for construction project management are summarised in Table 01 below. While the Easy administration has been selected as anticipated and the most responded reason, “forced due to competitors, project teams and consultants” became the second most responded which reflects an important background of the industry.

Use of Software for Project Management task

Reason	ICTAD Grading			
	C1	C2	C3	C4
Easy Administration works, Integration & approach to repetitive	50%	64%	12%	49%
Standardizing company formats	6%	9%		17%
Forced due to competitors, Project teams, Consultants	32%	9%	52%	17%
To reduce cost	12%		24%	
Desire to keep up to date with development		18%	12%	17%

Table 01: Reasons for Software Usage in Project Management

According to the above figure, 50% of C1 grading companies use MS project management software to easy administration work and integrate and approach the repetitive task. Subsequently, C2 grading is 64% and C3 grading companies use 12%, and C4 grading companies 49% use for their task. Consider the use for the standardizing for the company formats C1, C2, C3, and C4 companies respectively use 6%, 9%0% and 17%. And also used for the project team consultants’ tasks, cost reduction and desire to keep up to date with development. According to the data, most companies use it for easy administration work and integrate and approach the repetitive tasks and forced due to competitors, project teams, and consultants’ tasks.

Extent of Software Usage

One of the objectives of this research was to find out the extent of software usage in construction project management by building contracting firms in the Sri Lankan construction industry. The usage of software for planning, scheduling and monitoring aspects of project management was limited only to the initial basic facilities provided by the software. For example, figure 03 below will show the usage pattern of the facilities available for planning activities in software by contractor firms. Furthermore, figure 03 shows the less utilization of cost & resource management facilities available by most of the firms for their management works. The X-axis of Figure 03 has been arranged to reflect the usage pattern identified through the study, of facilities available in software by contractors in a descending order.

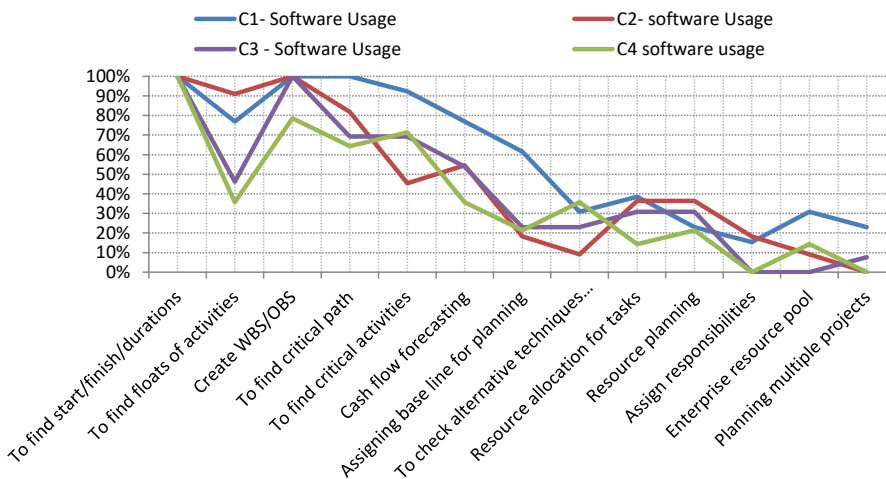


Figure 3: Extent of Software usage of companies in Planning Activities

The building contractor firms use the initial planning techniques, such as creating a work breakdown structure, to find start, and finish dates & durations, etc of a project & use almost all the firms, as per the data obtained through the survey. The usage of software to find critical paths, and critical activities was around 75% while assigning a baseline for planning was almost below 40% of the firms. Construction firms have indicated very little concern for monitoring & controlling functions available in the project management software. Only firms C1 & C2 show considerable usage of software facilities for report generation, cash flow monitoring & controlling, measuring performance using the S curve, etc.

Satisfaction levels

In this scenario consider the satisfaction level of the software usage in C1 grading construction companies.

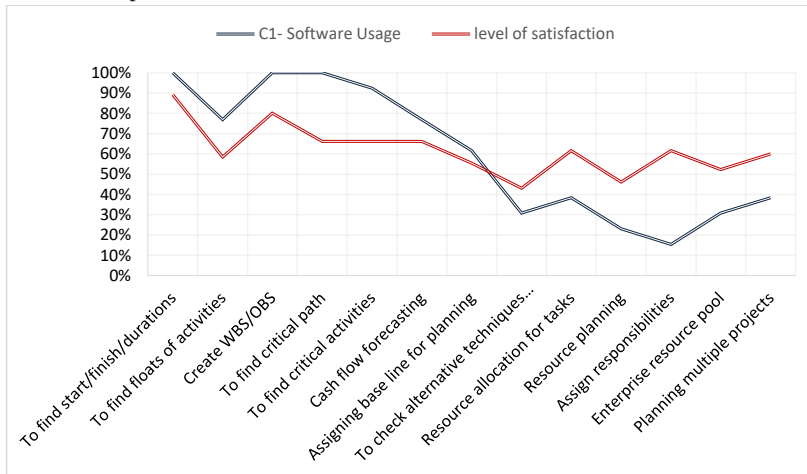
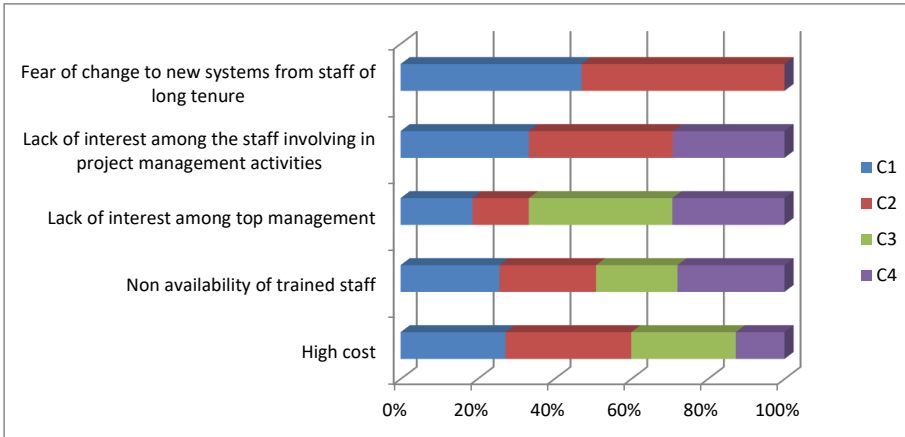


Figure 04: Extent of Software usage vs. satisfaction (irrespective of software usage) in Planning Activities (for ICTAD: C1)

The analysis was extended to get the software usage plus the level of satisfaction attained in each project management activity (ex: planning, scheduling, monitoring & controlling activities) irrespective of software usage (figure 04). The satisfaction levels, irrespective of software usage for those particular areas are also decreased along with the software usage, where this implies that, if the extent of usage is expanded, may have the opportunity for a more efficient process and an outcome. Depending on the type of firm & the nature of the projects involved, there are some areas where considerable satisfaction can be achieved in project management activities even without adopting software techniques to the project management process.



Contribution factor	No of companies responded			
	C1	C2	C3	C4
High cost	15%	18%	15%	7%
Nonavailability of trained staff	46%	45%	38%	50%
Lack of interest among top management	23%	18%	46%	36%
Lack of interest among the staff involved in project management activities	8%	9%	0%	7%
Fear of change to new systems from staff of long tenure	8%	9%	0%	0%

Table 02: Difficulties faced by contractor firms

The nonavailability of trained staff has become the most significant difficulty faced by construction firms in the usage of dedicated project management software. Lack of interest among top management in utilizing the latest project management software within their companies has become the second most responded reason, as the difficulties faced.

Only around 35% of construction firms in the industry have a plan to develop their software systems in the future to facilitate project management activities. The rest, 65% do not have any plan of improving their systems.

Easy management and administration activities & generating quality reports through the software within a short period have become the most attractive reasons under benefits gained through software usage by contractor firms. There were very few responses to the increased profit margins & increased company reputation.

5.0 Conclusions

It can be concluded that contractor firms use only the basic and initial features of the project management software and gradually decrease the usage with the complexity of features. For example, initial planning techniques, such as creating work breakdown structure, to find start; and finish dates & durations etc are being used almost by all firms. The usage was around 75% of firms find critical paths and critical activities while assigning baselines in planning was below 40%. Cash forecasting, resource planning & allocation, planning multiple projects were also at a minimum. A similar situation was identified for scheduling activities with less usage in resource leveling, sharing, etc and the facility *linking between projects* was hardly used & limited only to C1 & C2 categories, even though most of the firms handling several projects simultaneously. It can be summarized that approximately less than half of the facilities available in Project Management software were utilized by construction companies in their project management practices.

Very little concern was identified for monitoring & controlling, especially in cost and resource functions available in the project management software. Only the firms C1 & C2 showed considerable usage for report generation, cash flow monitoring & controlling, measuring performance using the S curve, etc. Still, some traditional methods and ordinary software are being used in the industry for monitoring & controlling tasks. The limited activities performed in the planning and scheduling functions of a project will lead to less usage of monitor & control facilities of software at later stages due to the lack of information available.

Through the satisfaction indicators, a pattern can be identified that a high level of satisfaction has been reached by all firms when the software usage for that particular area is high. Even without the software, a medium level (around 60%: refer to Figure 04) of satisfaction can be achieved for most of the activities, but the possibility is there to increase efficiency through software usage.

Project management software is being used by firms to attain easy administration, integration & approach to repetitive tasks. Forced due to competitors, project teams & consultants are being highlighted as the second response factor for the usage of project management software. The nonavailability of trained staff has become the most significant difficulty faced by construction firms with project management software usage. Lack of interest among top management in utilizing the latest software became the second, as the difficulties faced.

Only around 35% of construction firms in the industry have a plan to develop their software systems in the future. Among them, getting training the staff has become the 1st place activity and 28% of firms in a place to introduce the latest/ newer versions of software to their firms.

6.0 Limitations of Study

The study was limited to the software that provides dedicated project management facilities basically in the areas of planning, scheduling, monitoring & controlling in this study. Only the contractor firms involved in building constructed works were streamlined considering the tough competition among local contractors in the building sector; most of the contractors in the industry are building contractors and finally, the authors' practical experience is limited to the building industry.

To obtain a realistic sample of selected contractor firms and also to provide a clear platform for analysis work, the firms registered under ICTAD (Institute for Construction Training and Development) and the grades C1, C2, C3 and C4 were considered for this research. Since the number of contractors registered in ICTAD was more than 275 & considering the difficulty of reaching all the firms, it was further limited to take 100% of C1 firms & 50% of C2, C3 & C4 firms as samples for the study.

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Passionate about environmental sustainability and conservation, **Iresha Hewage** is a graduate of the University of Ruhuna in Sri Lanka, specializing in Green Technology (BSc. Hons). She is currently pursuing her Master's degree at the University of Moratuwa while actively working as a research assistant at the Pro Green Lab, University of Moratuwa. With a keen focus on biodiversity conservation and addressing the challenges posed by polythene plastic pollution, she is dedicated to finding innovative solutions that promote a cleaner and healthier environment. Additionally, her interest in wood technology complements her multidisciplinary approach to sustainable practices. Driven by a strong commitment to environmental management, conservation, and waste management, she strives to make a positive impact in these areas. With a passion for exploring new avenues and collaborating with like-minded professionals, she is eager to contribute to meaningful projects that address pressing environmental issues. She can be contacted at <https://lk.linkedin.com/in/iresha-s-hewage-4020a2200>