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Investigate the Efficiency of Project Management Software in Construction Projects

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Abstract: Construction projects are usually regarded as massive and mostly have significant complexity and risky projects, they take longer times to be accomplished, also have a lot of phases, for that fact this research will be dedicated to finding how can project management software help in the success and deliverable of construction projects in high efficiency. Hence, project management software is used in different types of projects not only construction projects but also are used in IT projects, oil and gas projects, industrial projects …etc., this article is focused on mainly "construction projects" as mentioned earlier they are the vast and hard to delivered and overdue time can happen in most cases. The research seeks to discover the different types of project management software popularly used in construction projects and how they help or assist in such projects. The research is carried out within the commercial cities of Kazakhstan country (Almaty, Nur sultan, and Atyrau) with a qualitative mode; all data are sourced by individual interviews, recommendations, questionnaires, and observations. At the end of the research, a comprehensive result was gathered on the relative usage of project management software, with the analysis of how they are used and how they improve efficiency and support their roles in such projects.

Keywords: Project management software, Construction projects, Real estate development, Project performance

Introduction

Project management software are prepared to simplify the work of a project manager and provide more efficient results, by providing applications that can aid in planning, to manage project costs, and to track the activities and monitor schedules (Liberatore et al, 2001). The complexity of construction projects makes it to be uncertain and a times causes rising issues like mistakes, risk and changes in the future from many work plans and or stakeholders who are involve in the project. To simplify the task of the project plan and reduce the problem of uncertainty and future risks, it could be better to use some certain IT software that may assist in project schedule plan, finance and procurement of the project materials (Hamada, & Akzambekkyzy, 2022). Making project plan manually comes with a cost of paying the errors and time wasted in the old system, note that the modern software could easily find errors where it's made and show you the future outcome of each and every work plan, or excess cost that maybe wasted (Chepachenko et al, 2020).

The assorted project management software were found to address the issue of time management, project plan and control, project finance, communication and other tasks involved. The construction projects includes complicated process which require building information models somtimes, such as in UK, BIM Adoption reached 73% in 2020 (Wang & Chen, 2023) . Gantt charts were first used on large construction projects and they proved their efficiency in remarkable projects like the Hoover Dam, started in 1931. Modern IT Project management software made it easier to plan and manage large projects with up to date result.(Kuznetsov et al, 2022). As mentioned earlier the constraints of planning and managing construction projects need to be simplified using the available IT applications that are being developed nowadays, this research will try to answer the following research questions and test three research hypotheses will answer the following questions in this research:

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Q1: Do construction companies in Kazakhstan use Project management software?
Q2: For which purposes do they utilize such software?
Q3: Does that software give them a positive result according the purpose that are used?
Q4: On what kind of projects do they use such software?
Q5: Does this software simplify and facilitate the work of these companies?
Q6: How effective are project management software in construction works?

Research Hypotheses

H1: Project management software have a positive impact on construction projects.
H2: Project management software simplify and reduce project workload.
H3: Project Management software are effective in Construction projects.

What are Project Management Software?

Project management software (PMS) is computer based applications designed to assist and help plan, organize, or manage resource tools as well as to develop resource estimates. Based on the specification of the software (Cobb, 2023), it can manage estimation and planning, scheduling, cost control and budget management, resource allocation, collaboration software, communication, decision-making, quality management, time management and documentation or administration systems. Numerous PC and browser-based project management software and contract management software products and services are available (Hamilton, 2001).

Project management software can:

- Help in project planning, and project setup.
- Simplify communication process within project members and stakeholders.
- Develop future changes and control the present project milestone.
- Assist in making schedule for project, or easily make changes to schedule.
- Make consistent project finance plan.
- Manage future risks.
- Manage project procurement plan.
- Manage work breakdown structure and smaller project tasks.

Projects usually have specific start and finish dates (Al-Refaie et al., 2023), with smaller tasks and work breakdown structures that lead to tangible outcomes or final project deliverables (Ahmad & Malik, 2023). For that constraints like schedule, cost, resources, budget, time and communication all depend on a project's feasibility (Moreno-Monsalve et al., 2023). So, programs are enacted of several smaller projects that, when combined, will provide a long-term business objective. Project managers oversee individual projects, and program managers supervise groups of multiple projects, focusing on a major goal. Sometimes there are functional managers who oversee smaller tasks in a project, for that project management software are built. Considereing that, there are important elements for a successful project management skills beside using software tools, such as the integration of knowledge, skill, leadership, ability and competencies which are necessary for successful construction project completion (Ghorbani, 2023).

Application of Project Management Software to Construction Projects

The construction industry is one of the most industries in which PM software is used for essential. As huge users of PM software, professionals in the construction industry have a strong interest in improving the tools and techniques available for better project planning and control (Hamada et al., 2021). Several studies demonstrated that construction managers continue to be very interested in developing better methods for project planning and management. In addition, a few studies have considered the application of these tools in PM software (Ahuja et al, 1994).

How do Software Contribute to Construction Projects?

PM software are found for the purpose of supporting most aspects of construction. They were primarily designed as solutions to specific problems that may arise during the project management process. These Solutions can be (Sun, M., & Howard , 2004):

1-Planning, Scheduling and Management
2-Computer Aided Design and Visualization
3-Building Engineering applications
4-Business information management
5-Digital Facilities Management
6-Project Integration
7-Computer cost estimation and finance

Research Problem Statement

The complexity of construction projects makes it to be uncertain and a times causes rising issues like mistakes (Gamil, & Abd Rahman, 2023), risks, and changes in the future from many work plans and or stakeholders who are involve in the project. To simplify the task of the project plan and reduce the problem of uncertainty and future risks, it could be better to use some certain IT software that may assist in project schedule plan, finance and procurement of the project materials. Making project plan manually comes with a cost of paying the errors and time wasted in the old system, consider that the modern software could easily find errors where it's made and show the future outcome of all work plans, or excess cost that maybe wasted. The assorted project management software were found to address the issue of time management, project plan and control, project finance, communication and other tasks involve. Modern IT Project management software made it easier to plan and manage large projects with up to date results. In addition, a few studies have considered the application of these tools in PM software. Over the past five years, there has been a significant increase in the usage of PM software especially by construction firms, also projects now are involving a huge amount of big data, and this type of data needs specific analytical processing (Hassanin & Hamada, 2021). For these reasons, we found a necessity to investigate the feasibility and the efficiency of software project tools in construction projects.

Research Method & Design

This study sought to explore and investigate into the implication of software towards the success of construction projects, as well as highlight their significant importance in the construction industry. The research design was explanatory and descriptive using qualitative research methods (Creswell, 2002). It was explanatory because knowledge about project Management software PMS in the construction project was discussed also, the study gives an in-depth and description on the role of PMS on construction and IT tools that facilitate the effective and efficient implementation of construction projects are described. Responses from the questionnaire was requested and assigned theoretical values to describe the data. Also information gathered was described using frequencies and percentages. In 2012 Almaty has 10% of residential construction works followed by Nur-Sultan 13% as well as Atyrau 10% (US export, 2016).

In this research, the population consists of selected contractors and construction companies, consultants and stakeholders who are undertaking construction projects in Kazakhstan (Almaty and other few regions). Contractors in the region were considered in this research. These are construction companies registered as certified companies under the law of Republic of Kazakhstan (Flagma.kz, 2020). So, to select the main sample size from the population as a reason of sample size table (Riley et al, 2021), the total population is between 200 and 300. In order to make the better representation of the sample, the higher number was selected for sample size which is 285 with 95% confidence level. In view of the given fact that some respondents may not answer the questions, we need to know the minimum respondents that we could have in our sample size. It shows the minimum number of respondents with this given formula (Tejada & Punzalan, 2012):

$n' = n / (1+ (n/N))$ n is the minimum sample size and N is the population. With our numbers, (n′) the adjusted minimum should be 130 at least.

Data Collection Method and Analysis

The main instruments used in this study were questionnaires and interviews for the quantitative and qualitative sections. The questionnaire contained an open – ended, closed – ended type of questions. Likert scales were also used in gathering some of the data. The questionnaires were made up of four sections with a total of 20 questions. The qeustionairs are distribuuted to the registered constructions companies in the big regions Kazakhstan country, there are 310 Members of Union builders of Republic of Kazakhstan, where main data of the expected population was gained, with all of the firms that operate as construction companies. Almaty region has 97 construction companies under the union from which the research data will be obtained as shown in figure (1)

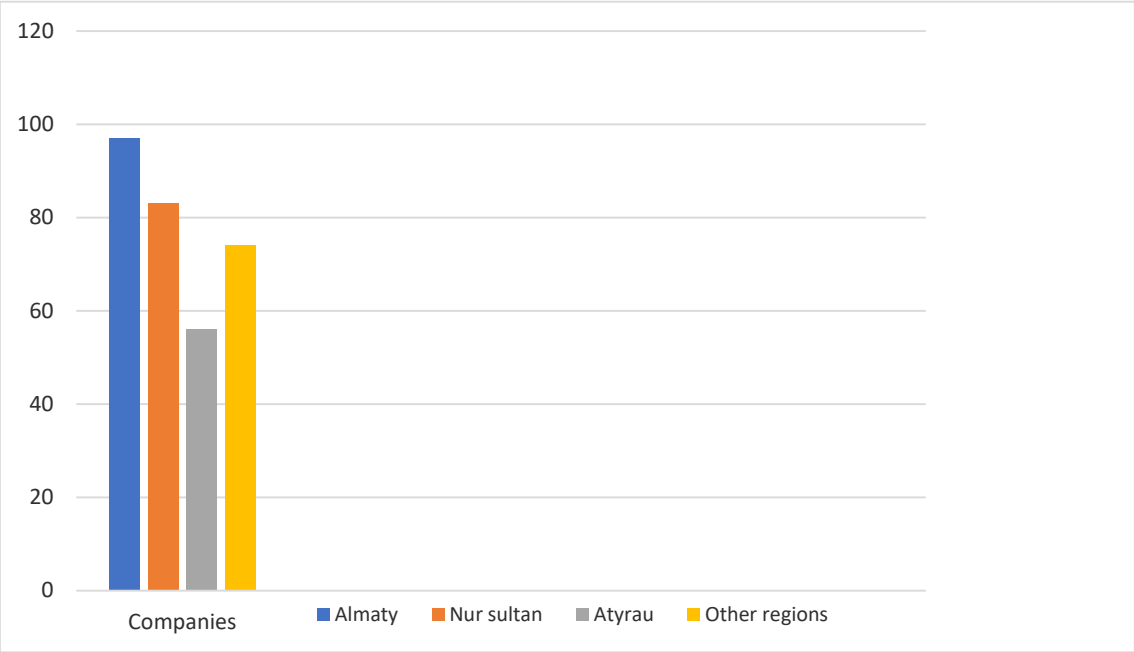

Figure 1. Distribution of construction companies in Republic of Kazakhstan.
Source: https://www.zoominfo.com/companies-search/location-kazakhstan-industry-construction

The company's background and experiences was briefly checked as shown in Figure (2), to see which will best fit for the research to find how each use IT and modern software in its projects, the target companies were identified under the members of the Union of builders in Republic of Kazakhstan. Large enterprise firms who have been operating for more than 10 years and have delivered more than 50 large projects which the researcher chose as the exact sample group. One by one meeting was held with a top official of experienced operating companies, while questionnaires were sent out to other categories.

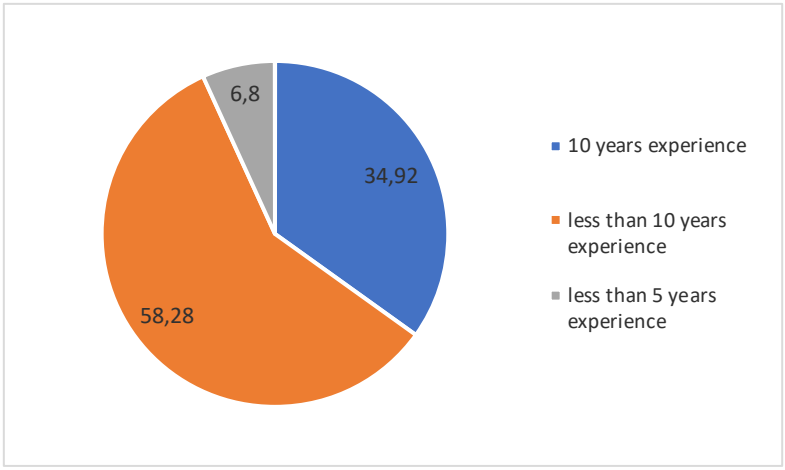

Figure 2. Categories of companies based on their years of experience.

Data gathered from the research field was analyzed qualitatively and quantitatively in a thematic system. The interviews obtained were also formatted into text. Both the literature studied, and the data gathered from the

participants and respondents were measured accurately and then SPSS was the tool used for analyzing the data which was later presented in tables, pie charts and bar graphs.

Results and Discussion

The background of respondents was first considered to ensure the respondents qualifications for the research study, and it was realized that all of them are contractors. The respondents also indicated the number of years they have been working in the construction industry. It was realized that 33% of the respondents have worked in the construction industry from six to ten years. While twenty per cent (20%) of the respondents have worked in the construction industry for less than six years (0-5years) and then the last 47% have worked in the construction industry for more than 10 years as explained in figure (3).

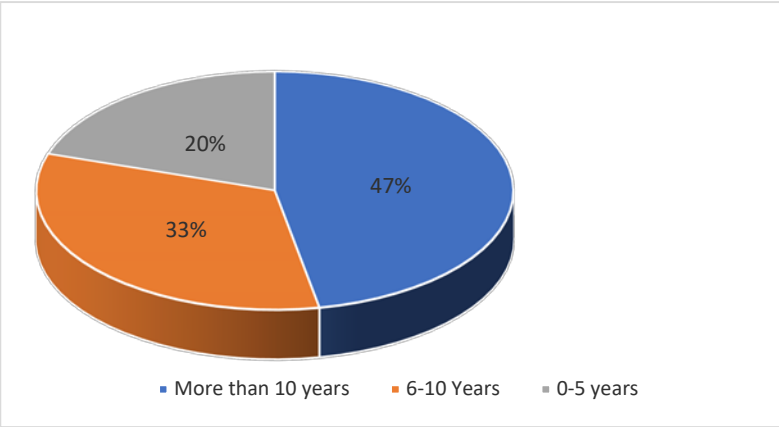

Figure. 3. Graphical representation of respondent's experience

The respondents were asked to indicate which type of construction projects their organization engages in as shown in figure (4), which indicates that most of the organizations work on housing and business centers project, they were represented by 38%. Then (12%) of the respondents said that their organizations work on Building School projects. Sixteen (16%) of the respondents indicated that their organizations work on Hotel projects. Civil Engineering Projects was indicated by 32% of the total respondents, while only 2% indicated other building projects such as building and maintenance of homes.

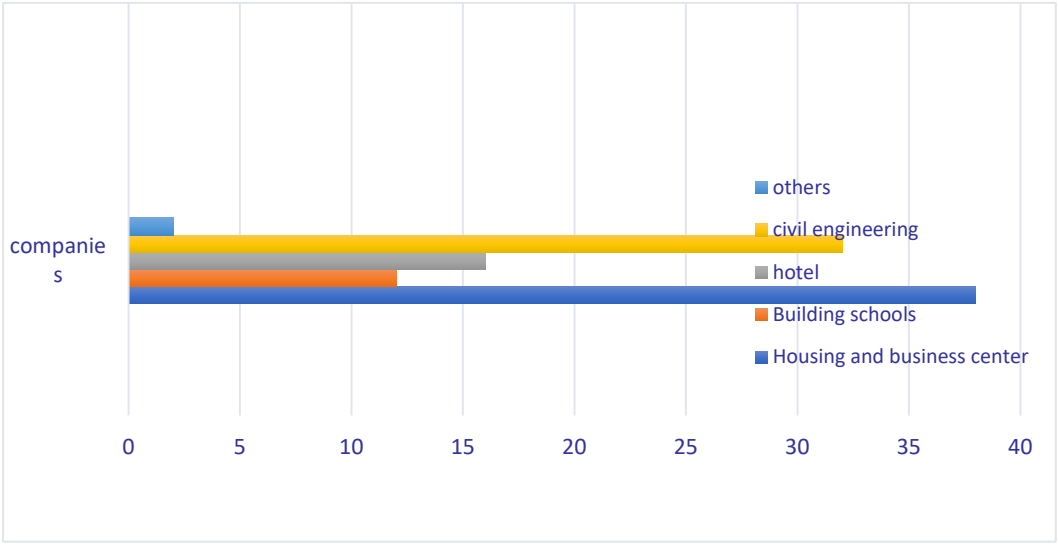

Fig. 4 Graphical representation of projects types respondents have taken part in

The questionnaire also asked respondents to indicate the main types of contracts that they are engaged in. The majority of the respondents (82%) indicated that they are engaged in Traditional Contracts while 18% of the respondents indicated that they are carried out Design-Build-Operate Contracts. The study reveals that the average duration of the projects that most of the respondents are engaged in had 12 to 18 months having the

highest frequency of 37% of responses, 33% indicated that the average duration of the projects are between 18 and 24months, 19% of the 34 respondents indicated that the average duration of the projects are between 24 and 30months while 11% of the respondents indicated that the average duration of their projects last less than 12months as explained in Figure (5)

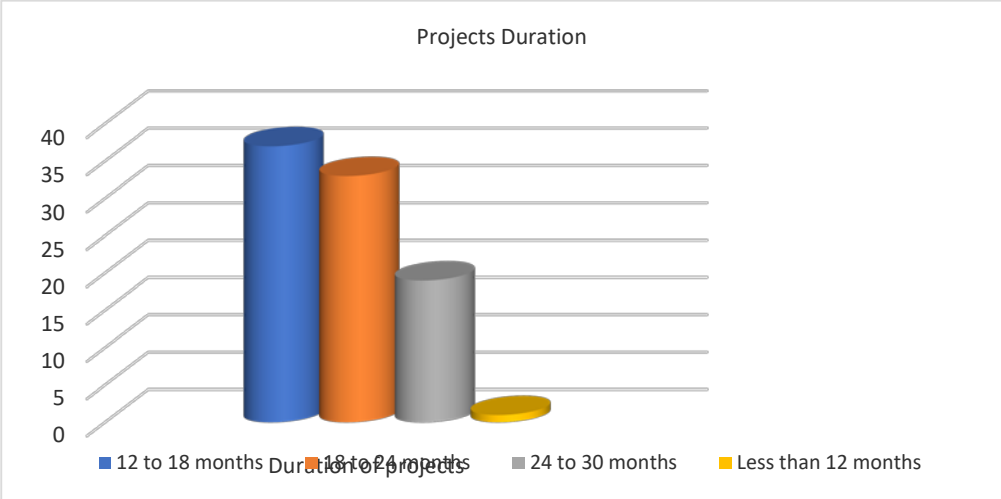

Figure 5. Graphical representation of projects duration among participants

The Role of Project Management Software in the Construction Industries

Construction respondents are heavy users of critical path analysis for projects planning and control, also resource management, scheduling, and earned value analysis for project control. The number of activities in a typical project and the use of software for all active projects were the key determinants of the usage of specific analytical techniques in the industry. The modern world of Information technology brings significant changes to our profession and the way we carry out tasks in every daily activity, likewise the project management of construction now has too much to do with software. The study shows that 92% of respondents use Project management software while only 2% are not using the IT tools and the remaining 6% use it sometimes but not always.

The participants were asked about their view on the importance of PM software, and it reveals that 78% believe that the different types of project management software are important and 13% said it's not necessarily important, and 5% agree that it's partially important. Furthermore, integrated software are in use in 34% of the total respondents' company, 61% are yet to develop such software and 5% believe that they will build PMS in the future. Table (1) and figure (6) summarize the response that collected from the participants about PM software.

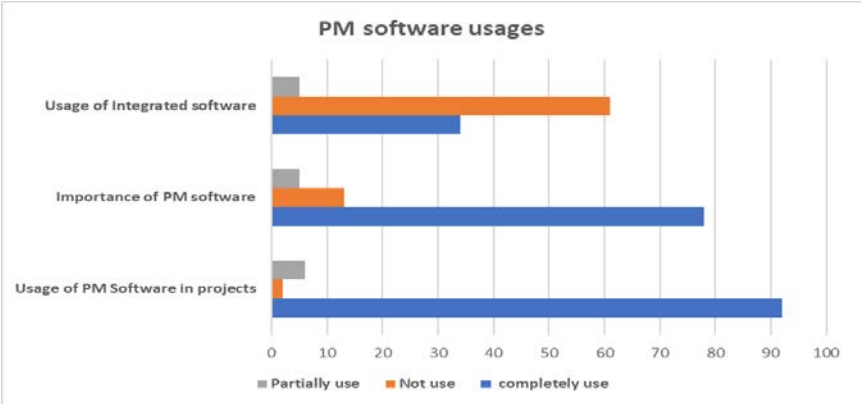

Figure 6. Importance and usages of PM software in construction projects

Table 1. Importance and usages of PM software in construction projects

Variables	Completely use	Not use	Partially use	Rank
Usage of PM Software in projects	92	2	6	1
Importance of PM software	78	13	5	3
Usage of Integrated software	34	61	5	2

Table 2. Stages at which respondents used PM software in construction projects

Project phases	Planning	Execution	Monitoring/control	Closing
At what phase do you use PM software?	37%	33%	22%	8%

Also, the respondents were asked to indicate the projects phases and aspects that they use such software in their duty. Table 2 explains the phase and Table 3 explains the project aspects. The table above show the stage or phase at which managers and stakeholders use PM software more is planning level with 37% of respondents agree to that, followed by Execution level. This might be due to the much work of planning in construction projects that consist of cost estimation, scheduling and risk plan. While in monitoring and control managers use software for communication project tracking and team development and it's the third with 22% of respondents that agree to this point. We see that only 8% participants agree the point that they use PM software at closing phase, because this is the final phase in the project and it requires a few strength and task.

Table 3. The aspects in which PM software helps respondents

Project aspects	Time Management	Cost Reduction	Managing team	Simplify Procurement
In which aspect does PM software helps you?	32%	31%	23%	14%

Table 3 prescribed the different aspects respondents use PMS at, with the highest 32% believe it saves their time in managing tasks preparing schedules or monitoring the project performance. 31% agree that it reduce cost of project, through identifying risks, simplifying works and resource allocation, while 23% manage their team using the software tools and the last 14% believe the software simplify their procurement process in managing projects.

Categories and Purpose of PM Software

This study finds the main purpose and the categories of software in construction Project management.

Table 4. Purposes of PM software in construction

Question	Planning	Cost Estimation	Team Management & Collaboration	Visual Design
For what purpose do you use PM software?	35%	17%	30%	18%

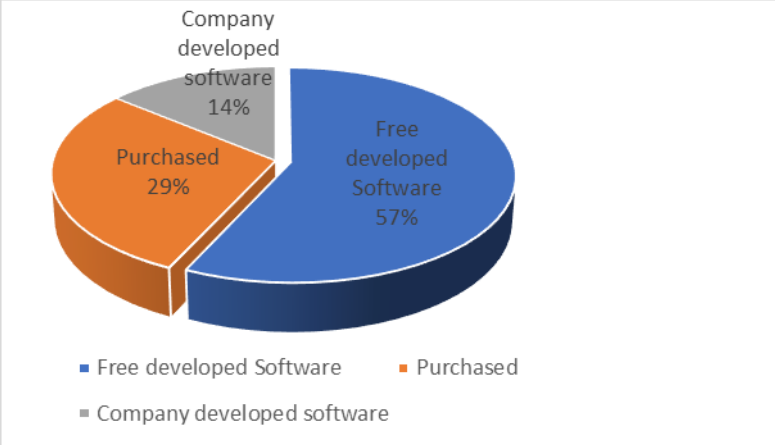

Figure 7. Graphical representation of source of PM software

As represented in Table 4 the main usage of project management software is for planning purpose as per the study, because 35% respondents showed that they use PM software for planning their project, then followed by team management and collaboration with 30%, which means that the tool is effective in solving team related issues during their projects. Visual design and cost estimation are 18% and 17% respectively, still visual design has a bit priority hence construction is something that has to do with design, but cost estimation is also important independently on it's on.

The study finds that most of the respondents rely on the free developed software on the internet with 57% agree to this fact, followed by 29% whom purchase software for their project usage and then 14% of participants use integrated company software as shown in Figure (7). The study further analyzes the main type of software being used in the construction project industry, below is a table for the result as displayed in Table 6

Table 6. PM software popularly used in construction

Software type	Microsoft Project	BIM	CAD	Other
Which among the following do you use in your projects?	47%	24%	16%	13%

The results above show the major software used in construction project is MICROSOFT PROJECT with 47% of respondents using it, then Building information modelling as the second most used software with 24% and CAD at third with 16%. Other software are also in use with 13% among respondents. These may include software that aids procurement, communication and other miscellaneous tasks in project.

Impact of Project Management Software

The following Table explains the impact factors of Software project management and tools in the construction projects and ranked according to the importance of each factor to achieve the project objectives and fulfillments. As seen from the table 7., "PM software enhance team performance or simplify project team members collaboration" in the first rank which ensure the necessity of using these types of software in construction projects.

Table 7. The impact factors of PM software that popularly used in construction projects

Impact factors of Software PM	Mean	Standard Deviation	Rank
IT tools and software are effective from the initiation to closing phase of a construction	3.84	0.96	4th
PM software have significance impact towards cost reduction throughout the project	3.82	1.14	11th
Finance and budget could be tracked and managed using PM software	3.80	1.01	6th
PM software enhance team performance or simplify project team members collaboration	3.76	0.74	1st
PM software could absolutely be used to manage communication aspect in construction	3.70	1.09	8th
Software could be used be to easily minimize onsite workload in a construction project	3.66	1.21	13th
Help in the availability of experienced & skilled labor	3.64	1.10	9th
Project delay can be managed significantly using a software to control schedule	3.62	0.97	5th
Software and IT tools could be used to manage large team as in construction project	3.56	1.07	7th
Procurement and transportation of resources could also be hastened using PM software	3.56	0.93	2nd
PM software provide a better risk management and mitigation option	3.50	0.95	3rd
Software are essential in stakeholder's relationship within a project	3.50	1.18	12th
Construction Project planning might be done properly without an IT software	3.50	1.10	10th

Regression Analysis and Testing the Research Hypotheses

In order to find the best model for data analysis, the Stepwise regression technique is used for multiple regressions, in this method, variables are input to this equation in order of their relationship with dependent variable and also this would be continuous until the entry process is significant on the model used. When variable's entry is not significant on a model, entry process will stop (Stepwise Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100). As we can see, all independent variables were entered, and removal variables were found as zero. Table 8 presents coefficient determinant of *R*, *R*2 and Adjusted R. In the model, after inputting all independent variables, R is equal to 0.820 which at the end describes a strong relation between independent variables and the dependent variable. R square is equal to 0.679. This reflects that 69 percent of changes in dependent variable (positive impact) are described by these independent variables (negative impact). Here the point is R square didn't involve degree of any freedom in the analysis. Henceforth, with using Adjusted R square which it involves in the table we have R2 − Adj = 0.673, which is more reliable.

Table 8. Regression model summary

Model	R	R Square	Adjusted R	Std. Error of the Estimate
Regression	.830	.679	.673	.29230

Hypothesis Testing

Now let's use the tables above to clarify the test of research hypotheses.

Hypothesis One: In view of table 7 and the regression model in table 8, the correlation between effectiveness in project management and impact on cost reduction record 0.496 & 0.374, it shows positive relation between them. Also, according to P-value which is significant in 0.001 we can reject H0, it's mean that the first hypothesis of this study is accepted, H1: Project management Software have a positive impact on construction projects

Hypothesis Two: According to the correlation table, it shows the most positive relation with minimizing workload in comparison with managing project delay. Also tracking finance in table 7, which is 0.731, shows strong direct positive impact on managing the delay. According to P-values which are significant in 0.001 we can reject H0 and therefore second hypothesis of this study is accepted too, H2: Project management software simplify and reduce project workload.

Hypothesis Three: Based on the correlation coefficient between managing procurement and managing communication in table 7 which is 0.449, shows positive relations between them. Also, percentage of usage of PM software in table 1, which is 92%, shows how effective are software in PM. According to P-values which are significant in 0.001. We can reject H0 and then the third hypothesis of this study is accepted also, H3: Project Management software are effective in Construction projects

Conclusion

This research invistigate the importance of project management software to facilitate and support the fullfilment of the construction projects. To prescribe this importance of project management software in construction projects; We confirmed that IT and software tools have significant importance within construction project lifecycle. Most respondents clarify software can help them in planning project and simplify major planning activities like scheduling, cot estimation and managing project team members. Also, software used in construction projects, the study tested that most construction firms, they relied on Microsoft Project as their most used software. Software can save their time and reduce cost of project by making easy planning and schedule automatically. Furthermore, project management Software can assist the managers to acheive control and monitering in construction projects; the research finds that PMS are useful to construction industry managers and stakeholders for simplifying onsite and offsite workload.

Respondents who took part in the research study were all contractors and their firms were all over 10 years of experience. Due to the minimal representation of the sample size, the study picked companies that have been operating over 10 Years so as to gain valid and concrete data. This shows that the most respondents have a good idea of Kazakhstan construction industry. The main types of contracts that the respondents are involved in are

traditional contracts (82%) and design-build-operate having eighteen per cent. Out of these types of contracts the construction of housing and business centers ranked the highest with thirty-eight per cent while the least was maintenance of homes and building with only two per cent of contracts allocated. We also see that most construction works (37%) have a duration of twelve to eighteen months while the least (11%) allocated to of contracts took less than twelve months to be delivered. The study revealed that 92% of project managers use PMS in their projects, and 82% believed that PMS are important in their work and 34% used their company integrated software.

The research found that the least stage at which respondents use PMS is at the closing phase, while the main phase that the PMS is needed is planning phase. Furthermore, respondents believe that PMS are helpful in planning project with a relevant data that showed the highest percentage in this group is 35%, followed by team management and collaboration with 30% and the least is cost estimation with a statistical data of 17%. In the study we see that most of the respondents use Microsoft project as relied project management software with their highest respondents of 47%, while the other software have a statistical data of thirteen.

Recommendations and Suggestion for Further Research

This research recommends all the project managers who manage construction projects adopt modern software tools and modern technology in managing all project phases from planning the project until the closing phase. Also, there are significant impact factors discussed in the research, these factors affect the project's success, and managers should take them into their account to achieve the successful delivery of construction projects. Recommended Research areas to make further research may include:

- Apply the idea of this research in other fields or industries not only the construction industry, so this can maximize and explain the significant influence of software tools in project management.
- Maximize the role of data analysis by providing a large sample size and population to generate more findings and hidden insight from data analysis.

Scientific Ethics Declaration

The author declares that the scientific ethical and legal responsibility of this article published in EPSTEM journal belongs to the author.

Acknowledgements or Notes

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