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## Project & Portfolio Management Software Use in Construction Industry

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### Abstract

In recent years, a variety of software alternatives and capabilities have been made available for project and portfolio management (PPM). However, very little research has focused on the use of project and portfolio management software in the construction industry. Degree of adoption of PPM software and the reasoning behind these selections may vary among contractors, as each project's unique situation may have an impact on the contractor's decision. The objective of this research is to determine the current trends in PPM software use in the construction industry, and to investigate the reasoning behind the decisions that are related to the PPM software use. A practitioner survey is conducted to reveal the current project and portfolio management software trends of international contractors along with the adaptation of building information modelling in PPM. The questions of the survey are grouped under four sections; project management software practices, portfolio management software practices, evaluation of the PPM software, and BIM use and habits in PPM. The survey findings are presented and discussed to reveal the current trends in project and portfolio management software use within the construction industry.

**Keywords:** BIM; construction industry, portfolio management, project management, software

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### 1. Introduction

Construction industry is considered as a project-based industry [12]. This notion is based on the fact that every undertaking in construction industry, whether it is a new endeavor or simply maintenance work of an existing enterprise, is a project. Hence, project management plays a critical part in construction industry's fortunes. Not a new term anymore, principles of it have been around for more than 50 years now, project management, is one of the most important methods of management [1]. As Munns and Bjeirmi have concluded in their study, successful project management techniques have a key role to contribute to the achievement of projects" [9]. In today's highly ambitious construction industry where limits of engineering is challenged constantly, successful implementation of project management techniques, and in turn successful management of the project, is crucial and it is ensured by project and multi-project (portfolio) management software packages. As heavy users of project and portfolio management (PPM) software packages, professionals of construction industry differ in their PPM practices and software usage habits. Their projects usually tend to contain greater number of activities compared to other industries but they often include simultaneously on fewer number of projects than professionals of other industries [8]. They also prefer PPM software packages with multiple analysis capabilities like Primavera [8]. Although previous studies have established that project management professionals in construction industry possess a significant interest in improving their project management capabilities [7, 8, 10, 11], examination of available literature does not provide any recently dated study based on professionals' responses. Given the fact that there is now more computing power available recently, the need to update findings of previous studies arises. However, this study does not investigate the differences between project management professionals of different industries as done in previous research. Instead, in this paper, PPM and BIM software usage patterns of project management professionals in construction industry will be identified, addressing current usage patterns, comparing findings to previous studies.

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## 2. The Study

A practitioner survey, aimed at project management professionals employed by firms listed in Engineering News Record's (ENR) 2015 Top 250 International Contractors list was conducted [4]. The list contains 250 international contractors around the world and members of the list employ hundreds of thousands. The survey is sent to both individuals working at said firms and also firms' general contact email to be filled by their project management personnel. The survey is also sent to projects which are undertaken by joint ventures of multiple ENR Top 250 members. The survey consisted of 47 questions (available upon request), which served to gather information on project management professional's work environment and project management background, PPM software, PPM technique and BIM software usage. The survey was evaluated and pre-tested by several METU faculty members as well as project management individuals from construction industry.

## 3. Responses

Of the 250 surveys sent, 22 have responded, generating a 9% response rate. While this response rate is slightly lower than the usual 10-20% rate expected for this type of survey [2, 8], when contacted, some of the non-respondents stated that their main reason for not responding was simply lack of time.

## 4. Results

Findings of the survey are summarized in the discussion below, reinforced by visual breakdown of the results in form of charts and tables. (All graphs and tables are available upon request.) Results are discussed in the procession the questions are asked in the survey; starting with demographic factors (professional background) and work environment of the project management professional, followed by results belonging to how project management, portfolio management and BIM software are utilized. Finally, issues of PPM software according to professionals and areas of future research are discussed.

### 4.1. *Demographics and Work Environment*

First part of the study portray the work environment of an international contractor. Majority of respondents' firms have a respectable experience and continuity in construction industry with over 70% having more than 20 years of experience in the industry. Data also shows that more than 65% of the respondents work in organizations that employ more than 1000 people, with a significant portion of them (71.43%) working in a project environment and perform project/program management as their primary job function (52.38%). However, individuals whose primary job function can be classified as time management/scheduling/planning also represent a significant portion with 28.57%, which can be attributed to technological advances in special time management positions such as CPM scheduler.

When geographical data is examined, it can be deduced that commercial activities of international contractors are clustered around certain regions regardless of country of origin. Demographic profile of the project management professional in the construction industry shows a significant change when compared to findings of previous research. Respondents with more than 25 years of project management experience has dropped to ~5% compared to over 30% in 2001. However, respondents having experience between experience between 5-15 years have increased significantly, compared to previous studies [8]. This portion translates to the half of all respondents, suggesting increase in computers' role in PM resulted in a more computer proficient generation being employed for PM positions. A large portion of the respondents have received a post graduate degree (75%), which is consistent with the previous studies (74%) [8].

More than half of the respondents (61.90%) spend all or close to all of their time in PM. Of those responded, 38% work on a single project. When compared, those working on a multiple projects are both fewer in their numbers and work on fewer projects per person simultaneously than professionals of other industries. Numbers are also lower than findings of previous research on the subject [8].

### 4.2. *Project Management Practice and Software Usage Patterns*

During the last two decades, use of PM software steadily increased to a saturation point at the start of the new millennium. Nearly all respondents use or have used or expect to use PM software. Construction industry professionals use PM software for multiple purposes. Majority of the respondents have stated that they use PM software for project planning (scheduling) (90%) and project control (70%). Modern PM Software is also used for features such as general work planning/presentation, resource management and cost management by nearly half

of the respondents. Use of PM software have become a project based decision. A decision more often than not made in favor of PM software.

The increased need for PM software use in construction industry is closely related to increased size and complexity of modern projects. A large scale international contractor undertakes projects consisting of 3750 activities on average. Besides project size and complexity, outside requests and software capabilities are the most influential factors affecting use of PM software (Fig. 1).

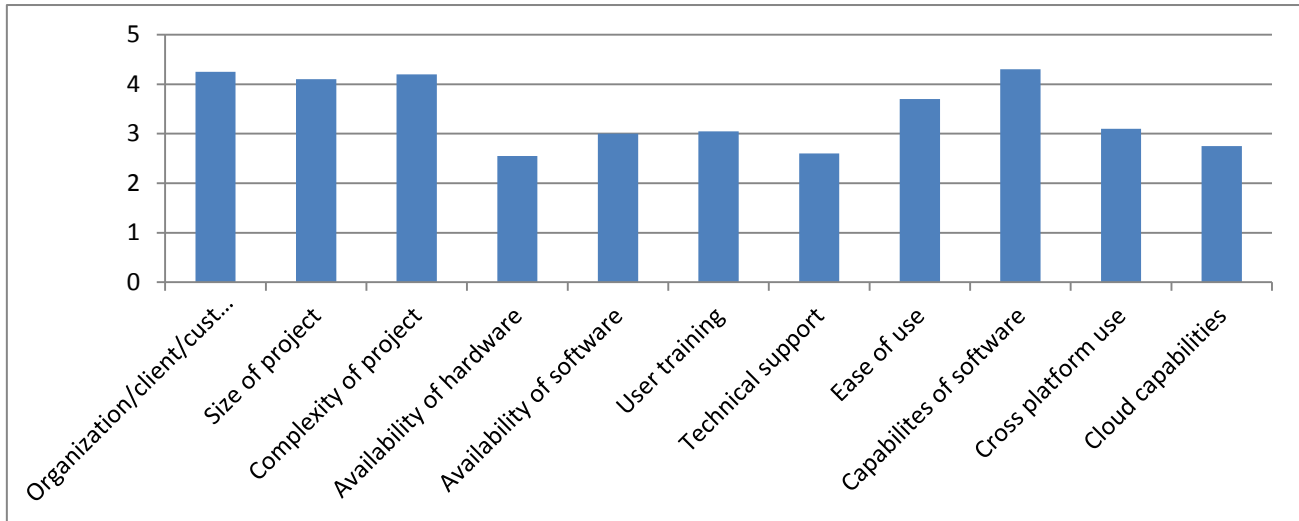


Figure 1: Factors influencing international contractors' decision to use PM software (Average of responses)

As observed in previous studies [8], Primavera Project Planner (P6 and other versions) is still the most popular (44%) with Microsoft's MS Project a distant second (27%) and SAP's different solutions (17%) a distinct third after them. In addition, responses have shown that MS Project is sometimes used together with other PM software, like Primavera, and SAP. As expected and concurrent with existing studies critical path analysis is the most commonly conducted one (90%). Resource loaded schedule analysis (75%) and earned value analysis (55%) are each also performed by more than half of the respondents.

An analysis of the information entered and updated demonstrates that almost every aspect of a project is initially entered to the software, a climb in frequencies compared to previous research. Moreover, every respondent also stated that not all but majority of the data they initially entered is updated. Of the updated data, most frequent are the actual activity start/finish dates and activity durations, once again consistent with previous studies.

#### 4.3. Portfolio Management Practice and Software Usage Patterns

Portfolio management is important in means of managing the interdependent projects of a contractor to accomplish strategic objectives in a more efficient way. The idea behind the objectives is provision of optimum risk-return combination. Besides, "fundamental aspect of portfolio theory in construction is the idea that the riskiness inherent in any single project held in portfolio is different from the riskiness of that project held in isolation [6]. Consequently, contractors can have chance to minimize their risks in their expected returns via holding their projects in a portfolio. To figure out the trend in usage of portfolio management of contractors, a section with 10 questions that try to grasp the objectives, practices and contentment is prepared in the survey. Out of 22 respondents, only 1 respondent conducts portfolio management and this indicates a low tendency of conducting portfolio management. When the answers of the portfolio management using respondent are examined, it is seen that the objective includes both minimizing the duration and cost of the project portfolio via using resource and risk management; software of SAP ERP is used; and ETA (Event Tree Analysis) is conducted. Furthermore, even though the majority of the respondents skipped this section of the survey, 80 % of respondents say no to sacrificing some projects by allocating less resource or delaying to meet overall portfolio objective. This may indicate the contractors' general perspective of giving more value to single project management. In the process of investigating the reasons behind this perspective, from face to face interviews with the managers who deal with the projects in Middle East and Eurasia, it is concluded that the scope of project management and control depend upon the requests of specifications owners provide during proposal stage. If the owner does not inquiry any advanced project analysis methods including resource scheduling and leveling analysis, then the contractor firm does not provide a significant resource -such as procurement of PM software for all members in EPC and

proposal departments- for project management; and this is generally the case for the contractors who does not respond the section of portfolio management in the survey.

#### 4.4. Rating and Issues of PPM Software

To determine the main purpose and context of PPM software usage, 5 different statements including various features of software are given and to be rated from 1 to 10. Weighted averages for corresponding statements are shown in the Table 1 and they declare the context level of the software usage. Accordingly, the quality of the automatic resource scheduling analysis is rated to be the most important one and handling uncertainty and risk capabilities is rated to be least important one. Relatively, weighted average of feature of integration with other software is low, as well. With respect to these results, it can be stated that generally PPM software is not used at a large scale of usage purposes. Furthermore, the importance and level of use of PPM Software change accordingly with the size and complexity of projects so that it is significant to determine to what extend PPM software should be used since not only planning but also controlling of the project is dependent upon this extend. To broaden the use of PM software, managers can be led to go beyond the conventional and limited techniques of planning via endorsing significant improvement in PM software. Correspondingly, the respondents are asked to choose the areas of improvement in software. Most voted one comes out to be better data exchange capabilities with other software (60%), following that optimal resource leveling capabilities (55%) and optimal crashing capabilities (50%) are the most chosen ones. These improvements are all related with the strategic objectives of minimizing the duration and cost of the project. Besides, relatively “enhanced portfolio management” (5%) and “better integration with BIM software” (5%) are rated at a very low percentage which shows that simply managers are not interested in the further improvements in the fields of project management they are not currently using.

Table 15: Rated statements of PPM software features according to their importance

Rated statements from 1-10 (With 1 being extremely unimportant and 10 being extremely important)	Responds (Weighted average)
How do you rate the quality of the automatic resource scheduling analysis of PM software?	7.85
How do you rate the quality of the automatic resource leveling analysis of PM software?	7.25
How do you rate PM software's capabilities to handle uncertainty/risk?	5
How do you rate PM software's integration with other software?	5.45
How do you rate the value of research directed toward improving PM software?	7.40

#### 4.5. BIM Practice and Software Usage Patterns

BIM can be defined as tools, processes, and technologies that are facilitated by digital machine-readable documentation which includes information of a building, its performance, its planning, its construction, and its operation [3] BIM is not a single method or software but rather an artificial environment based on smart and detailed models created and updated by multiple parties with multiple software. Compared to PM, BIM is a relatively new concept that still hasn't reached saturation. Even though it has been on an upward trajectory since 2005, BIM adoption levels still cause dispute (Graham, 2016). The most cited resource on BIM adoption levels is a McGraw Hill report that states around 70% of US contractors use BIM (McGraw Hill, 2012), but the report does not state contractors' engagement levels. Respondents of this study however, stated much lower adoption levels with only 20% using BIM actively. Of those using BIM, majority (85%) are using it on either selected projects or sparingly. Decision to use BIM is also dependent on multiple factors. Among those factors, the most influential according to respondents is client/customer requests. Following that are ease of use and software capabilities suggesting that contractors decide to use BIM only when they are convinced that it can be productive enough.

Autodesk products are clear the most frequently used BIM products. Majority (87%) of respondents using BIM, stated that they use at least one Autodesk product (Revit, Navisworks, BIM360 Field etc.) and often more than one (13% use both Autodesk Revit and Navisworks together). Autodesk Revit itself is the single most popular (40%) software while Synchro Professional and Bentley AECOsim Building Designer are the only non-Autodesk software preferred by contractors that responded to the survey.

Despite expectations, most popular feature of BIM used by international contractors is not modelling. While a significant majority (80%) use BIM for 3D modelling, of those respondents using BIM, all stated that they use BIM for clash detection (100%). Third most frequent use (60%) by international contractors are constructability analysis, 4D modelling and cost estimation (Fig. 2).

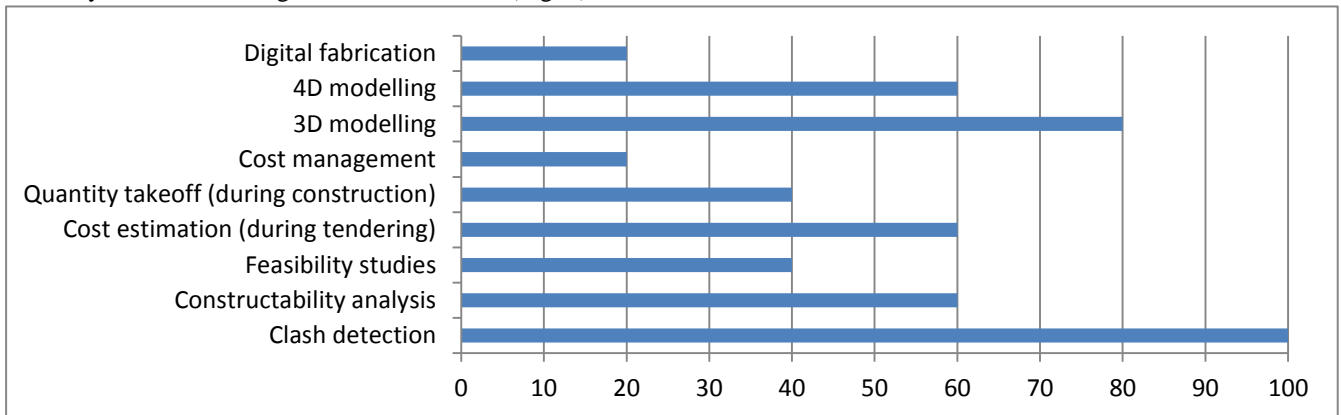


Figure 2: Features of BIM used by international contractors'

## 5. Summary and Conclusion

The results of this study mainly confirm previous research on the subject that international contractors are heavy users of PM software. The survey respondents tend to work on a few projects at a given time, fewer than previous studies reported, but the respondents projects usually consist of more activities than the other industries,. They also usually work in a project environment and spend a large portion of their time in PM.

The response rate of 9% can suggest that the obtained data may not be representative enough for the entire ENR Top 250 List. While it is true that all respondents are members of the aforementioned list, hence some of world's highest grossing international contracting companies, it can be argued that the available sample is not representative. Even though the study survey was sent out to all members of the ENR Top 250 List, responses were identified to be coming from firms that are familiar with METU. As a result, it can be observed that the responses were concentrated around the Middle East, Eastern Europe, Balkan and Caucasus regions. This fact can be interpreted as majority of respondents are formed by Turkish ENR Top 250 members and ENR Top 250 member firms that are in business with Turkish firms, hence making representativeness of this study questionable. A future study with a greater sample size will yield a more representative sample.

Concurrent with past observations and previous studies, professionals in the construction industry are using PM software quite frequently. Most influential factors on deciding the use PM software are project size and complexity both of which can make the project unmanageable without using any software. Other influential factors are client/customer requests and software capabilities. Construction professionals mainly use the PM software for project planning and control and they use various analyses on their projects, with CPM analysis leading the way.

Research findings suggest that use of portfolio management is not prevalent to the majority of the respondents, since single project management is widely preferred. These results may be due to the small number of respondents and the contractors' market region. Since mainly the respondents are Turkish contractors who take place in ENR Top 250 International Contractors List, they show a similar trend in project management capabilities and habits. Moreover, the results obtained from the survey's section "Rating of PPM Software" are correlated with results in Portfolio Management Practices as giving relatively less importance for uncertainty/risk management capability of software and rating at relatively very low percentage for improvement in portfolio management capabilities of PPM software show that the majority of the respondents are currently not interested in widening the extend of usage of software. Besides, managers seem to be concentrated on the improvement of conventional features such as resource scheduling and resource leveling of PPM software. Consequently, it can be stated that there is a direct correlation between the importance of a feature of software and the need of improvement of similar features.

BIM is often regarded as the future of construction management and the last decade have seen a significant increase in BIM adoption among contractors. However, these high adoption levels seem to be characteristic of all international contractors, as this study's respondents indicate low BIM usage rates. In addition, those who use BIM usually do not use it often. BIM usage is a project based decision, and the clients request is the most influential factor according to respondents. Contractors use BIM for clash detection more than modelling, but both 3D and 4D modelling are also used frequently.

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