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# A TECHNICAL STUDY ON SMART CONSTRUCTION IN VARIOUS CONSTRUCTION PROJECTS

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**ABSTRACT:**

The project management process was revolutionized by the invention of project management software. Computer-aided planning and scheduling provides efficient and practical planning for large projects. The basic functions of any project management software include creating and managing schedule, resource planning, delay estimation, budget allocation and team communication. This work aims to analyze and understand the existing construction project management measures and the aiding softwares. The Deficiencies in the current situation have been identified. One of the most common weaknesses of CPMS is the lack of an electronic procurement process.

Procurement of construction materials is a multifaceted process that covers the entire project life cycle. Social e-procurement involves the use of online collaborative networks to explore new opportunities for effective and efficient construction business. The features of ideal internet based smart construction management software are suggested. Some of these include calculating earned value check, effective dynamic scheduling with algorithms and e-procurement.

Keywords: project management, managing schedule, resource planning, budget allocation

## I. INTRODUCTION

Construction Management or Construction Project Management (CPM) is the overall planning, coordination, and control of a project from beginning to completion. CPM is aimed at meeting a client's requirement in order to produce a functionally and financially viable project. Construction industries throughout the world are challenged to improve performance if they are to contribute fully to the achievement of economic prosperity, sustainable environments and healthy fulfilled populations.

With the advent of internet era, smart construction management is dependent upon internet based integrated project management systems. Construction project management software (CPMS) refers to the systems that help project owner/operators, program managers, and construction managers, control and manage the vast amount of information that capital construction projects create. These systems, available from vendors, not only manage capital projects but also the entire project portfolio.

Procurement of construction materials is a multidisciplinary process spanning through the entire project life-cycle. Social e-procurement involves the usage of online collaborative networks that is effective and discovers new prospects of construction business. The features of ideal internet based smart construction management software are suggested. Some of these include calculating earned value check, effective dynamic scheduling with algorithms and e-procurement.

### 1.1. STEPS IN CONSTRUCTION MANAGEMENT

*1.1.1. PRE-CONSTRUCTION*

(a) Site evaluation
(b) Obtaining Financing
(c) Budgeting
(d) Design
(e) Scheduling

*1.1.2. CONSTRUCTION PROJECT AND SITE MANAGEMENT:*

(a) Procurement

Procurement is the acquisition of goods, services or works from an external source. It is favorable that the goods, services or works are appropriate and that they are procured at the best possible cost to meet the needs of the acquirer in terms of quality and quantity, time, and location. Corporations and public bodies often define processes intended to promote fair and open competition for their business while minimizing exposure to fraud and collusion.

Procurement life cycle in modern business usually consists of seven steps

Identification of need
Supplier Identification
Supplier Communication
Negotiation
Supplier Liaison
Logistics Management
Additional Step - Tender Notification

*1.1.3. POST CONSTRUCTION:*

(a) Certificate of Occupancy
(b) Closeout Documentation

**1.2. QUESTIONS IN CONSTRUCTION MANAGEMENT**

*1.2.1. PROJECT SPECIFIC INFORMATION*

- Where is the project?
- What is the current state of the project? running, functioning, etc.?
- How long did it take?
- How much is the budget?
- Why was it built?
- Who will be in charge of the various steps of project?
- Why is it a noteworthy project?

*1.2.2. LABOUR*

- Who are the labourers? How will they be paid? Will the labourers be paid sufficiently?
- How many specializations/trades/guilds are involved or how many subcontractors?
- How will the workers be trained or apprenticed?

*1.2.3. DESIGNERS*

- Who will do the design?
- How many design specializations?
- How will the designers be trained?
- How will the designer be selected?

*1.2.4. PROJECT DEVELOPMENT AND FINANCING*

- Who will provide the financing?

*1.2.5. PROJECT MANAGEMENT AND PERFORMANCE*

- What is the safety performance?
- What is the quality performance?
- What is the cost/schedule performance?
- Will there be any construction/design failures?
- How to organise the project?
- How will the design be presented and documented?
- Who will supply the required material?
- How will the quality control/quality assurance be accomplished?
- How will the project be managed and delivered?
- How will the contractor be selected?

*1.2.6. CONTRACTS AND LEGAL ISSUES*

- What are the law that regulated the commercial exchange?
- What codes or standards are used to regulate design or construction?
- How will the disputes be negotiated?
- What kinds of contracts will be used?

*1.2.7. INNOVATION*

- What technical innovations will be involved?
- What design innovations will be involved?

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## II LITERATURE REVIEW

Conlin.J and Retik.A (1997) classifies the procurement software characteristics into general, technical and specialist features. General features are the basic information about the software while technical features perform the examination of particular features. Specialist features indicate the key features uniquely offered by the software.The critical path algorithm is frequently used in the implementation of various planning and scheduling software. In rare scenarios, earned value is used for controlling the overhead occurred during the scheduling phase.

Costa.A.A and Tavares.L.V (2014) discusses two game theory based models for analysis of e-procurement network dynamics. The simulation for procurers and administrative environments reveal that with constant rules and features of the network, the benefits for administrators diminish over time. Unbalanced equilibrium between existing and new users and suppliers derails the growth of the network.

Liberatore.M.J et al. (2009) emphasizes the need for project management software to provide near-optimal schedules. An option to maximize the net present value of cash flow is advisable. The project management software should be inter-operable with other enterprise wide software packages facilitating cross platform functioning. Since the system involves the usage of various protocols, the speed and quality of communication has been improved. This enhances collaboration and coordination between firms in construction companies.

Ryd.N. (2004) discusses the information flow between the client and the contractor is very much important throughout all phases of construction. Project schedule mismatch to actual progress can be compensated by inserting time allowances in procurement supply chain process. But these time buffers are used inefficiently leading to time wastage.

Enhanced critical supply chain management is modeled by Yeo.K.T and Ning.J.H (2006) to achieve better time management in the material procurement process. This model aggregates the variations and provides an accurate forecast and resource alertness. The scheduled and synchronized model of critical supply chain is flexibly and dynamically controlled.

The generic tools and digital technologies used in procurement process are discussed by Ibem.E.O and Laryea.S (2014). Most of them are web-based applications facilitating real- time collaboration and communication in construction supply chain. In Kamara.J.M and Anumba.C.J (2001) the requirements of the clients are analyzed and structured into primary, secondary and tertiary interest groups. Formulation of client's requirements and decision making process deals mutually with outcome of the construction and the client's satisfaction. The briefing of documents to encourage innovation, physical, contract regulating and administrative function. The output for the client is provided with equal importance for the design and operations. The primary software and can be further developed towards better user interface and integration with other software packages.

## III METHODOLOGY

### 3.1. TRADITIONAL METHODS OF CONSTRUCTION MANAGEMENT

Differences in cultures can be used to understand variations in construction practices. This cultural understanding of construction has two levels; first relative to the dominant culture of the day and then relative to the culture of the project.

Investigation of a "building culture" must first develop an appreciation of the larger culture in which the construction project occurred. Understanding at this level helps explain the major societal forces that shape construction practice. Considering the relationship between the building culture and its society leads to consideration of the impact of individual projects on society. For example, large religious projects - Ankor Wat, Cambodia; Chartres Cathedral, France_ were often the major enterprise of the local community for decades. They were both the source of livelihood for many and the object of monetary donations by affluent citizens of the community. These projects were the source of pride for rich and poor alike.

Understanding the larger culture requires an appreciation of the role of churches and kings, as opposed to commercial interests, in major construction endeavours. Historically, most projects had religious, military/civil works, or monumental motivations _St. Paul's, United Kingdom; Great Wall, China; Roman Aqueducts, Rome; Pyramids, Egypt_ and only very recently have projects been developed as purely commercial ventures. Consideration of the major human roles in a construction culture helps understanding transitions from a master builder culture to the more specialized division of labour common in modern construction. Rapid changes in construction practices are seen during those periods that experienced profound cultural changes, e.g., agrarian to industrial economy, changes from royal to democratic governments. For example, the rise of democratic, industrial economies allowed the growth of specialized contracting firms and increased autonomy for workers' organisations. On the other hand investigation of "project culture" helps us to understand the growth and motivation for specific construction practices. Issues such as the flow of money, training of workers, sharing of design knowledge, and nature of contracts and agreements are central to defining fundamental construction practices.

### 3.2. NEED FOR e- CONSTRUCTION MANAGEMENT

The management of construction projects requires knowledge of modern management as well as an understanding of the design and construction process. Construction projects have a specific set of objectives and constraints such as a required time frame for completion. While the relevant technology, institutional arrangements or processes will differ, the management of such projects has much in common with the management of similar types of projects in other specialty or technology domains such as aerospace, pharmaceutical and energy developments.

The convergence of information services, communication, and computing functionality in the Web technologies allows practitioners in construction to perform Web-based project management over the Internet. More than 100 software developers have developed web- based project management software and services for the construction industry (Extranet World 2000). A number of construction companies all over the world adopted this technology either because they realized its competitive advantages or they were being forced to adopt it by their clients. When a construction company commits to adopt a Web-based project management system, there are two possible strategies that the company can choose in developing the system: in-house development or outsourcing this activity to a professional consultant.

Regarding the first option, construction firms that decide on in-house development should keep in mind the substantial financial, technical, and human resources necessary to develop and maintain the system. The company can host a Web server internally and customize its functionality to fulfill the corporate needs and those of the project operations. Also commercially available Web-enabled project management software can be customized into proprietary systems. On the other hand, the second option to outsource is useful for companies with limited resources to develop their own Web-based project management systems, and there are a variety of opportunities in outsourcing. Consultants may be hired to build a web site to fulfil the company's Internet advertising needs, solicit job applications, or conduct comprehensive project management over the Internet.

### 3.3. BENEFITS OF e- CONSTRUCTION MANAGEMENT

Small and large companies around the world choose Web-based software to manage their projects today. Web-based project management software brings more usability, convenience and value to companies of any size and industry. Web-based project management software doesn't require dedicated technical specialists to maintain and support. It is up and running in seconds. Web-based project management tools improve your project communications and the overall productivity of your team.

Information Technology (IT) is now routinely used in the construction industry as a tool to reduce some of the problems generated by fragmentation. The use of IT improves coordination and collaboration between firms participating in a construction project, leading to better communication practices. Its benefits include an increase in the quality of documents and the speed of the work, better financial control and communications, and simpler and faster access to common data as well as a decrease in documentation errors.

- Web-based project management software gives you access to your data from any computer
- Web-based project management software makes collaboration easy
- Web-based project management software increases productivity
- Web-based project management software is affordable

### 3.4. PROBLEMS IN e- CONSTRUCTION MANAGEMENT

Besides the benefits that s may provide, some important barriers to implementation still exist and should not be overlooked. These barriers need to be addressed in order to increase public confidence in adopting e-CMs in construction projects. The literature shows that these barriers include a wide range of issues that can be summarized as follows.

*3.4.1. DIFFICULTIES IN QUANTIFYING COSTS AND BENEFITS:*

It is difficult to persuade every organization participating in a construction project to make the necessary level of investment to fully implement a e-CM, which is due in part to the fact that there is still no reliable data on the economic

impact of e-CM s for projects or firms. The temporary nature of relationships in a construction project also provides little or nor incentive for investing in innovative technologies.

*3.4.2. SYSTEM RELIABILITY:*

Ideally, a PM-ASP should be available to users at all time to ensure its high reliability. However, this is rarely the case. When servers are down, users become disconnected and unable to work online. Data can also be lost if the system is not backed up or is improperly housed. With hundreds of new ventures competing for the industry's attention, a PM-ASP provider may not be able to adequately take care of users' needs or could even go out of business, leaving users without recourse in the middle of a project.

*3.4.3. SYSTEM SECURITY:*

System security is probably the most important issue considered by A/E/C firms when implementing PM-ASPs and e-commerce. This issue is well founded, especially in the wake of recent, highly publicized ''hacking'' break-ins. A high-security PM-ASP is a system with low or no chance of unauthorized users or competitors accessing the system and data. Although most PM-ASPs currently employ a ''user name and password'' scheme to protect an unauthorized access to their sites, this scheme is too simple and still inadequate in satisfying the security requirements of electronic transactions in construction projects.

*3.4.4. LEGAL ISSUES OF ELECTRONIC TRANSACTIONS:*

Although the existing legal environment may provide essentially clear guidelines for construction practitioners to manage a contract in a paper-based environment, new collaborative tools such as PMASPs change the work method, making legal responsibilities in this new environment unclear. In fact, an online contract enabled by PM-ASPs is still a new approach that may pose risks, particularly in the area of jurisdiction and enforcement. Since the Internet marketplace is global, e-commerce participants potentially are subjecting themselves to the laws of distant states and countries. A simple solution is to use the forum selection and choice of law provisions in online contracts. However, there is no guarantee that a court will always enforce such language.

*3.4.5. LACK OF SOFTWARE INTEROPERABILITY:*

An important inhibitor to the adoption of PMASPs is the technical difficulties caused by the incompatibility of systems. Companies participating in a construction project usually deploy different software programs to manage their enterprises, resulting in inter-organizational incompatibility and creating an inherent barrier to information sharing when implementing a PM-ASP. Although this problem has been overcome by the adoption of common standards for the construction industry, such as IFC and aecXML, incompatibility often remains a problem in international transactions. It is expected that a widespread adoption of PM-ASPs will be more likely when universal standards are defined and users are able to seamlessly share data between multiple systems.

*3.4.6. DATA OWNERSHIP AFTER PROJECT COMPLETION:*

The actual ownership and control of data after project completion is of considerable importance when implementing PM-ASPs. Although most ASPs allow project owners to archive the entire project record on CD-ROM after project completion, there is still debate on who should get copies of the project record and what information should be included or excluded from each party's version.

*3.4.7. INTERNET ACCESS AND BANDWIDTH PROBLEMS:*

Internet access is a prerequisite to the use of PMASPs. Although some government agencies and large A/E/C firms may have a high percentage of employees having access to the Internet, most small and medium A/E/C firms still have little or no access.

Moreover, most A/E/C firms still use dial-up modems to access PM-ASPs. A dial-up connection may be adequate to simple electronic communications such as e-mail, Internet Relay Chat (IRC), and newsgroup; however, it is not appropriate to convey large and complex project information, i.e., CAD drawings, or to process requests for large amounts of information online.

*3.4.8. RESISTANCE TO CHANGE:*

An information system implementation can cause considerable organizational change that people tend to resist. Practitioners in the construction industry generally resist change and need to know how to use a PM-ASP effectively or how the system can facilitate their work tasks. They usually require a road map to integrate a PM-ASP into their work prior to their acceptance of a new system. The likelihood of this resistance increases with the scope and magnitude of the changes that the system creates.

*3.4.9. PASSWORD BARRIER:*

Most PM-ASPs use password protection as a key to allow users to access project information database. However, it is impractical to give everyone a password. Therefore, a project team needs to define individuals who should have access to the system. This defined use creates a problem such that a system will not be used by all project members. Some participants who have access to the service may need to employ dual systems of electronic and traditional means communication in order to deal with project members who do not have access to the system. This duplicative process may significantly undermine the effectiveness of PM-ASPs.

*3.4.10. DENSITY OF COMMUNICATION CHANNELS:*

The density of communication channels in a construction project poses challenges for the use of a PMASP. Since other channels exist, it is easy for a project team member to bypass a PM- ASP with more familiar technologies such as a telephone, a mobile phone, a fax machine, and a beeper.

*3.4.11. TEAM TOOLS AND PROBLEMS OF SOMETHING FOR EVERYONE:*

Most PM-ASPs have not been specifically designed to interact with the standard tasks of individual project team members. As a tool for the team, a PM-ASP offers a little something for everyone but is not a complete communications and information handling solution for anyone. This makes it harder for team members to integrate the system into their work and helps to explain the lack of creativity exhibited by users.

*3.4.12. COLLABORATIVE MATURITY:*

Collaborative maturity represents the level to which team members are willing to work together and share information and experience to make the project succeed. It is suggested that the collaborative maturity of a team varies greatly. Currently, PM-ASPs are more useful to a team that possesses a high level of collaborative maturity. However, practitioners in the construction industry are still uncomfortable giving power away even within a team with a high degree of collaborative maturity.

### 3.5. IMPROVEMENTS IN e- CONSTUCTION MANAGEMENT

Lean development is an approach to outline creation frameworks to limit misuse of materials, time, and exertion with a specific end goal to produce the most extreme conceivable measure of significant worth. The most critical determinants of development should be work process

dependability and work stream, however lean development has changed the conventional perspective of the venture as change, and grasps the idea of stream and esteem era. Lean development is made out of the accompanying strategies:

*3.5.1. CONCURRENT ENGINEERING*

Concurrent designing can be depicted as parallel execution of different errands by multidisciplinary groups with the objective of getting most good items concerning usefulness, quality, and profitability. Planning could be recuperated by arrange investigation (CPM and PERT). Numerous different open doors can be accomplished through covering exercises, part exercises and decreasing the Exchange time between various exercises. The essential arranging parameters for booking simultaneous exercises are lead time, amount, and hazard under equivocalness. Simultaneous building is concentrating on the collaborations; correspondence and data sharing are the keys for finding new thoughts. While collaborating with subcontractors and providers can likewise be great changes in regards to simultaneous building, the achievement of lean generation is relying upon the inclusion of all members in the beginning times of the plan;

*3.5.2. LAST ORGANIZER:*

The last organizer is the individual or gathering of individuals in charge of generation unit control, which implies fruition of individual undertakings at the operational level. Last organizer requires work process control, finding out the flood of supply, plan, and establishment all through creation units. This must be finished by utilizing look-ahead calendar, which decides the movement and rate of work. It cuts up the ace calendar into many bundles, determining the systems of check limit, execution, and sets up a reserve of remaining by work. The extent of look-ahead timetable reaches from 2 to a month and a half and ought to be placed all together by cooperation;

*3.5.3. DAILY CLUSTER GATHERINGS:*

Daily group gatherings gives a stage to the colleagues to share their perspectives and to share what has been accomplished, in the meantime, disk issues they are confronting amid the creation procedure;

*3.5.4. THE KANBAN SYSTEM:*

The procedure of Kanban is grounded on key segments, i.e., commercial center, provider kanbans, gathering vehicle, satellite stores, and stock administration framework. Commercial centers are site distribution center that allot distinctive materials and little apparatuses to the laborers. Correspondingly, satellite stores are arranged nearby, where they get items from commercial centers. Accumulation vehicle gathers materials from favored providers to the operational site. Kanban utilize plastic containers as a flag to pull materials from providers to site, utilizing the idea of Just In Time. Demand shapes are typically utilized as kanban motions between commercial center and satellite stores. The arrangement of kanban begins regularly with open entryways, so the site can pull materials from the provider up to specific borders. Therefore, the material asked for from providers touches base at market, and items are later on picked from the stores, which are typically overseen by recorder focuses;

*3.5.5. PLAN CONDITIONS AND WORK ENVIRONMENT IN THE CONSTRUCTION INDUSTRY (PCMAT):*

The object is to present an arrangement of wellbeing and security into the venture execution, called "Plan of Condition and Work Environment." These security exercises can create impediments for planned errands and that is the reason it ought to be held onto as a piece of assignments. All security rehearses are along these lines amalgamated in here and now arranging, which can be examined through every day criticism from team and subcontractors individually.

*3.5.6. VISUAL INSPECTION:*

Visual examination demonstrates the uneven idea of the development and prompts the utilization of visual devices for material, work and data stream, and so forth. Distinguishing proof of materials can quicken redundant procedures and lessens the danger of choosing incorrectly item. Advance outlines and calendars can execute the commitment to the fruition of assignments. Data and innovation can likewise enhance the correspondence between leader and executer, and can quicken the procedure also.

### 3.6. DIFFERENCE: MANUAL AND e-CONSTRUCTION MANAGEMENT

Traditional procurement and electronic procurement both have advantages and disadvantages. Procurement is generally done face-to-face, or via telephone, while e-procurement is generally done online. Procurement is really a collection of processes that involve many steps and interactions with the other departments of a company and with suppliers. Because purchasing costs typically run to 50% of operational costs, the procurement process provides many opportunities for cost savings that can make a great difference to a company's bottom line. The rule of thumb is that a

5% savings in purchasing costs can increase profit by 50%, and would equal an increase in revenue of 50%, or a reduction in overhead costs of about 20%.Traditionally, procurement was paper- and conversation-based, usually with procurement officers interacting with long-time partners or well-known suppliers and purchasing at fixed prices. In recent years, this has changed to become a strategic function: Procurement officers seek suppliers that fit with a company's overall strategy.

E-procurement involves moving the procurement process online to cut out steps and save money. For example, traditional procurement involves getting quotes and then approval, probably from finance, as well as a purchase order, which could take more than a week. With e-procurement, this process is simplified and speeded up considerably, thanks to real-time interaction with pre-approved suppliers and trading partners, who can be anywhere in the world. With online purchasing, the purchase can be approved online and the order completed within minutes; the required item often arrives within days.

In business, time is money, so the more a company can reduce staff time involved in purchasing, and the more quickly it issues a purchase order, the more it can reduce operational costs.

### 3.7. BENEFITS OF e- CONSTRUCTION MANAGEMENT

Small and large companies around the world choose Web-based software to manage their projects today. Web-based project management software brings more usability, convenience and value to companies of any size and industry. Web-based project management software doesn't require dedicated technical specialists to maintain and support. It is up and running in seconds. Web-based project management tools improve your project communications and the overall productivity of your team. Information Technology (IT) is now routinely used in the construction industry as a tool to reduce some of the problems generated by fragmentation. The use of IT improves coordination and collaboration between firms participating in a construction

project, leading to better communication practices. Its benefits include an increase in the quality of documents and the speed of the work, better financial control and communications, and simpler and faster access to common data as well as a decrease in documentation errors.

Web-based project management software makes collaboration easy: Collaboration is an intrinsic part of project management. When you work in the same office, it might not be a problem. However, if you need to share a project plan with your international partners, delegate tasks to your offshore team or control contractors across the country, you need a reliable platform for collaboration. Web-based project management software helps you keep the project plan in a central place, so all of you have up-to-the-minute access to the business-critical project information. Teams can share knowledge and collaborate smoothly to complete tasks and deliverables. Online project management software can help you adjust activities quickly to accommodate project changes and updates. If your project plans change often, you need to keep everybody in the loop. Online project management software's help is vitally important to you. Smart notifications via email keep team members well-informed on newly assigned and updated tasks, making your team able to work efficiently. Online project management software allows you to work on tasks together, communicate on issues and discuss problems as efficiently as if you were working in the same office.

Web-based project management software increases productivity: Keeping project information in single place makes collaboration smooth and reduces misunderstanding. Online project management software helps people to work together more effectively and increase organizational productivity Web-based project management software saves the project manager's time on routine operations like updating plans, collecting reports and reminding people about what needs to be done. The project manager can always see who is responsible for each task, instantly keep track of changes and evaluate project progress. Each team member knows exactly what needs to be done. Hosted project management software puts you in control and your team on the same page.

Web-based project management software is affordable: Instead of a thousand dollars, you pay only a few dollars per month. You pay for the period of time when you run your project and use the project management software. Web-based project management software does not require installation and maintenance costs. This allows you to start using online software as soon as possible without additional investment or rescheduling your budget.

Web-based project management software is updated automatically: When using a Web-based project management solution, you are always using its latest version. All software updates are made automatically, so you don't need to worry about it. Besides, such software updates are made for free, so you save time and money.

Web-based project management software is easy to use: When you buy hosted project management software, you save time and money on employee training. Even inexperienced users can be quickly plunged into collaboration.

### 3.8. PROBLEMS IN e- CONSTRUCTION MANAGEMENT

Besides the benefits that s may provide, some important barriers to implementation still exist and should not be overlooked. These barriers need to be addressed in order to increase public confidence in adopting e-CMs in construction projects. The literature shows that these barriers include a wide range of issues that can be summarized as follows.

- Difficulties in quantifying costs and benefits
- System reliability
- System security
- Legal issues of electronic transactions
- Lack of software interoperability:
- Data ownership after project completion

### 3.9. IDEAL E- CONSTRUCTION MANAGEMENT

*3.9.1. CALCULATING EARNED VALUE:*

Earned Value Management measures progress against a baseline. It involves calculating three key values for each activity in the WBS: The Planned Value (PV), (formerly known as the budgeted cost of work scheduled or BCWS)—that portion of the approved cost estimate planned to be spent on the given activity during a given period. The Actual Cost (AC), (formerly known as the actual cost of work performed or ACWP)—the total of the costs incurred in accomplishing work on the activity in a given period. This Actual Cost must correspond to whatever was budgeted for the Planned Value and the Earned Value (e.g. all labor, material, equipment, and indirect costs). The Earned Value (EV), (formerly known as the budget cost of work performed or BCWP)—the value of the work actually completed.

These three values are combined to determine at that point in time whether or not work is being accomplished as planned.

The most commonly used measures are the cost variance: Cost Variance (CV) = EV – AC and the schedule variance: Schedule Variance (SV) = EV – PV. These two values can be converted to efficiency indicators to reflect the cost and schedule performance of the project. The most commonly used cost-efficiency indicator is the cost performance index (CPI). It is calculated thus:

CPI = EV / AC The sum of all individual EV budgets divided by the sum of all individual AC's is known as the cumulative CPI, and is generally used to forecast the cost to complete a project. The schedule performance index (SPI), calculated thus: SPI = EV / PV is often used with the CPI to forecast overall project completion estimates.

A negative schedule variance (SV) calculated at a given point in time means the project is behind schedule, while a negative cost variance (CV) means the project is over budget.

*3.9.2. EARNED VALUE MANAGEMENT SYSTEM (EVMS):*

A list of guidelines is provided which covers areas such as planning, scheduling & budgeting; accounting issues; management reports, and so forth, however there are no "approved" systems identified. But the basics of any EVMS are: A methodical, organized, thorough, and complete WBS A baseline schedule A baseline budget, organized into control accounts Measurement of the work by control account (e.g. $, units in place, man-hours, etc.) Scheduling the authorized work is no different than in any large construction project—it is a necessary activity for the success of the project. However in an EVMS the schedule will

integrate all of the technical, cost, and schedule aspects of the work, resulting in the expected sequence of work. Interdependencies are established that result in the total work time and reveal the critical path, which is also the shortest project duration. Within each task it is then necessary to identify objective interim measures to allow for accurate performance assessment each month. A sufficient

number of these interim measures will be defined after the detailed schedule is established to ensure the performance is measured as accurately as possible.

*3.9.3. DYNAMIC SCHEDULING:*

Dynamic project scheduling and the network diagram of a project predecessor network show us the task sequence and allow us to design concurrent or parallel tasks which can significantly shorten a project's duration. Successful project managers use dynamic project scheduling because it saves them significant amounts of time and also because it allows them to quickly model the impact of changes in resources work or cost. Dynamic scheduling saves this time because it automatically recalculates the duration and budget for the project every time we make a change in the resources, hourly rates, hours of work, predecessor relationships with a number of people working on the project. Many commercial software scheduling products allow for dynamic scheduling and there are a couple of critical elements that we need to have for the dynamic schedule to work. First our scheduling needs to be based on the use of predecessor relationships between tasks, not the use of fixed start and finish dates. There are three primary kinds of predecessor relationships and the entire schedule has to be built on these relationships. The second requirement is that the schedule needs to be based on durations which are calculated from resource availability and work estimates. As an example, we enter the amount of work and the resource's availability, say 80 hours of work for a person working half-time, or four hours a day. The project manager enters that date and the software calculates the duration of 25 working days because the half-time team member can only complete four hours a day. Having this data available means we need to tell the software how many hours a day each resource can work. We use dynamic scheduling with predecessor relationships to control the sequencing of the tasks in our project plan. So as an example, we may specify a finish-to-finish predecessor relationship. That tells our project management software that we want two tasks and their resources to be scheduled so that both tasks finish at the same time. When we are finished specifying all our predecessors, our project plan becomes a network of tasks, linked by the predecessor relationships. The end result is often called a PERT chart and it displays our project plan and its network of tasks. Each of the task bars is linked to the project network which allows our dynamic scheduling to control the sequencing of tasks based on the predecessor relationships and the amount of work in the task.

## IV RESULTS AND ANALYSIS

An online survey was conducted through Google form. The survey contained 20 questions about various construction management software used in the industry, practical difficulties and the need of the industry in construction project management. About 51 responses were received for the survey and the results were analyzed using available online data analysis tools.

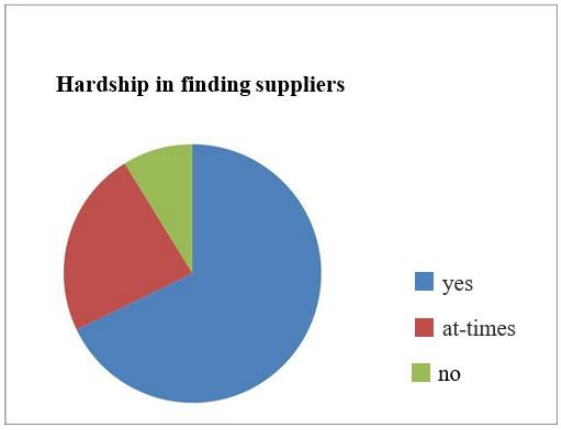


**Figure 4.1 : Pie chart depicting the percentage of companies who have hardship in finding suppliers.**

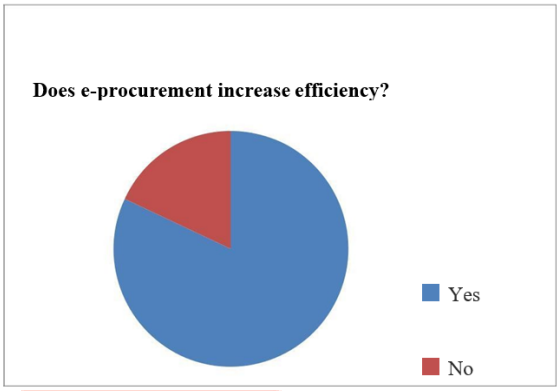


**Figure 4.2: Pie chart to depict the of increase in the efficiency using e-procurement**

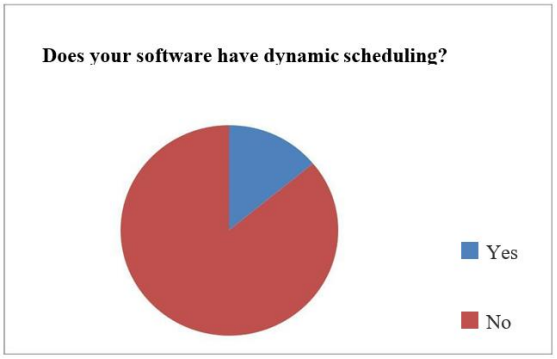


**Figure 4.3: Pie chart revealing the percentage of industries using dynamic scheduling software**

## V CONCLUSIONS

The importance of web- based developments in the construction industry has increased manifolds in the internet era. Capital project management software (CPMS) refers to the systems that are currently available that help capital project owner/operators, program managers, and construction managers, control and manage the vast amount of information that capital construction projects create. A collection or portfolio of projects only makes this a bigger challenge. These systems go by different names: capital project management software, construction management software, project management information systems. Usually Construction Management can be referred as subset of CPMS where the scope of CPMS is not limited to construction phases of project. There are systems available from vendors which will not only manage capital projects but also the entire project portfolio (Program). This work

lists the various features of construction management software currently used by the construction project managers. Procurement management and scheduling are the two basic needs catered by the project management software. The procurement process in web- based scenario is degraded due to lack of availability of collective resources which further adds to human intervention. The delay in the construction schedule can be further decreased with the adoption of e-commerce. The security and negotiation through the electronic agent is an optimized solution to increase the efficiency of the construction. Scheduling processes should be designed to manage all possible delays on-site and in procurement. CPMS is a critical component of overall IT strategy for Capital project owners and capital project owners are realizing it now, more than ever. The need of the hour is a new software that can provide dynamic scheduling evolutionary procurement strategies to minimize the expenditure.

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