BENCHMARKING FRAMEWORK TO MEASURE EXTENT OF ICT ADOPTION FOR BUILDING PROJECT MANAGEMENT

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ABSTRACT

This paper discusses a component of the research study conducted to provide construction organizations with a generic benchmarking framework to assess their extent of Information Communication Technology (ICT) adoption for building project management processes. It defines benchmarking and discusses objectives of the required benchmarking framework and development of the framework. The study focused on ICT adoption by Small and Medium Enterprises (SMEs) in the construction industry and with respect to SMEs it is important to understand processes, their indicators and measures in the local context. Structure of the suggested benchmarking framework has been derived after extensive literature survey and a questionnaire survey conducted in the Indian construction industry. The suggested benchmarking process is an iterative process divided into four stages. It can be implemented at organization and industry levels for rating the construction organizations for ICT adoption and performance measurement. The framework has a generic structure and can be generalized and applied for other countries with due considerations.

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- Benchmarks
- Buildings
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INTRODUCTION

Building project management comprises inter-organizational communication. Collection, analysis and real time communication of information is essential for the quick detection of time, cost, scope and quality deviations from planned performance and timely decision making for responding to problems, disputes and deviations detected from the planned performance. At present, the communication problem between the project team members is often a cause for project delay, expensive reworking and building defects (Huang et al. 2002) and with traditional tools of communication, the project managers often lose the ability of timely change management. Required communication can be achieved by adopting IT for effective data management and information communication or by using Information Communication Technologies (ICT).

ICT provides opportunities for real time access of information to all and improves coordination and collaboration between project team members. Benefits of ICT adoption include an increase in the quality of documents and speed of work; better financial control and communications, and simpler and faster access to common data as well as a decrease in documentation errors (Nitithamyong and Skibniewski 2006). ICT is required not only to free up project managers for more decision making tasks but also to deliver the required levels of 'consistency and reliability' of information in the construction supply chains (Sturges and Bates 2001).

Effectiveness of a building project management information system is measured by the effectiveness of all project team agencies to communicate with and feedback to the rest of the project team throughout the project life-cycle. Effective ICT adoption for building project management at the national level can be assessed by the extent to which ICT tools and technologies replace manual methods in the information systems supporting building project management processes at the industry level. The paper discusses Benchmarking as a tool for measuring effectiveness of building project management information systems. It addresses study of technical, managerial, social and cultural issues and can be implemented at industry and organization levels.

In construction industry, majority of the organizations can be categorized as Small and Medium enterprises (SMEs) (Dainty et al. 2001; Hegazy and Ersahin 2001; Ribeiro and Lopes 2002; Love et al. 2004) and the communication management research is required to address management and communication processes adopted by SMEs. Also, by virtue of the number of SMEs, greatest strategic scope exists at this level (ed. Betts 1999). Thus, the research discussed in this paper is focused on measurement of ICT adoption for building project management by SMEs. These issues can be addressed by global research, but also require clear understanding of the management and communication processes followed by SMEs of each distinct regional area or country.

The paper starts with the discussion on the importance of evaluation of ICT enabled information systems and suggests Benchmarking as a tool for evaluation. It leads to the discussion of the adopted research methodology. Next part of the paper defines

benchmarking, objectives of the required benchmarking framework and development of the framework. Suggested benchmarking process has four iterative stages of Benchmarking and BenchMeasurement, BenchLearning, BenchAction and BenchMonitoring.

ICT ADOPTION EVALUATION AND BENCHMARKING

Measurement is one of the first steps in any improvement process (Lee et al. 2005). So, to strategically increase effective adoption of ICT in the construction industry, a system of evaluation of the ICT based Information Systems (IS) is required to be developed. There is also a consensus among researchers and practitioners that ICT related investments should be carefully justified, measured and controlled (Milis and Mercken 2004) and a strong correlation exists between the control and measurement of Information Systems and higher effectiveness of Information Systems, however measured (Shank and Govindarajan 1992 cited in Milis and Mercken 2004).

In a paper, Back and Bell (1995) have discussed the research which shows that time and cost process benefits attributable to EDM technologies are significant; Fowler and Walsh (1999) have discussed through case studies the differing perceptions of various stakeholders regarding the success of information systems projects; Leuven and Voordijk (2001) have evaluated ERP implementation in construction industry with reference to Nolan growth curve; Stewart and Mohamed (2001) have studied potential applications and benefits of using the Balanced Score Card as a framework to evaluate the

performance improvement resulting from IT/IS implementation by a construction organization. Based upon the framework discussed in this paper, Stewart and Mohamed (2004) have also investigated the interrelationship between the framework perspectives and indicators; Skibniewski and Zhang (2005) have reviewed IT investment evaluation methods for the construction industry and have concluded that a single economic analytical method or a simple combination thereof is insufficient to justify or decline an investment in Web based Project Management; Yu et al. (2006) have suggested an evaluation model for IS benefits in construction management processes. But, researchers have serious doubts about the efficacy of using traditional capital investment appraisal techniques for the appraisal of ICT adoption and a multi-layer evaluation process is suggested (Milis and Mercken 2004).

In the multi-enterprise scenario of the construction industry, effective adoption of ICT for building project management requires measurement and improvement of the system in the total supply chain of the projects and in the whole industry. But, to date, a definite methodology has not been developed to examine the potential contributions of information management strategies in reducing overall project schedules and cost (Back and Moreau 2000).

Researchers have suggested benchmarking as system for the evaluation of construction systems. Lee et al. (2005) presented a benchmarking system developed by the Construction Industry Institute (CII) for broad application in the construction industry; Ramirez et al. (2004) have discussed a benchmarking system that has been recently

established in the Chilean construction industry by incorporating qualitative management aspects in addition to performance indicators; Love and Smith (2003) have proposed a generic framework for benchmarking rework at the interfaces of a project's life cycle; Clark et al. (1999) have discussed benchmarking for studying the supplier management system with respect to IT; Love et al. (2004) have reported a series of benchmark metrics for benefits, costs and risks of IT and posit that these metrics can serve as a reference point for initiating benchmarking, which should form an integral component of the IT evaluation and learning process; and Brewer et al. (2003) have discussed a study commissioned by CRC CI in Australia to study the development of a benchmarking tool to measure ICT uptake in the construction industry.

This paper discusses Benchmarking as a system for measuring ICT adoption for building project management.

RESEARCH METHODOLOGY

The study focused on ICT adoption by SMEs in the construction industry and with respect to SMEs it is important to understand the processes, their indicators and measures in the local context and this research studied issues with respect to the Indian construction industry. Based on the literature review, for the research study, an SME is defined as an organization with its number of staff upto 250.

The research utilized a sequential mixed methods approach focused on collecting and analyzing both quantitative and qualitative data in a sequential manner. Factors affecting ICT adoption for building project management are the research variables and were identified through literature survey. Data collection for the analysis was done through a questionnaire survey (quantitative analysis) conducted in the Indian Construction Industry. The main objectives of this survey were to examine the current practices of ICT adoption for building project management in the Indian construction industry, test the hypotheses formulated in the research and identify the issues that required further study. The unit of analysis for the survey was organization and the sample population was SMEs in the Indian construction industry. In order to generalise the results, it is necessary to select a sample that is a true representation of the population. Thus, those organizations were included in the sample, which were either managing building projects after being appointed as the project managers or had the authority to manage their projects if a project manager was not appointed formally. Therefore three groups of organizations were included in the sample: builders, project management consultancy organizations and architectural organizations. Targeted respondents were the senior level executives in the organizations.

Data analysis (quantitative analysis) included empirical analysis of data (Ahuja et al. 2009) including Structural Equation Modeling analysis (Ahuja et al., 2010), conducted to study the causal relationships between the identified factors. Questionnaire survey data analysis led to the development of a benchmarking framework for rating construction organizations for ICT adoption for building project management. Benchmarking

framework administration and finalization included Semi-structured interview survey data collection and analysis including Data Envelopment Analysis (quantitative and qualitative method); and Case Studies analysis conducted by SAP-LAP analysis (qualitative method) leading to synthesis of the results of all the stages of research. The purpose of this sequential mixed methods study was to start with pragmatic assumptions, obtain statistical, quantitative results from a broad sample of organizations to analyze or study research variables at industry and organization level and then follow up with a few organizations and projects to study the research variables at the level of organization and projects to probe, explore and validate the results in more depth.

BENCHMARKING DEFINITION

Benchmarking is a formal method and as per Fong et al. (1998) researchers (Camp 1989a; Mittelstaedt 1992) have suggested that a systematic method would lead to outstanding performance while other informal methods would not.

Benchmarking has been defined in literature with different perspectives (Construct IT Report 1998; Bendell et al. 1998; Clark et al. 1999; Love and Smith 2003; Costa et al. 2006)

These references help in summarizing benchmarking as a tool: to measure mission-critical processes or the processes under study of an organization against those of the other similar organizations in the same sector and similar sectors; to establish a benchmark or a standard for comparison and help in continuous improvement in the

processes by helping organizations in measuring differences, conducting objective competitor analysis, systematically acquiring knowledge, improving productivity, introducing new ideas and encouraging innovation.

The above definition of benchmarking indicates that benchmarking results in an industry wide measurement and improvement of the benchmarked system, by facilitating comparison between different organizations.

Researchers have classified benchmarking with different perspectives. Lewis and Naim (1995) have identified four types of benchmarking: internal, competitive, parallel industry and best practice (Clark et al. 1999). Fong et al. (1998) have classified benchmarking as per the nature of referent, content of benchmarking and purpose for the relationship.

Internal benchmarking is a comparison between different operating divisions, departments or business units of the organization where data is often readily available and accessible. *Competitive or competitor* benchmarking occurs between organizations within the same industry sector. To be successful, it should be performed by a third part benchmarking agency (Fong et al. 1998) and should be directed at technical or general managerial processes (Construct IT report 1998). *Industry* benchmarking involves more number of benchmarking or comparison parties and may also include non-competitors. Thus it is more feasible. *Generic or Parallel Industry* benchmarking occurs between organizations from different sectors that undertake a similar process of production or

service (Clark et al. 1999). *Strategic* benchmarking involves the assessment of organizational strategies, such as the long-term development of organizational infrastructure, rather than key operational practices (Bogan and English 1994 cited in Fong et al. 1998). *Best practice* benchmarking suggested by Lewis and Naim (1995) considers the merits of a comparison with a particular market leader who is known to have an exemplary process that is similar to the process under study (Clark et al. 1999).

As per Costa et al. (2006), a strategic performance measurement system for SMEs must be very resource effective and should produce noticeable short-term results. In addition, it must be dynamic and flexible enough to accommodate strategic changes, since these organizations tend to experience sudden contingencies.

As per Bendell et al. (1998), all management and service areas are candidates for benchmarking. Thus, a consistent ICT evaluation framework would allow benchmarking ICT adoption for building project management by the SMEs. It can provide organizations with the opportunity to document and review their business processes so that the added value that the ICT adoption can provide is identified.

BENCHMARKING FRAMEWORK DEVELOPMENT

Effective ICT adoption for building project management at the national level can be assessed by the extent to which ICT tools and technologies replace manual methods in

the information systems supporting building project management processes at the industry level.

Benchmarking Framework Structure Attributes

Benchmarking study at the industry level requires an analysis of the existing activities and practices in the industry with respect to the processes under study and requires academic and industrial knowledge. Benchmarking study should be stakeholder driven, forward looking and focused on quality (Construct IT report 1998). It should also identify the appropriate basis for measurement (Bendell et al. 1998).

The key to any successful measurement system is simplicity, both in the nature of the individual measures and in the means by which it is unified into a coherent, focused whole (Bendell et al. 1998). A unified approach to measurement can be obtained by identifying measurable critical success factors with respect to the processes under study. These are the key indicators directly linked to those processes and should be between 6-12 (Bendell et al. 1998). To effectively support improvement initiatives, the measurement system should include a mixture of leading and lagging indicators (Costa et al. 2006).

Developed measurement models should be multidimensional and facilitate alignment of the performance indicators with an organization's strategic objectives and should link the indicators with key managerial processes of the organization (Costa et al. 2006). Thus, measurement needs to be undertaken through a structured methodology as indicators and

measures reflect the goals and objectives of each level of assessment in the organizations. To avoid relying only on subjective assessment, measures that extend beyond typical perceptions of performance must be included. Thus, each indicator should have one or more performance measures that allow quantitative data to be obtained for a particular process (Stewart and Mohamed 2001). Such composite indicators provide a powerful and reliable summary of the measured data and can also improve the reliability of the data in terms of random variation associated with each term or measurement as random variation tends to average to zero when summed across all the terms in the indicator.

In due course of time, the dynamic industry situation may change the gap between the benchmarked organization and the best practice, may reposition the best practice organization and may even change the best practice parameters. Thus, the framework is required to be reviewed periodically in order to make suitable changes as well as for introducing the new relevant factors and for omitting the factors that are not relevant, or when periodic recalibration of a benchmarking framework is required.

Objectives of the Required Benchmarking Framework

In the context of this research, a generic 'Benchmarking Framework' was required to be established to measure the extent of ICT adoption for building project management by SMEs in the construction industry. It was required to fulfill the following objectives:

- As per Bendell et al. (1998), as well as a strategy for benchmarking, at the organization and at the national level, there is also a requirement for the

benchmarking of strategy. Thus, it should facilitate **benchmarking of present strategies and long-term strategic goals** of the organization with respect to ICT adoption for **building project management processes' and other processes** having causal relationship with these processes.

- The benchmarking framework should also be a **performance measurement** tool, which measures efficiency of the organizations in implementing their strategies for ICT adoption for building project management.
- It should facilitate **competitive benchmarking** within organizations in the construction industry by having a **generic** structure.
- Administration of the framework has to be an **industry level initiative** taken up by the national level agencies in the construction industry as it is indicated in the literature that benchmarking carried out by a third party agency is successful. This would help in conducting **collaborative** benchmarking, leading to more number of organizations participating in the process and would lead to an improvement in ICT adoption at the **industry level** by creating a learning atmosphere.
- The research is in the context of ICT adoption of SMEs of the construction industry. Thus, SMEs in the construction industry can learn from the best practice primarily defined by the large organizations of the construction industry and it would not be relevant to compare their ICT adoption with the best practice from a parallel industry. Thus, the benchmarking framework should facilitate establishing a '**best-practice benchmark**' from the construction industry.

- The benchmarking framework should be **modular** in structure, to accommodate inclusion and deletion of the factors or measurement indicators as per the changing pattern of usage of ICT in the construction industry.

Benchmarking Framework Development, Structure and Measurement System

Eight critical success factors or the performance/measurement indicators were established after the questionnaire survey data analysis and ongoing literature survey. Each indicator is measured by one or more performance measures derived from the questionnaire as the questionnaire survey data analysis provided the validity, relevance and significance of these performance measures. The measures have their own metrics, data sources and minimum and maximum limits relevant to the industry standards and established after the questionnaire data analysis. The maximum limits of the measures reflect the 'Best Practice' in the Indian Construction industry. The goal was to develop generic measures that would be meaningful to both, the participating organizations and the industry as a whole, and would be repeatable to simplify the process of recalibration.

The measurement indicators (MIs) or the critical success factors included in the benchmarking framework are discussed below:

Strategic use of ICT indicator (MI1) focuses on present strategic use and long-term strategic goals of the organization with respect to ICT adoption in the organization. It is also representative of the management's ability to instill the necessary change to embrace

new technology with the help of training of employees. Employees with the ability to adapt to an ever-changing work environment will be more receptive to new ICT applications. This indicator is measured by 7 performance measures.

Strategic project communication indicator (MI2) measures strategic planning for use of ICT and communication methodologies for the projects. This indicator is measured by 4 performance measures.

Measuring benefits of use of ICT indicator (MI3) is also a strategic indicator as it studies ICT adoption benefits evaluation initiatives within the organization. The tangible benefits in the framework include benefits related to the measures of project success with respect to time and cost savings and can be evaluated quantitatively. The intangible benefits are more difficult to measure and are included in the framework as benefits related to effective team management, effective use of technology and increased organizational efficiency. These benefits can be evaluated subjectively or qualitatively. This indicator is measured by 7 performance measures structured in a lead on format.

ICT infrastructure indicator (MI4) measures ICT infrastructure maturity at an organization's head office and project sites and is measured by 15 performance measures.

ICT for general administration indicator (MI5) measures extent of ICT adoption for general administration within office and with external agencies and is measured by 12 performance measures.

ICT for time management (MI6), ICT for cost management (MI7) and ICT for project administration and resource management (MI8) indicators measure extent of ICT adoption for specific project management processes of time management, cost management and project administration and resource management at different stages of the projects. These indicators are measured by 13, 6 and 11 performance measures respectively.

Structural Equation Modeling (SEM) analysis established that there is a causal relationship between all the suggested indicators and thus all are required to be considered to assess extent of ICT adoption for building project management by an organization (Ahuja et al. 2010). Analysis of these causal relationships helped us in understanding that an increased and matured use of ICT for general administration works within the organization would lead to an improved ICT infrastructure within the organization, development of electronic databases and the staff that is confident of using IT tools. In such a scenario, staff would use advanced software and IT technologies for project management processes and that would lead to an increased adoption of ICT for project management processes. But, for general administration also, ICT adoption would be enhanced if the organization is interacting more with geographically separated agencies and the senior management perceives that significant benefits would accrue by adoption of ICT. All the factors are inter-related and their effect can not be maximized in isolation. Also in the analysis of the perceived enablers for increasing ICT adoption,

components of strategic planning for ICT adoption within an organization and for the projects were found as most important perceived enablers.

The above analysis helped in establishing the relationship between performance indicators of the benchmarking framework and also defined their relative importance leading to the establishment of weights for groups of indicator variables (Fig. 1). Thus, formula for calculating the rating of construction organizations for ICT adoption for building project management was derived.

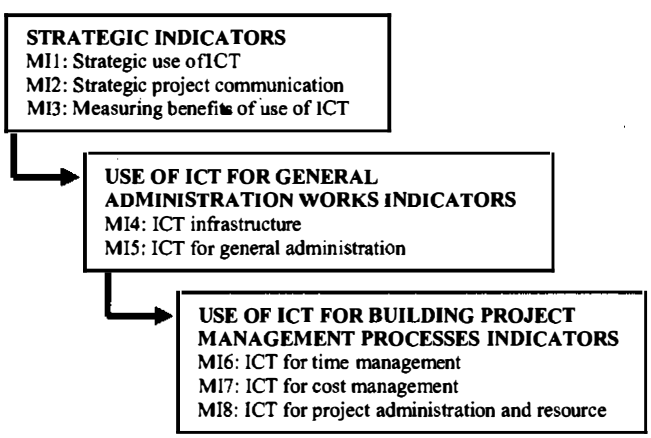

Fig. 1: Relationship between Performance/Measurement Indicators

$$\text{RATING VALUE} = 3(MI1 + MI2 + MI3) + 2(MI4 + MI5) + MI6 + MI7 + MI8$$

The rating of an organization can range from (75-285). Divided into three equal ranges, organizations can be rated at the following three levels:

Low rating: (75-144) Middle rating: (145-215) High rating: (216-285)

References in literature indicate researchers establishing such equal range levels for benchmarking (Hamilton and Gibson Jr. 1996)

Benchmarking Framework and the Organization Management Information Systems

With respect to the decision-making and MIS, researchers have divided an organization into a pyramid structure of three levels (Marakas 2003); strategic, tactical and operational or in four levels (Davis and Olson 1984) where tactical level is further divided into two levels. At the top of the pyramid are the seniormost executives of the organization involved in strategic planning and policy making, second level consists of the senior managers involved in tactical planning and implementation of the decisions taken at the strategic level, third level consists of the middle managers involved in operational planning, decision making and control, and the foundation of the pyramid consists of the operational level employees taking decisions regarding day to day activities. The middle and operational level employees are involved in regular interaction with the external agencies.

After study of the construction industry, pyramid structure is further modified for the construction organizations (Fig. 2). The lower two levels of the pyramid are further divided as some of the employees of these levels would be at project sites. At head office also some employees of this level would be dedicated to projects' coordination and some would be conducting general administration works. All the groups of employees in the pyramid manage information with respect to the projects and are linked with the critical success factors. Thus the benchmarking framework indicators span all the levels of the organization as indicated in Fig. 3.

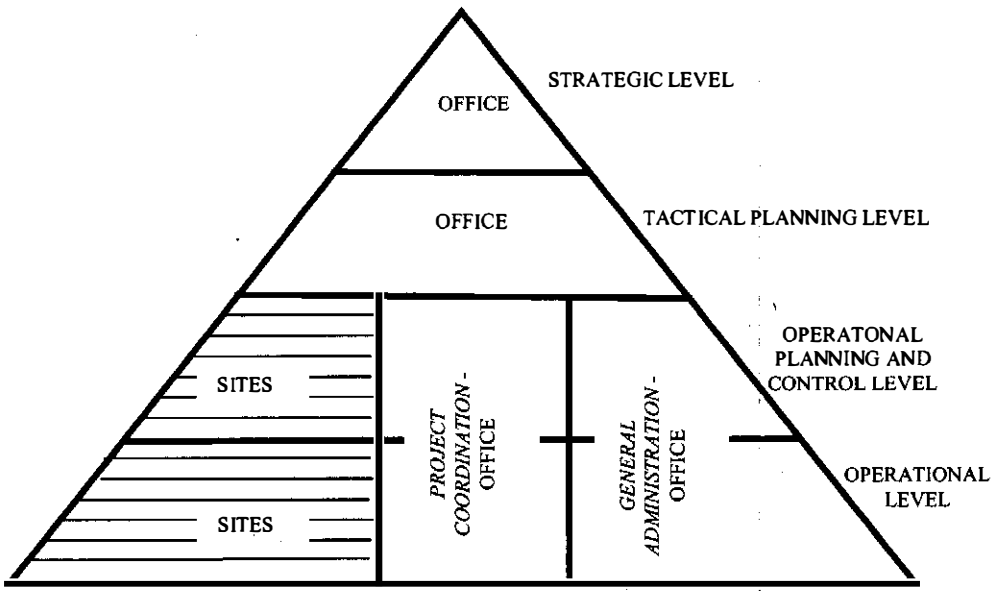

Fig. 2: Construction Project Management Organization Structure with Respect to Decision Making and Information Management

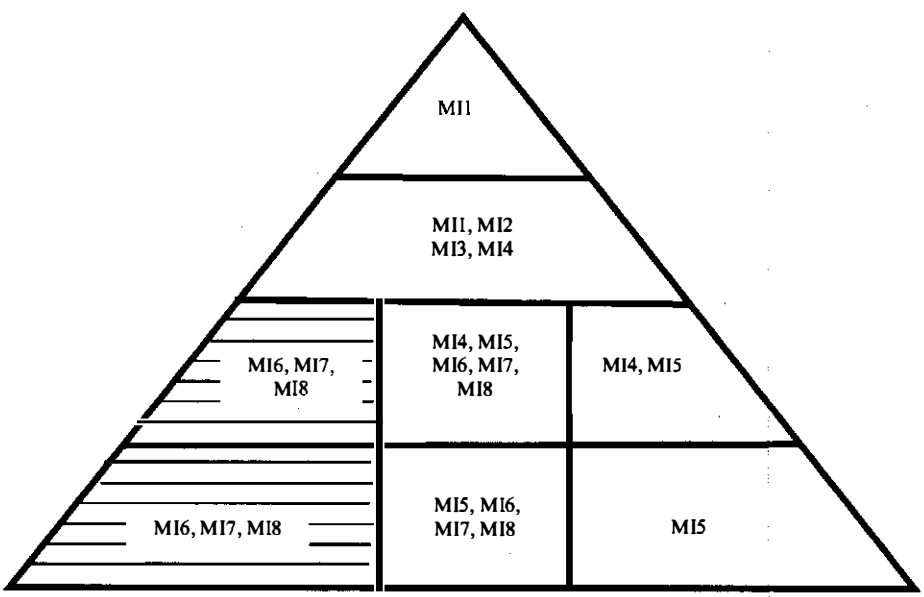

Fig. 3: Benchmarking Framework Indicators spanning all the Levels of the Organizations

Benchmarking Framework Attributes

Attributes of the developed framework are discussed below:

- The suggested benchmarking framework is developed around a generic model of ICT adoption for building project management and was designed after mapping of the building project management processes adopted by SMEs in the Indian construction industry. Thus, the framework provides a **common basis for comparison** between SMEs of the industry.
- The framework is **stakeholder driven,** as it measures extent of ICT adoption for communicating within the organization and with external project team organizations including the clients, consultants, contractors, material suppliers and other external agencies.
- The framework includes **leading as well as lagging indicators.**
- The framework is **forward looking** as the strategic indicators assess long term strategic goals of the organization for use of new ICT tools and technologies and maximum measurable limit of each performance measure signifies **best practice in the industry** established after questionnaire survey data analysis.
- Performance measures were derived from the questionnaire and non-response bias with respect to the questions was not experienced in the questionnaire survey. Thus, it can be established that the measurement structure is **simple** and unambiguous. Also, the suggested method of comprehending the whole measurement structure and rating the organizations is **simple** and can also be carried out by organizations as a self-analysis exercise.

- Each MI in the benchmarking framework is completely defined. Thus the complete framework is a **whole comprising of completely defined part** and organizations' use of ICT can also be measured for each of the three components individually.

BENCHMARKING PROCESS

Researchers have identified different models of the benchmarking process derived from the essential features of the Deming cycle, namely focus, plan, do, and review. Hamilton and Gibson Jr. (1996) have used the four-phase model of planning, analysis, integration and action. Fong et al. (1998) have suggested a five-phase model largely adapted from the model of Vaziri (1992) and Camp (1989b). It includes an additional maturity phase.

Love and Smith (2003) have proposed a three-phase system of benchmarking (organizations evaluating themselves against the best practice organizations in the industry), bench learning (organizations determining how they can learn from the best practice organizations) and bench action (actual implementation of the planned changes through development of the skills of staff, training and organizational development).

There is an overlap between the essential features of the two models discussed above except for the focus on communication and commitment stressed in the model of Fong et al. (1998). They have explained that communication of the benchmarking findings to all the employees will help in gaining support, commitment, and ownership.

Bench learning or the Analysis phase would allow migration of the benchmarking initiatives from performance measurement processes to performance management systems as suggested by Costa et al. (2006). It requires understanding how performance can be improved and, as per Bendell et al. (1998), it requires qualitative assessment.

Bench action or the Integration, Action and Maturity phases can generate innovation in the industry and as per Garvin (1993) it can happen in a receptive environment. It requires national industry level initiatives to generate a receptive environment in the industry (Costa et al. 2006). It could be a transnational as well as an international initiative.

For the transnational initiative, benchmarking clubs can be initiated. These are forums for individuals to learn from the best practices within a local support network (Constructing Excellence 2004 cited in Costa et al. 2006), and for providing learning opportunities to participating organizations by identifying and sharing their own and other organizations' best practices, gaps in the practices and methodology for improvement. It is equally important that the benchmarking teams share what they have learned with the aim of creating an atmosphere in which knowledge transfer is actively encouraged (Hinton et al. 2000 cited in Costa et al. 2006). Brewer et al. (2003) have discussed a web-based tool for benchmarking.

In this research, the suggested Benchmarking process is derived from the above two discussed frameworks and further modified to include four phases of:

- Benchmarking and BenchMeasurement
- BenchLearning
- BenchAction
- BenchMonitoring

Benchmarking and BenchMeasurement phase comprises of two components:

- Benchmarking to measure the extent of ICT adoption for building project management by SMEs in the construction industry. This would help in rating the organizations into three levels of low, medium and high and identifying trends and gaps in practices in the industry.
- BenchMeasurement to measure the efficiency of organizations in implementing their strategies for ICT adoption for building project management. BenchMeasurement would be conducted through 'Data Envelopment Analysis' (DEA) technique.

BenchLearning would include qualitative study of results of BenchMeasurement incorporating study of gaps in practices and trends identified at the Benchmarking stage. It would be conducted through case study analysis for each organization under study. SAP (situation-actor-processes) – LAP (learning-action-performance) framework for research enquiry is suggested for case study analysis. Sushil (2000) has recommended

SAP-LAP as a systematic and formal analysis methodology for critically examining a case study.

BenchLearning would suggest actions to overcome the trends, gaps in practice and other identified issues. These actions would form a component of the **Bench Action** stage. It is assumed that the implementation of the suggested actions at the industry and organization levels would increase effective ICT adoption for building project management in the industry. Also, the benchmarking rating of the organizations would improve.

Communication at industry and organization levels is important for successful implementation of the process and forms an integral component of 'BenchAction'.

- At industry level, national bodies should create awareness about the process through forums like seminars and conferences and communicate its importance to the organizations. As discussed above, benchmarking clubs should be initiated for interaction between the different organizations. A formal rating system like ISO certification should be initiated in the industry to increase participation by the organizations.
- At the organization level, communication of the benchmarking process results and suggested actions to operational as well as middle level managers is very important for successful implementation of suggested actions in the organization.

In practical terms, any performance measurement should be iterative, so that the strategic relevance of performance measurement is consistently maintained (Costa et al. 2006).

Accordingly **'BenchMonitoring'** stage includes periodic Benchmarking and BenchMeasurement exercise conducted in the organizations followed by BenchLearning and BenchAction. After each Benchmarking and BenchMeasurement, it should be identified whether existing framework is applicable or not. If it is applicable, directly BenchLearning can be conducted. If it is not applicable, remapping of the project management processes and adopted communication technologies should lead to recalibration of the Benchmarking framework (Fig. 4).

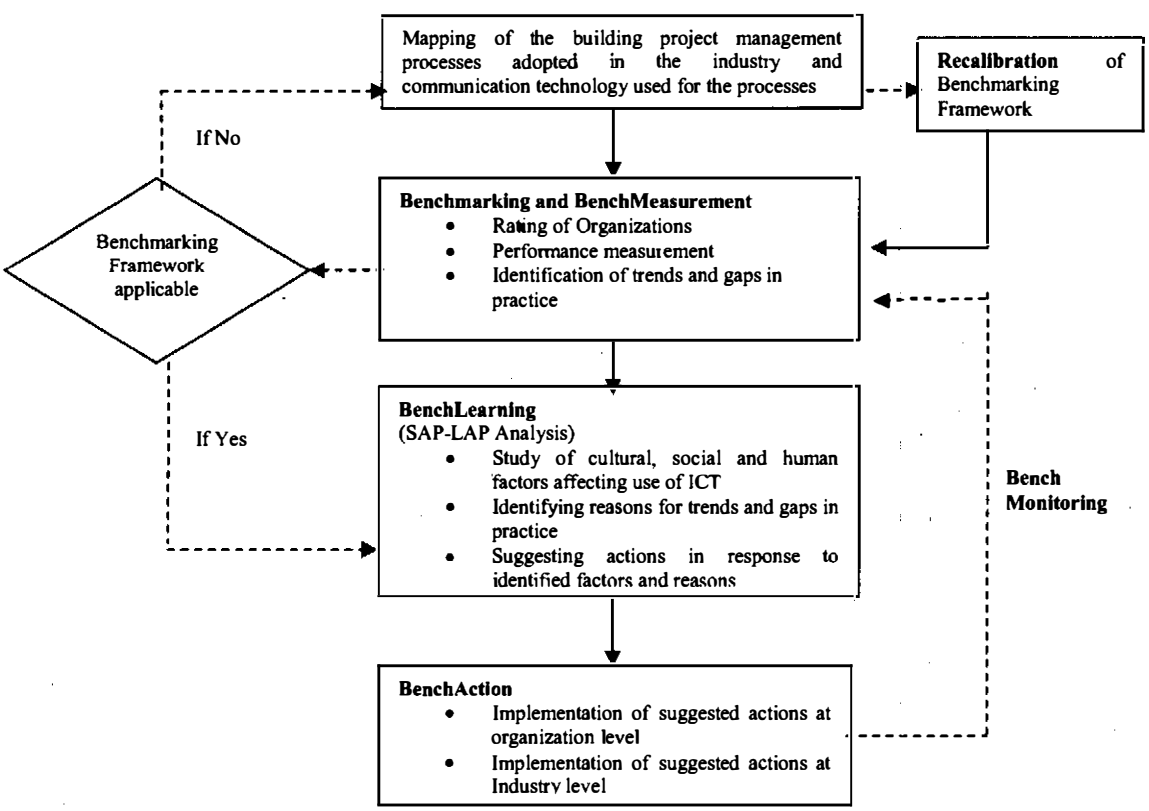

Fig. 4: Suggested Benchmarking Process

BENCHMARKING FRAMEWORK ADMINISTRATION AND FINALISATION

One organization from each group of the surveyed organizations i.e Builders, Project Management Consultancy Organizations and Architectural Organizations was selected for benchmarking framework administration and finalization. Organizations with higher ICT adoption were selected and approached. A semi-structured interview was conducted for discussion of the benchmarking framework and rating of organizations as per the suggested framework. This resulted in framework finalization, benchmarking or measurement of ICT adoption by these organizations for building project management processes and measurement of the efficiency of the organizations for implementing their strategies for ICT adoption.

Case study analysis formed the qualitative analysis part of the research and was conducted to identify and validate the identified cultural, social, human and other qualitative factors that are required to be considered for increasing effective ICT adoption for Building Project Management by Small and Medium Enterprises (SMEs). It also helped in assessing the reasons for gaps in practice for ICT adoption for building project management in the benchmarked organizations. Thus, it complimented performance measurement or benchmarking with performance management or bench-learning component.

DISCUSSION

The suggested Benchmarking Process provides a framework for objective competitive analysis of the organizations in the Indian construction industry with respect to ICT adoption for building project management. It can be utilized at the industry level to map the stratification of construction industry for ICT adoption for building project management and also at the organization level by construction organizations for self-analysis and identification of improvement opportunities. The measurement system is a generic system providing a common basis for comparing use of ICT between different organizations. The development of the benchmarking framework and benchmarking process was done after detailed literature review. The critical success factors or the performance indicators and the associated measurement metrics were established based on the questionnaire survey data analysis and the semi-structured interviews conducted in the three benchmarked organizations. Each MI in the benchmarking framework is completely defined. Thus the complete framework is a whole comprising completely defined parts and organizations' use of ICT can also be measured for each of the three components individually. The performance measurement system of 'Benchmarking and BenchMeasurement' is complimented with performance management system by including phases of 'BenchLearning' and 'BenchAction'. BenchMonitoring signifies process of continuous learning, adaptation and improvement in the organizations and in the industry. Performance indicators identify actions for the structural changes required in the organizations for embracing continuous improvement.

Following features would facilitate successful implementation of the framework:

- MIs measure technical or general management processes and do not require information about the commercially sensitive information.
- Implementation of this framework by the National level bodies in the construction industry suggests benchmarking process implementation in a collaborative atmosphere.
- The framework includes leading as well as lagging indicators, thus its focus is on initiating a learning atmosphere and helping organizations and the industry to identify the strengths as well as the weaknesses.

The proposed framework is applicable for the Indian construction industry in the current environment. Periodic review of the framework is suggested. It is required to make suitable changes as well as to introduce the new relevant MIs and omit the MIs that are not relevant, leading to recalibration of the framework.

While the research was conducted in the Indian context, the research outcome is envisaged to be widely applicable in other countries as the factors affecting ICT adoption for building project management or the research variables were identified after extensive literature survey. Data collection instruments like questionnaire survey and proposed benchmarking framework have a generic structure. Thus, even though the research has been conducted with focus on Indian construction industry, it can be generalized and applied for other countries with due considerations.

CONCLUSIONS

Building project management information systems comprise multi enterprise information communication and real time information flow is required for successful completion of projects. Such information flow can be achieved by use of ICT. But construction industry has been slow in adopting ICT and it is envisaged that measurement and evaluation of ICT enabled information systems would enhance use of ICT in the industry. The paper discusses development of a benchmarking framework for rating construction organizations for use of ICT for building project management. Majority of the organizations in the construction industry are SMEs and the research is focused on use of ICT by SMEs. Structure of the suggested benchmarking framework has been derived after extensive literature survey and a questionnaire survey conducted in the Indian construction industry. The suggested benchmarking process is an iterative process divided into four stages of Benchmarking and BenchMeasurement, BenchLearning, BenchAction and BenchMonitoring. It can be implemented at organization and industry levels. The framework has a generic structure and can be generalized and applied for other countries with due considerations.

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