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Benchmarking for Improve the Inventory Management System in Small Scale Industry

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Abstract – *The construction industry is dynamic in nature. The concept of project success has remained ambiguously defined in the construction industry. Project success is almost the ultimate objective for every project. However, it means different belongings to different people. While some writers consider time, cost and quality as predominant criteria, others suggest that success is something more complex. The aim of this manuscript is to develop a framework for measuring success of construction projects. In this manuscript, a set of key performance indicators (KPIs), measured both objectively and subjectively are developed from beginning to end a comprehensive literature review. The paper presents benchmarking method dealing by means of identification of measurable business performance indicators the validity of the proposed KPIs is also tested by three case studies. Then, the limitations of the suggested KPIs are discussed. With the development of KPIs, a benchmark for measure the performance of a construction project can be set. It also provides significant insights into developing a general and comprehensive base for further research.*

Keywords: *Benchmarking, benchmarking process, performance indicators.*

1. *INTRODUCTION*

Inventory management is pivotal in effective and efficient organization. It is also vital in the control of materials and goods that have to be held (or stored) for later use in the case of production or later exchange activities in the case of services. The principal goal of inventory management involves having to balance the conflicting economics of not wanting to hold too much stock. Thereby having to tie up capital so as to guide against the incurring of costs such as storage, spoilage, pilferage and obsolescence and, the desire to make items or goods available when and where required (quality and quantity wise) so as to avert the cost of not meeting such requirement. Inventory problems of too great or too small quantities on hand can cause business failures [11]. If a manufacturer experiences stock-out of a critical inventory item, production halts could result. Moreover, a shopper expects the retailer to carry the item wanted. If an item is not stocked when the customer thinks it should be, the retailer loses a customer not only on that item but also on many other items in the future. The conclusion one might draw is that effective inventory management can make a significant contribution to a company's profit as well as increase its return on total assets. It is thus the management of this economics of stockholding, that is appropriately being refers to as inventory management. The reason for greater attention to inventory management is that this figure, for many firms, is the largest item appearing on the asset side of the balance sheet. Essentially, inventory management, within the context of the foregoing features involves planning and control. The planning aspect involves looking ahead in terms of the determination in advance:

(i) What quantity of items to order; and
(ii) How often (periodicity) do we order for them to maintain the overall source-store sink coordination in an economically efficient way?
(ii) How often (periodicity) do we order for them to maintain the overall stock coordination in an economically efficient way? The control aspect, which is often described as stock control involves following the procedure, set up at the planning stage to achieve the above objective. This may include monitoring stock levels periodically or continuously and deciding what to do on the basis of information that is gathered and adequately processed.[12]

1.1. Key Performance Indicators For Measuring Construction Success

Most industries are dynamic in nature and the construction industry is no exception. Its environment has become more dynamic due to the increasing uncertainties in technology, budgets, and development processes. A building project is completed as a result of a combination of many events and interactions, planned or unplanned, over the life of a facility, with changing participants and processes in a constantly changing environment. Temporary, fragment and short-term are also significant characteristics inherent in the construction industry. Such characteristics greatly affect the effectiveness of project team, especially the project managers. The concept of project success is developed to set criteria and standards by which project managers can complete projects with the most favourable outcomes. However, this concept has remained ambiguously defined among construction professionals. Many project managers still attend to this topic in an intuitive and ad hoc fashion as they attempt to manage and allocate resources across various project areas. Although a number of researchers had explored this concept, no general agreement has been achieved. Project success means different things to different people. The criteria of project success are constantly enriched. Therefore, a systematic critique of the existing literature is needed to develop framework for measuring construction success both quantitatively and qualitatively. (Refer Albert P.C. Chan et. al. 2004)

2. *LITERATURE REVIEW*

1. **"Rethinking Trust In Construction Contract Formation: Dispute Resolution Method Selection", (2016)**

Low trust negatively affects the efficiency, schedule performance, and administrative cost functions of construction project team. However, trust is seldom taken into consideration during contract formation; in particular, in the dispute resolution method (DRM) clauses. The objective of this paper is to investigate how trust influences contract terms and conditions related to the DRM clauses. Data from 27 construction projects were collected and 11 DRM experts participated in the study. The results show that although expert recommend the choice of DRMs based on the trust level between parties, the DRM really used on construction projects is not affected by the trust level between partners. Negotiation was the most recommended DRM for high-trust projects, but was the least used DRM in practice on such projects. The conclusion of this investigate is an incremental step to rethink social factors that are overlooked in construction management and that proved influential on how contracts are drafted.

2. **"Modelling And Analysis Of Inventory Management Systems In Healthcare: A Review And Reflections" (2019)**

Inventory management in a healthcare system needs to be compatible with its operations and Critical characteristics ensuring minimization of inventory-related cost as well as maximization of service level with a significant reduction in the price of treatment and wastage of resources. Over the years, numerous approaches and methodologies have been developed by the researchers and practitioners for modelling and analysis of varieties of inventory management systems in the healthcare sector considering these aspects. In this paper, the existing modelling approaches and solution methods concerning inventory systems in healthcare are classified and critically reviewed. An integrated research framework as applicable in the present context is presented as a direct consequence of the review of the literature with future research directions.

3. **"Research On Construction Schedule Management Based On Bim Technology" (2017)**

The construction schedule management in the traditional mode will be affected by the natural environment, the objective environment and the subjective environment, leading to the interruption or obstruction in the construction process. But in the actual construction process, through assisting the BIM model and BIM5D software in the construction schedule management, not only ahead of schedule can be aware of the next step schedule of the required resource requirements, equipment demand and capital requirements; but also in the actual construction process Timely monitoring the progress of the completion of the percentage of the plan, the actual use of the amount of funds accumulated and the amount of budgetary funds deviation and so on; at the same time in the actual construction process can form a set of complete construction schedule management mode that timely supervising the construction quality and safety issues, recording defects on the spot, integrating data and associating model, timely rectifying or Repairing defects, and then checking the project.

3. *INVENTORY MANAGEMENT AND BENCHMARKING PROCESS*

3.1. Inventory Management - Definition and Concepts

There is need for installation of a proper inventory control technique in any business organization in developing country in India, inventory management refers to all the activities involved in developing and managing the inventory levels of raw materials, semi-finished materials and finished good so that adequate supplies are available and the costs of over or under stocks are low. The cost of maintaining inventory is included in the final price paid by the consumer. Good in inventory represents a cost to their owner. The manufacturer has the expense of materials and labor. [11]

Inventory as a stock of possessions is maintained by a business in expectation of some of the future demand. This definition was also supported who stressed that inventory management has an impact on all business functions, particularly operations, marketing, accounting, and finance. He established that there are three motives for holding inventories, which are transaction, precautionary and speculative motives. [11] The transaction motive occurs when there is a need to hold stock to meet production and sales requirements. A firm might also decide to hold additional amounts of stock to cover the possibility that it may have under estimated its future production and sales requirements. This represents a precautionary motive, which applies only when future demand is uncertain. The speculative motive for holding inventory might entice a firm to purchase a larger quantity of materials than normal in anticipation of making abnormal profits. Advance purchase of raw materials in inflationary times is one form of speculative behavior.

3.1.1. Inventory Model: The Economic Order Quantity (EOQ) Model

Undoubtedly, the best-known and most fundamental inventory decision model is the Economic Order Quantity Model. Its origin dated back to the early 1900s. The purpose of using the EOQ model in this research is to find out the particular quantity, which minimize total inventory costs that are the total ordering and carrying costs.

3.1.2. EOQ Assumptions

The EOQ has been previously defined as the ordering quantity which minimizes the balance of cost between inventory holding cost and re-order costs. Stressed further that to be able to calculate a basic EOQ, certain assumptions are necessary:

(i) That there is a known, constant, stock holding costs;
(ii) That there is a known, constant ordering costs;
(iii) That the rates of demand are known
(iv) That there is a known constant price per unit
(v) That replenishment is made instantaneously, that is the whole batch is delivered at once.
(vi) No stock-outs are allowed

It would be apparent that the above assumptions are somewhat sweeping and that they are a good reason for treating an EOQ calculation with caution.[11] Also, the rationale of EOQ ignores buffer stocks, which are maintained to cater for variations in lead-time and demand. The above assumptions are wide ranging and it is unlikely that all could be observed in practice. Nevertheless, the EOQ calculation is a useful starting point in establishing an appropriate reorder quantity. The EOQ formula is given below; it's derivation and graphical presentation.

$$EOQ = \frac{2C_O D}{C_C} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Where

Co, Cc and D denote the ordering costs, carrying cost and annual demand respectively.

$$Annual\ stock = \frac{Q}{2}$$

$$Total\ annual\ carrying\ cost = \frac{C_C Q}{2}$$

$$No.of\ order\ per\ annum = \frac{D}{Q}$$

$$annual\ Ordering\ \ cost = \frac{C_O D}{Q}$$

$$Total\ \ cost = \frac{C_C Q}{2} + \frac{C_O D}{Q} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

The EOQ formula is given below; it's derivation and graphical presentation.

$$EOQ = \frac{2C_O D}{C_C}$$

Graphically, the EOQ can be represent in the Figure

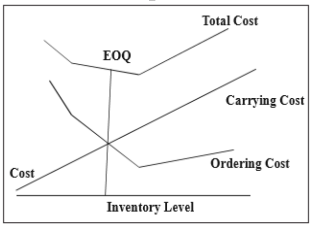

Figure 1. Presentation of EOQ graphically

3.2. Benchmarking Term And Fields Of Application

Benchmarking is a business concept applied to fields of strategic planning, marketing, restructuring, financial management and a practice to "learn from the best". Under conditions of growing competition, the benchmarking became very popular as a tool which supports making and sustaining of a competitive advantage. Data obtained from a benchmarking process contribute to:

- Identification of company's strengths and weaknesses,
- Identification of the current and potential comparative advantage in relation to other participants in the commercial business operations,
- Evaluation of risks by using the alternative action lines.

Benchmarking relies on determination of factors critical for success of the company. Processes which determine these factors are analyzed. The best attributes of key parameters used for target improvements are defined. Only understanding of internal processes enables recognition and integration of differences, improvements and innovations which exist in companies with the best practice.

Benchmarking is a continuous process of identification, understanding and adjustment of products, services, equipment and processes of the company with the best practice aiming at improvement of its own business. This process includes:

- Comparison of the company and its sectors with the best ones but not limited to the activity or the country where the activity is performed,
- Comparison of production activities or some other company's activities with the corresponding activities of other companies doing same business in order to define the best ones,
- Comparison of company's products and services with services of the competitors having the best results,
- Comparison of company's technical solutions in order to choose the best special purpose equipment,
- Application of the best defined business process,
- Planning future development directions and active adjustment to new trends, satisfying and exceeding the consumer expectations.

Benchmarking is a search for the best industry practices that lead to more superior performance. First of all, it is research and observation of the best practice of competitors and/or search for the best industry practice leading to producing the more superior performance

3.3. Benchmarking Types

Various business situations require that operation managers and staff apply different benchmarking skills. In accordance with these applications, three benchmarking types are defined:

- Process benchmarking,
- Performance benchmarking,
- Strategic benchmarking

Process benchmarking requires identification of the most effective work practices in the companies having similar operating functions. If one organization improves the basic process, it has an influence on performance improvement (increased productivity, lower costs or improved sale). Effects of application of benchmarking process are shown in the improvement of financial results in very short time period. Performance benchmarking enables managers to assess their competitive position by comparison of products or services. Performance benchmarking is usually focused to price elements, technical quality or characteristics of service (rate, reliability, etc.). Numerous industries apply performance benchmarking as a standard method in relations with competitors. Strategic benchmarking researches long-term successfulness pattern and tries to identify the winning strategies that have enabled success of companies in their markets. The organizations that look for short-term benefits apply process benchmarking which produces the results much faster. In addition to this, there are numerous classifications but the most often used is classification which differentiates two benchmarking types:

3.3.1. Internal Benchmarking

Internal benchmarking implies comparison of some sectors and divisions within the organization. This benchmarking type is generally used in big, multinational companies where each company's department performs specific activity or operation. In these companies a starting point for the benchmarking project is an intensive internal research in order to get an insight into business operations, department's strengths and weaknesses and operating method of each department,

3.3.2. External Benchmarking

External benchmarking which is divided into external competitive benchmarking, external industrial or functional benchmarking and external generic benchmarking. External competitive benchmarking is comparison of company's activity with direct competitors. The objective of external competitive benchmarking is obtaining specific and important data on the competitor's business and it facilitates positioning of products and company's business services on the market in relation to competitors. External industrial or functional benchmarking compares company's functions with functions of other companies. It is used when company wants to make improvements by comparing the elements of its business with the elements of other companies from the same industry but which are not the direct competitors. External generic benchmarking broadens fields of application of benchmarking process beyond the limits of specific company and industry it belongs to. In this benchmarking type, different industries having similarities in many business processes are compared and benchmarking applied to these operation elements enables important insight into information originated from the industries which are not interconnected.

Table 1: Comparison Of Different Benchmarking Types

Benchmarking Types	Decision Making Time	Benchmarking Partners	Results
Internal Benchmarking	3-4 month	Within the company	Significant improvements
External Benchmarking	6-12 month	Competitors	Better than competitors
External industrial Benchmarking	10-12 month	Same industry	Creative breakthrough
External generic benchmarking	12-14 month	All industries worldwide	Change of rules
Combined internal and external benchmarking	12-24 month	All industries worldwide	The best of kind

3.4. Benchmarking Process

There are numerous different models of benchmarking process (they differ in number and name of phases) but all models have the same essence. According to some authors, if benchmarking is globally considered, we can talk about:

- Pre-benchmarking phase – it includes making decision on what will be measured, how the measurement will be performed and which partners or criteria will be used in that process,
- Benchmarking phase – process of collecting data, measuring results and assessing gap is formulated in the course of this phase,
- Post-benchmarking phase – the results are obtained, action plan formulated, strategy created and initiated,
- Reinstitution of the process – providing feedback as a base for future decisions is very important in this phase. Review of the strategy, reset of goals and continuous planning of improvements in this phase lead back to the first step i.e. pre-benchmarking phase.

3.5. Performance Measurement Systems for Benchmarking In The Construction Industry

In the last few years, specific systems were established. Their primary goal is to indicate requirements related to use of performance measures for benchmarking in the construction industry and to identify key factors of effective design and application of performance measurement system. The text below presents some of these systems, such as:

- National Benchmarking System for the Chilean Construction Industry (CDT),
- Construction Industry Institute Benchmarking and Metric (CII),
- Performance Measurement System for The Brazilian Construction Industry, (SISIND)
- Key Performance Indicators in the United Kingdom (KPI).

3.5.1. National Benchmarking System For The Chilean Construction Industry

National Benchmarking System of Chile had in its data base 120 projects provided by 22 Chilean companies. These companies are members of the Chilean Chamber of Construction. The main difficulties in the implementation of the system were:

- The indicators were not easy to measure for all of the companies involved (not all of the companies had quality management systems),
- The essence in the approach is to create a measurement culture within the organization that will facilitate future implementation. Most of companies had difficulties in introducing performance measurement and in involving their work force in this initiative,
- There was poor standardization of measures, lack of continuity of measurement and inexistence of a regular and committed project team in many companies.

3.5.2. Construction Industry Institute Benchmarking And Metrics (CII)

In 2000 CII established this set of indicators:

- Cost indicators
- Schedule indicators
- Safety indicators
- Changes indicators
- Rework indictors

3.5.3. Performance Measurement System For The Brazilian Construction Industry (SISIND)

The SISIND Project was established in 1993, involving the Building Innovation Research Unit (NORIE) of the Federal University of Rio Grande do Sul (UFRGS), the Association of Building Contractors of the State of Rio Grande do Sul (SINDUSCON/RS) and the Agency for the Support of Micro and Small Businesses (SEBRAE/RS). The aim of this project was to disseminate performance measurement concepts, principles and practices in the construction industry. The SISIND Project has been focused on small sized construction firms, since they correspond to a very large percentage of the industry in Brazil both in terms of the number of companies and output. Since then, several initiatives have been established involving academic institutions, research funding agencies, industrial bodies and the Federal Government. The most recent initiative is the SISIND-NET project, which involves the conception and implementation of a performance measurement system for benchmarking for the Brazilian Construction Industry. The SISIND project initially devised a set of 35 performance indicators for the residential and commercial building segment of the industry, which can be used as a starting point for establishing sets of measures for specific companies. Later for the benchmarking initiative, ten indicators have been jointly chosen by the research team and industry representatives:

- Cost deviation
- Time deviation
- Non-conformity index for critical processes
- PPC (percentage of plan completed)
- Supplier performance
- Degree of user satisfaction (product)
- Sales time
- Ratio between the number of accidents and total man-hour input
- Construction site best practice index

- Degree of internal client (workers) satisfaction

The following activities were carried out in the SISIND project:

- Production of a publication describing the set of indicators
- Production of five reports based on the data collected by partner companies
- Development of research studies related to the definition and use of new measures for a number of key processes.

3.5.4. Key Performance Indicators (KPI) In The United Kingdom

The KPI Programme was launched by the UK Best Practice Programme in 1998, the purpose of the KPI programme is to enable measurement of project and organizational performance throughout a large number of projects and hence provide indications about performance of the construction industry. The main ways that Construction Consultants KPIs are used in the construction industry are:

- To benchmark the performance of a specific project or company
- To provide a measurement framework for partnering and framework agreements
- To provide evidence of value for money in procurement
- To provide measures other than price to support procurement decisions
- As a marketing tool
- To meet the requirements of ISO 9001 quality management systems
- To provide a health check as part of a continuous improvement programme.

3.5.5. The KPI Data, the KPI Groups, the Level of KPIs

Each year, on behalf of the BIS (Department for Business Innovation and Skills) and the project partners, the KPI Consortium carries out data collection surveys of clients and consultants across the United Kingdom. Data are collected by questionnaires and processed and the results are presented in the reports and graphs showing performance level for critical questions. Then the results are entered in the corresponding databases. Access to databases is enabled by appropriate on-line software supporting the corresponding project performance analyses related to the corresponding benchmarks. Clients of the construction industry want their projects delivered: on time, on budget, free from defects, efficiently, right first time, safely, by profitable companies. The KPI framework consists of seven main groups:

- Time
- Cost
- Quality
- Client Satisfaction
- Client Changes
- Business Performance
- Health and Safety

3.5.6. Procedure to Implementing KPIs and Main Problems Identified KPIs

There are seven basic steps to the successful use of KPIs as shown in figure.

Figure 2. Seven Basic Steps to The Successful Use Of KPIs

The set of KPIs is annually updated by the Construction Best Practice Programme. A few hundred companies have been participating in this programme. Despite the initiatives of the KPI Programme in promoting the comparison between companies, a fairly limited number of companies are really involved to the benchmarking programme.

3.6. Key Performance Indicators

The purpose of the KPIs is to enable measurement of project and organizational performance throughout the construction industry. The process of developing KPIs involved the consideration of the following factors. KPIs are general indicators of performance that focus on critical aspects of outputs or outcomes. Only a limited, manageable number of KPIs is maintainable for regular use. Having too many (and too complex) KPIs can be time- and resource-consuming. The systematic use of KPIs is essential as the value of KPIs is almost completely derived from their consistent use over a number of projects. Data collection must be made as simple as possible. A large sample size is required to reduce the impact of project specific variables. Therefore, KPIs should be designed to use on every building project. For performance measurement to be effective, the measures or indicators must be accepted, understood and owned across the organization. KPIs will need to evolve and it is likely that a set of KPIs will be subject to change and refinement. Graphic displays of KPIs need to be simple in design, easy to update and accessible. With these factors in mind, a set of KPIs including objective indicators and subjective ones is developed to measure the performance of a construction project. With reference made to earlier research, each KPI will be discussed in detail and practical approaches to measure these KPIs will be introduced. The calculation methods of the proposed KPIs are divided into two groups. The first group uses mathematical formulae to calculate the respective values. Formulae will be presented after the detail explanations of each KPI, such as time, cost, value, safety and environmental performance. The other group uses subjective opinions and personal judgment of the stakeholders. This group includes the quality, functionality of building and the satisfaction level of various stakeholders. A seven-point scale scoring system is adopted to measure these KPIs. As discussed in the following paragraphs, there are nine KPI categories in total; each may include one or more measuring methods. Figure 4.2 shows a graphical representation of the KPIs

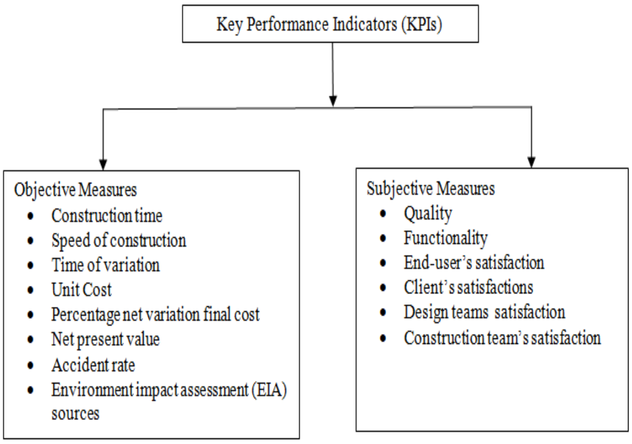

Figure 3 KPIS For Project Success

4. *RESULT AND DISCUSSION*

4.1 Construction Industry Benchmarking And Metrics

✓ **Cost Indicators**

Table 2: Calculation for Cost Indicator

Description	Actual Total Project Cost	initial predicted project cost	Approved Changes	Actual Phase cost	Initial predicted cost	Project Cost Growth	Delta Cost Growth	Project Budget Factor	Delta Budget Factor	Phase Cost factor	Phase cost Growth
	Rs	Rs	Rs	Rs	Rs	Rs		Rs			Rs
Case 1	2893011	2583045.49	578602.2	454775.3	395456.8	0.120	0.120	0.92	0.08	0.15	0.15
Case 2	4612649	4118436.88	1153162	633573.2	550933.2	0.12	0.12	0.88	0.13	0.15	0.15
Case 3	2786576	2488014.2	557315.2	483840	420730.4	0.12	0.1	0.92	0.08	0.15	0.15

Sample Calculation: Case Study 1

$$\text{Project Cost Growth} = \frac{Actual\ Total\ Project\ Cost - Initial\ Predicted\ Project\ Cost}{initial\ predicted\ project\ cost}$$

$$= \frac{(2893011 - 2583045.49)}{2583045.49}$$

$$= 0.15$$

$$\text{Delta Cost Growth} = |Cost\ growth|$$

$$= |0.15|$$

$$= 0.12$$

$$\text{Project Budget Factor} = \frac{Actual\ Total\ Project\ Cost}{initial\ predicted\ project\ cost + Approved\ changes}$$

$$= \frac{2893011}{(2583045.49 + 578602.2)}$$

$$= 0.92$$

$$\text{Phase Cost Factor} = |1 - Budget\ factor|$$

$$= |1 - 0.92| = 0.15$$

$$\text{Phase Cost Growth} = \frac{Actual\ phase\ Cost - Initial\ Predicted\ phase\ cost}{initial\ predicted\ project\ cost}$$

$$= \frac{(2893011 - 2583045.49)}{2583045.49}$$

$$= 0.15$$

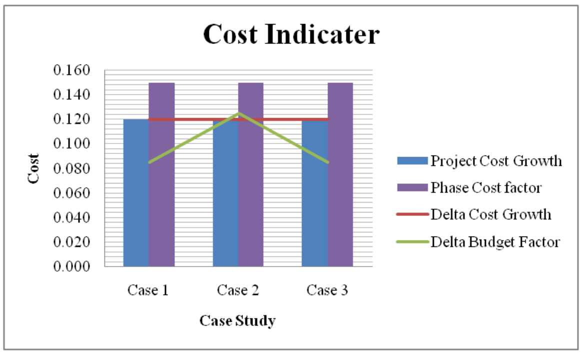

Figure 3. Result for Cost Indicator

✓ **Schedule Indicators**

Table 3: Calculation For Schedule Indicator

Description	Actual Project Duration	Initial Predicted Duration	Approved Changes	Actual Phase Duration	Project Schedule Growth	Delta Schedule Growth	Project Schedule Factor	Delta Schedule factor	Phase Duration Factor	Total Project Duration
	Days	Days	Days	Days	Days					Weeks
Case 1	850	820	170	900	0.037	0.0366	0.9	0.141	1.06	121.4
Case 2	950	921	237.5	980	0.0315	0.0315	0.8	0.180	1.032	136
Case 3	1100	1010	220	1200	0.0891	0.0891	0.9	0.106	1.1	157.1

Sample Calculation: Case Study 1

Project Schedule Growth = $\frac{Actual\ Total\ Project\ Schedule - Initial\ Predicted\ Project\ duration}{Initial\ predicted\ project\ duration}$

$= \frac{(850 - 820)}{820}$

= 0.037 Days

Delta Schedule Growth = $|\text{Schedule growth}|$

$= |0.037|$

= 0.0366

Project Schedule Factor = $\frac{Actual\ Total\ project\ Duration}{initial\ predicted\ project\ duration + Approved\ changes}$

$= \frac{850}{(820+170)}$

= 0.9

Delta Schedule Factor = $|1 - \text{Schedule factor}|$

$= |1 - 0.9|$

= 0.141

Phase Duration Factor = $\frac{Actual\ phase\ Duration}{Actual\ overall\ project\ duration}$

$= \frac{900}{850}$

= 1.06

Total Project Durations = Actual Total Project Duration (weeks)

= 121week

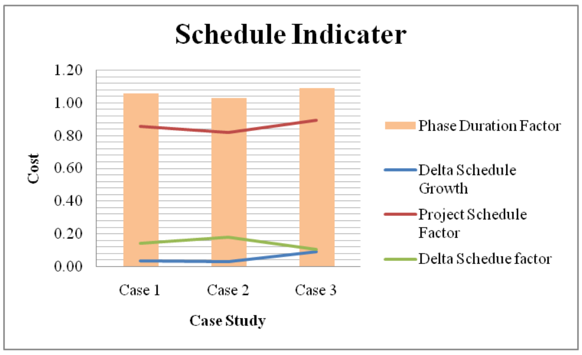

Figure 4. Result For Schedule Indicator

✓ **Safety Indicator**

Table 4: Calculation For Safety Indicator

Description	Incident Cases	Work Hours	Total Recordable Incident rate
Case 1	35	8	875000
Case 2	25	8	625000
Case 3	Nil	8	0

Sample Calculations: Case Study 1

Total Recordable Incident Rate = $\frac{Total\ no.of\ recordable\ bases\ x\ 200000}{total\ site\ work\ hours}$

$= \frac{35\ x\ 200000}{8}$

= 875000

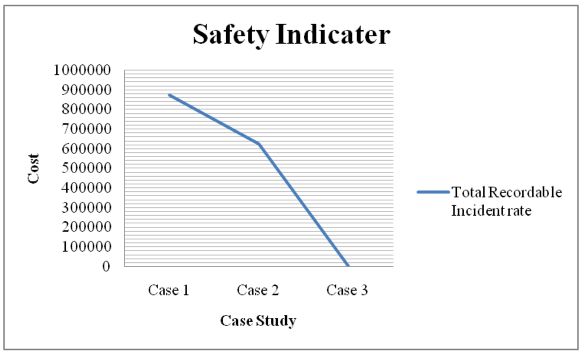

Figure 5. Result for Safety Indicator

✓ **Change Indicator**

Table 5: Calculation For Changes Indicator

Description	Actual Total Project Cost	Total Cost of Changes	Change Cost Factor
	Rs	Rs	
Case 1	2893011	2583045.49	0.9
Case 2	4612649	4118436.88800	0.89
Case 3	2786576	2488014.235	0.8929

Sample Calculations: Case Study 1

Changes Cost Factor = $\frac{Total\ cost\ changes}{Actual\ total\ project\ cost}$

$= \frac{2583045.49}{2893011} = 0.9$

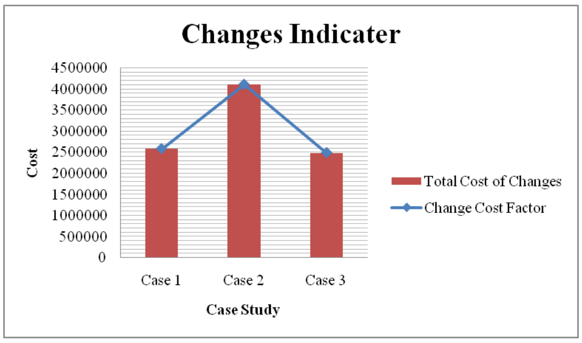

Figure 6. Result for Changes Indicator

✓ **Summary**

Following result are concluded in 3 residential building case study

Table 6: Summary of Indicator Factors Results

Cost Indicator	Actual Total Project Cost	initial predicted project cost	Project Cost Growth	Delta Cost Growth	Phase cost Growth
	Rs	Rs	Rs		Rs
Case 1	2893011	2583045	0.12	0.12	0.15
Case 2	4612649.315	4118437	0.12	0.12	0.15
Case 3	2786576	2488014	0.12	0.12	0.15
Schedule Indicator	Project Schedule Growth	Delta Schedule Growth	Project Schedule Factor	Delta Schedule factor	Phase Duration Factor
	Days				
Case 1	0.037	0.0366	0.9	0.141	1.06
Case 2	0.0315	0.0315	0.8	0.18	1.032
Case 3	0.0891	0.0891	0.9	0.106	1.1
Safety Indicator	Total Recordable Incident rate				
Case 1	875000				
Case 2	625000				
Change Indicator	Actual Total Project Cost	Total Cost of Changes	Change Cost Factor		
	Rs	Rs			
Case 1	2893011	2583045	0.9		
Case 2	4612649	4118437	0.89		
Case 3	2786576	2488014	0.8929		

5. *CONCLUSION*

The principal aspects of this research can be summarized in the following specific points:

- Benchmarking is an efficient tool for collecting data and information related to competitors' business, financial situations and possibilities for business in the specific market sectors.
- Benchmarking identifies production-related and other operations in the company that should be improved and goes much beyond the traditional analysis of the competitors.

It implies deeper analysis of the best competitors, detailed examination of their achievements and how they did them as well as analysis of operation capabilities and characteristics of competitors' products aimed at taking actions to improve their own performance and business. Benchmarking benefits are well recognized and nowadays companies all over the world increasingly implement benchmarking to improve continuously business functions and products and to strengthen their positions into the global market. Performance measurement and information about performance are very rare in the construction companies.

Benchmarking introduction in the companies is a complex project requiring considerable effort and investment. Limiting factor for many companies to make comparative analyses, especially external ones, is relatively high project operational costs. Continuity of involvement, lack of resources – especially in the small-sized companies – insufficient training level of managers and absence of performance measurement system which provides key information for decision making are additional difficulties for introduction and implementation of benchmarking.

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