Research Article *focuses on the analysis and resolution of managerial issues based on analytical and empirical studies.*

Application of Analytic Hierarchy Process to Benchmarking of Project Management Performance: An Application in the Caribbean Public Sector

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Benchmarking can be described as the search for the best practices leading to superior performance of an organization. This study demonstrates how analytic hierarchy process (AHP), a multiple attribute decision-making technique, can be used for benchmarking project management practices. The methodology has been applied to benchmark project management practices of Caribbean public sector organizations, organizations in the Indian petroleum sector, and infrastructure sector organizations of Thailand and UK. This study illustrates the effectiveness of a proposed benchmarking model using AHP and suggests measures for effective project management.

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The need for effective project management has been increasing in recent years. It has become imperative for organizations to implement new and augmentation projects faster and within budgeted costs. The parameters for any project are on-time completion within specific budget, and with requisite performance (technical requirements). Unfortunately, the current project management practices do not always ensure success. The main problems with project planning and implementation have been cost and time overruns and lower than expected quality levels.

The main contributing factors are expansion of scope and subsequent quantity increases of input resources, engineering and design changes, underestimation and incorrect estimation, unforeseen inflation, project size and complexity, unforeseen technical difficulties, schedule changes, tight schedules and excessive concurrence of project phases, poor contract administration and policies, poor project definition, labour problems and poor industrial relations, changes in government policies and regulations, non-involvement of project staff in the planning stage, and project staff not working full-time on the same project.

One way by which organizations can achieve excellence is by monitoring competitors' activities and world best practice in all aspects of the business (Bendell, Boulter and Kelly, 1998). Benchmarking is a dynamic process of comparing various aspects of business on a definitive scale to measure the relative position of an organization with respect to others. It is carried out with the objective of improving performance of organizations. However, if improvement targets are set without knowledge of what others are doing and achieving, the target may not be taxing enough to be in business.

Project management's growing popularity has stimulated interest in how companies compare in their application of project management processes, tools, and techniques. Though many other industries (automotive, semiconductor, engineering construc-

tion) have benchmarked their operations for years, the project management profession has lagged in this regard (Ibbs and Kwok, 1998).

Benchmarking is expected to produce satisfactory answers to various issues faced by project management and is likely to reveal various best practices which can be adopted with careful modification to match with the objectives and policies of the organization.

This paper provides a broad overview of the literature on benchmarking and analytic hierarchy process. It then describes an application of the technique in participating Caribbean project organizations to compare their project management performance. Project management practices of public sector organizations in the Caribbeans are then compared with organizations in the Indian petroleum sector and in the infrastructure sector of Thailand and UK. The development of the benchmarking tool and its application necessitated the study of project management practices of a few Caribbean public sector organizations, a questionnaire survey, and interviewing of the organizations' executives in a workshop environment.

Project Management in Caribbean Public Sector Organizations

The Caribbean government is currently planning and implementing development programmes valued in excess of US$2 billion a year. Many of these programmes are funded either through local borrowing or by international development agencies and focus on broad areas of national development. There is increasing concern expressed by both the government and international development agencies regarding:

- the quality of strategic planning used as the basis for development programmes and projects
- the quality of project proposals and adequacy of appraisal reports
- levels of transparency used in selection of con tractors, suppliers, and consultants, and their quality
- project performance in terms of time (schedule), cost (budget), and quality (performance)
- project monitoring and control including the reporting mechanism
- increasing number of scope change incidents during various phases of projects
- the extent to which project deliverables are compatible with the achievement of strategic objectives as defined in the associated strategic plans
- the methods and system used in evaluation of project performance
- the extent to which programme deliverables can be managed, on a sustainable basis, in seeking to achieve defined economic objectives.

A strengths, weaknesses, opportunities, and threats (SWOT) analysis was carried out with the involvement of project executives of Caribbean public sector organizations during the workshop. Table 1 shows the SWOT matrix of Caribbean organizations. Major weaknesses in project management of Caribbean public sector organizations were identified through a subsequent questionnaire survey. These issues and problems in project management in Caribbean public sector organizations were identified in relation to different phases of projects. The different phases of projects in the Caribbean infrastructure sector are shown in Figure 1 as an illustration and Appendix 1 lists the issues and problems according to the phases.

Benchmarking Project Management Practices

Benchmarking has become one of the most popular business management tools of the 1990s. It has been promoted as a technique that brings change and improvement to an organization's business processes through a process of learning from other organization's successes and application of these practices in one's own firm. Benchmarking is said to promote change and deliver improvements in quality, productivity, and efficiency. "Benchmarking is used to improve performance by understanding the methods and practices required to achieve world-class performance levels" (Camp, 1995). In fact, it happened with Xerox Corporation, which invented benchmarking sometime in the later part of the 70s. When Xerox Corporation, a pioneer in photocopying, started losing market share to Japanese competitors, it developed the benchmarking tool by which it could quickly learn many effective work practices from different sources in order to achieve world-class performance and regain market leadership.

Many look at benchmarking as an organized method for quoting data to make comparison for finding out a gap. Others see it as a tool that promotes

Table 1: SWOT Matrix of Caribbean Project Organizations

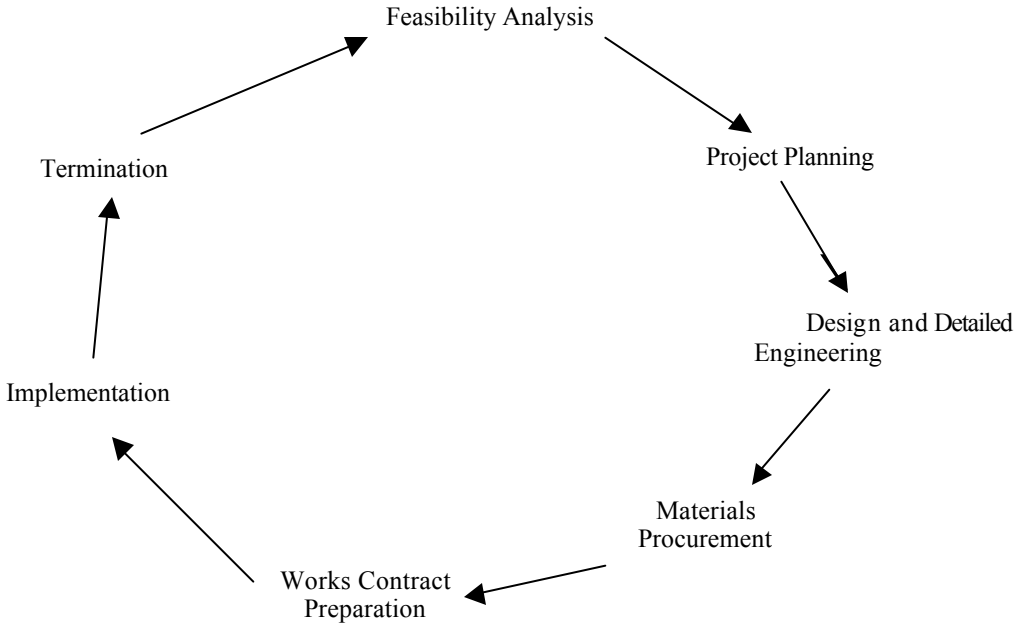
	Strength (S)	*Weakness (W)*
Internal Factors	Qualified manpower	Use of IT is limited within the project organization
	Faster information flow among project stakeholders	Training of manpower for implementation as well as for operations
	Internal/external project team members are brought closer for better decision-making	Many changes in the present system
	Provide benefits to the organization for long period	
External Factors	Implementation calls for involvement of functional as well as system people	
Opportunities (0)	*SO - Strategies*	*WO - Strategies*
• Globalization in business function • Vertical integration with all stake holders • Financial stability • Process integration	• Customer focus • Vertical integration • Globalization • Development of decision • Process reengineering in IT	• Formation of flat hierarchy in organization structure • Training manpower for implementation and operations • Mind setting the people • Change management in IT framework
Threats (T)	*ST - Strategies*	*WT - Strategies*
Returns on investment take time Cost of implementation is very high Implementation takes time Success is not always assured	Much desk research before implementation Implementation through pilot project	Management commitment Employee motivation

learning and stimulates organization changes (Bogan and English, 1994). Spendolini (1992) characterizes benchmarking as a continuous process, a process of investigation providing valuable information, a process of learning from others, a pragmatic search for ideas, a time-consuming and labour-intensive process requiring discipline, and a viable tool providing useful information for improving virtually any business activity. According to Furey (1987), benchmarking is an analytical process for rigorously measuring a company's operations against the best-in-class companies both inside and its markets. The goals of benchmarking process are:

- to identify key performance measures for each function of a company's operations
- to measure the internal performance levels of the company as well as the performance levels of the competitors
- to compare performance levels in order to identify areas of competitive advantage and disadvantages
- to implement programmes for closing the gap between the internal operations and the other companies.

Watson (1993) states that the evolutionary process of benchmarking resembles the classic "art-transitioning-to-science" model for development of a new management discipline, and benchmarking has now reached the fourth level in the process. The first generation of benchmarking is described as product-oriented reverse engineering or competitive product analysis with emphasis on comparing product characteristics, functionality, and performance with similar products or services from competitors. The second generation, competitive benchmarking, expanded the scope of benchmarking to include comparisons of processes with those of competitors. The third generation of benchmarking was reached as more quality leaders recognized that learning is easier from companies outside their industry than from competitive studies. The fourth generation of

Figure 1: Project Phases of Caribbean Public Sector Organizations in the Infrastructure Sector



benchmarking is labelled strategic benchmarking which can be defined as a systematic process for evaluating alternatives, implementing strategies, and improving performance by understanding and adapting successful strategies from companies that participate in an ongoing business alliance. The fifth and future generation of benchmarking involves global application where international trade, cultural, and business process distinctions among companies are linked and their impacts on improving business processes are understood.

Spendolini (1992) identifies the following reasons for using benchmarking:

- gathering relevant information to be used in strategic planning
- forecasting trends in relevant business areas, like the business directions of key players in the market
- generating new ideas and functional learning by exposing individual to new products, work processes, and ways of managing company resources, i.e., by thinking "out of the box"
- collecting and using information about the products or processes of competitors or excellent companies for setting standard or comparison for similar products or services
- setting performance goals in relation to state-of-the art practices.

The approaches to benchmarking can be divided into four main categories (Bendell, Boulter and Kelly, 1998). First, *internal benchmarking* refers to making comparisons with other parts of the same organization such as other departments or other sites. Arrangements for internal benchmarking are usually straightforward, the relevant information can be gathered relatively easily, and the results are instantly relevant and available. However, internal benchmarking is unlikely to lead to improvements that meet world-best practice. The second approach is labelled *competitor benchmarking*. As it is almost impossible to get full knowledge of how a direct competitor operates, competitor benchmarking is more difficult to perform than internal benchmarking. The third approach, *functional benchmarking,* involves comparing the company with typically noncompetitive organizations which carry out functional activities of interest, such as warehousing or procurement. This approach has many advantages as functional leaders are easily identified in many areas, confidentiality is not usually an issue, new practices can be discovered, and two-way partnerships can be established. The implementation of the discovered best practices in one's own company, however, can be a potential problem. The fourth approach is *generic benchmarking which* involves comparing business processes that cut across various functions and in different industries. Generic benchmarking is likely to produce the most innovative ideas and breakthroughs for unprecedented

improvement which, in turn, are the most challenging to implement in one's own company.

Based on his research on how companies apply benchmarking, Spendolini (1992) suggests a five-stage generic process for benchmarking. The first stage involves identifying the customers for benchmarking information and their requirements, defining the specific subjects to be benchmarked, and identifying and securing the required resources. The second stage is selecting, orienting, and managing a benchmarking team. At the third stage, information sources for collecting benchmarking information are identified. Possible sources include employees of benchmarking organizations, consultants, analysts, industry reports, and business and trade literature. Actual gathering of the information forms the fourth stage of the benchmarking process. Information is collected according to an established procedure and summarized for analysis. Information is analysed according to the original requirements and recommendations for action are produced. The last stage of the process involves taking action by implementing the recommendations and by identifying appropriate activities, including the continuity of the benchmarking process.

Watson (1993) divides the benchmarking process into four main steps:

- planning the benchmarking project
- collecting the necessary data
- analysing the data for performance gaps and enablers
- improving by adapting process enablers.

AHP-based Approach to Benchmarking

The analytic hierarchy process (AHP) developed by Saaty (1980) provides a flexible and easily understood way of analysing complicated problems. It is a multiple criteria decision-making technique that allows subjective as well as objective factors to be considered in decision-making. AHP allows active participation of decision-makers in reaching agreement, and gives managers a rational basis on which to make decisions. AHP is based on the following three principles: decomposition, comparative judgement, and synthesis of priorities.

AHP is a theory of measurement for dealing with quantifiable and intangible criteria that has been applied to numerous areas such as decision theory and conflict resolution (Vargas, 1990). It is a problem-solving framework and a systematic procedure for representing the elements of any problem (Saaty, 1983).

Researchers use AHP in various industrial applications. Partovi, Burton and Banerjee (1990) used it for operations management decision-making. Dey, Tabucanon and Ogunlana (1994) used it in managing the risk of projects. Mian and Christine (1999) used AHP for evaluation and selection of a private sector project. Meredith and Mantel (2000) described AHP as an effective tool for project selection. Dey and Gupta (1999) used AHP for cross-country petroleum pipeline route selection.

AHP has previously been used for benchmarking by Eyrich (1991). His application was for benchmarking computer integrated manufacturing (CIM) sites, and AHP was basically used for determining the success factors, the corresponding requirements, and their importance for a best-of-breed CIM site. Korpela and Tuominen (1996) used AHP for benchmarking logistic operations using a seven-step approach.

Formulating the decision problem in the form of a hierarchical structure is the first step of AHP. In a typical hierarchy, the top level reflects the overall objective (focus) of the decision problem. The elements affecting the decision are represented in intermediate levels. The lowest level comprises the decision options. Once a hierarchy is constructed, the decision-maker begins a prioritization procedure to determine the relative importance of the elements in each level of the hierarchy. The elements in each level are compared as pairs with respect to their importance in making the decision. A verbal scale is used in AHP that enables the decision-maker to incorporate subjectivity, experience, and knowledge in an intuitive and natural way. After comparison matrices are created, relative weights are derived for the various elements. The relative weights of the elements of each level with respect to an element in the adjacent upper level are computed as the components of the normalized eigen vector associated with the largest eigen value of their comparison matrix. Composite weights are then determined by aggregating the weights through the hierarchy. This is done by following a path from the top of the hierarchy to each alternative at the lowest level, and multiplying the weights along each segment of the path. The outcome of this aggregation is a normalized vector of the overall weights of the options. The mathematical basis for determining the weights was established by Saaty (1980).

Benchmarking is usually a team effort, and AHP is one method for forming a systematic framework for group interaction and group decision-making (Saaty, 1982). Dyer and Forman (1992) describe the advantages of AHP in a group setting as follows:

- both tangibles and intangibles, individual values, and shared values can be included in an AHP-based group decision process
- the discussion in a group can be focused on objectives rather than alternatives
- the discussion can be structured so that every factor relevant to the discussion is considered in turn
- in a structured analysis, the discussion continues until all relevant information from each individual member in a group has been considered and a consensus choice of the decision alternative is achieved.

A detailed discussion on conducting AHP-based group decision-making sessions including suggestions for assembling the group, constructing the hierarchy, getting the group to agree, inequalities of power, concealed or distorted preferences, and implementing the results can be found in Saaty (1982) and Golden, Wash and Harker (1989). For AHP in group decision-making, see Islie *et. al.* (1991).

In this study, an AHP-based approach to benchmarking project management practices has been demonstrated. The approach used here involves the following steps:

Step 1: Define the Project Management Critical Success Factors

The first step is to identify the critical success factors for managing projects. Critical success factors are the characteristics, conditions or variables that when properly sustained, maintained or managed can have a significant impact on the success of a company in a particular industry (Leidecker and Bruno, 1984). Project executives of various organizations were interviewed for identifying the critical success factors for project management of their organizations.

The project executives identified the following critical success factors:

Appropriate Feasibility Study of the Projects: This not only identifies the best alternative feasible project for the organization, but also allows to involve all stakeholders to take part in analysis through their requirement analysis and provides a solid foundation of projects and project management. This also provides basis for fast approval from competent authorities, funding agencies, and statutory authorities.

Adequate Project Plan: Detailed project plan in relation to schedule, budget, quality, organization, communication, procurement, and risk ensures effective implementation through standard parameters and forms a basis for team effort for managing projects.

Appropriate Design and Detailed Engineering: This ensures minimum change in technicalities of the project and effective management of technical change throughout the project phases.

Availability of Work Front: This is an important factor for successful project management. Work front shall be made available before the implementation phase of the project through adequate survey, compensation to project affected people, soil testing, and statutory approvals from authorities for construction.

Effective Material Procurement: Materials constitute a major portion of the project cost. Unless this is managed effectively, the project is bound to incur time and cost overrun. Procurement planning, supplier selection, inventory control, and effective surplus disposals form an effective procurement management approach for infrastructure projects.

Good Contract Management: All project team members (owner project management group, consultants, contractors, and suppliers) are committed to project achievement through some legal contract. The effective management of these contracts not only ensures smooth functioning of the project in various phases but also builds team spirit among project participants.

Appropriate Monitoring and Control: This measures the project performance in line with the planning standard. Managing projects through base line project plan and earned value analysis provides the basis for effective decisions across various phases of the project.

Effective Termination: The effectiveness of the project depends on how effectively it is handed over for operations. Contract close out, preparation of completion report, as-built drawings, and operating manual along with handling commissioning activities efficiently decides the project fate to some extent in the long run.

All the critical success factors are sub-divided into a few sub-critical success factors with the active involvement of project executives in the workshop

environment. Exhibit 1 shows the hierarchy of the entire critical success factors and sub-factors for effective project management.

Step 2: Identify the Organizations to be Included in the Analysis

In recent years, projects in the Indian petroleum sector have performed very well in terms of time, cost, and quality objectives (Dey, 1999). A few organizations have used quantitative risk management tools and achieved considerable benefits (Dey, 2001a). An organization has employed the fast track approach using concurrent engineering concepts and has achieved success in achieving project targets (Dey, 2000). Many organizations are using integrated project appraisal models (Dey, 2001b) and reengineering approach (Dey, 2001 c). Ogunlana, Promkuntong, andjearkjirm (1996) reported successful achievement of various construction projects in Thailand. The same study also demonstrates various positive aspects of the UK construction industry. Recently, the UK construction industry has developed the strategic sourcing approach to establish partnership arrangement across construction supply chain (Hamza, Djebarni and Hibberd, 1999). This has provided them overall improvement in project performance.

Step 3: Analyse Performance

Using AHP, the importance of each critical success factor is determined by pair-wise comparison with the active involvement of project executives. Extensive brainstorming among the project executives derives the ratings for each critical success factor. Their utilities and performance of the organizations are then derived through group consensus.

In order to evaluate the importance of the critical success factors and to analyse the performance of the organizations to be benchmarked, the success factors are structured in the form of a hierarchy along with ratings as shown in Exhibits 2 and 3.

The goal for the benchmarking analysis is located on the highest level of the hierarchy, the critical success factors on the second level, the critical success sub-factors on the third level, and ratings for each critical sub-factor on the last level.

The next step is to derive priorities for each element in the hierarchy. The priorities are derived by comparing each set of elements in a pair-wise fashion with respect to each of the elements in the higher stratum (Wind and Saaty, 1980). A verbal or a corresponding nine-point numerical scale (Table 2) is used for the comparisons which can be based on objective quantitative data or subjective qualitative judgements. In addition, comparisons can also be made graphically. In a group setting, there are several ways of including the views and judgements of each person in the priority setting process. In a common objective context where all members of the group have the same objectives, there are four ways that can be used for setting the priorities: consensus, vote or compromise, geometric mean of the individuals' judgements, and separate models or players (Dyer and Forman, 1992).

The priorities for the critical success factors and sub-factors are derived with the active involvement of project executives. Table 3 shows importance of the critical success factors as determined by the executives through pair-wise comparison. While comparing pair-wise, the executives used scale of relative importance from Table 2 in a group decision-making process in the workshop environment. For example, they felt that 'adequate project plan' is moderately important than 'appropriate design and detailed engineering' in their project management practices. Accordingly, they had suggested intensity 3 in the 'planning' row and 'design.' Hence, according to AHP rule, the 'design' row and 'planning' column has intensity 1/3. Similarly, all the cells were filled by the executives through brainstorming using 'scale of relative importance' as in Table 2. The

Table 2: Scale of Relative Importance for Pair-wise Comparison

Intensity	*Definition*	*Explanation*
1	Equal importance	Two activities contribute equally to the object
2	Moderate importance	Slightly favours one over another
3	Essential or strong importance	Strongly favours one over another
4	Demonstrated importance	Dominance of the demonstrated importance in practice
5	Extreme importance	Evidence favouring one over another of highest possible order of affirmation
2, 4, 6, 8	Intermediate values	When compromise is needed

Source: Saaty (1980).

Table 3: Pair-wise Comparison in Factor Level

	Feasibility	*Planning*	*Design*	*Work Front*	*Procurement*	*Contract*	*Monitoring*	*Termination*	*Importance*
Feasibility	1.00	2.00	2.00	3.00	2.00	3.00	2.00	4.00	0.24
Planning	0.50	1.00	3.00	2.00	2.00	3.00	1.00	3.00	0.18
Design	0.50	0.33	1.00	1.00	0.50	1.00	0.50	4.00	0.09
Work Front	0.33	0.50	1.00	1.00	0.33	1.00	0.50	3.00	0.08
Procurement	0.50	0.50	2.00	3.00	1.00	1.00	0.50	3.00	0.12
Contract	0.33	0.33	1.00	1.00	1.00	1.00	0.50	4.00	0.10
Monitoring	0.50	1.00	2.00	2.00	2.00	2.00	1.00	3.00	0.15
Termination	0.25	0.33	0.25	0.33	0.33	0.25	0.33	1.00	0.04

importance of the factors is determined by the following steps:

- divide number in each cell by corresponding column sum and form a normalized matrix
- average across each row to determine importance (weightage).

Subsequently, matrices are formed in sub-factor level also. The weightage of the factors and sub-factors is shown in Exhibit 4.

The second step in the priority setting procedure is to derive priorities for the ratings with respect to each critical success sub-factor. The ratings are pair-wise compared by the project executives in the group-decision making process in the AHP frame-work to derive true utilities of different performance level.

The performance level of organizations to be benchmarked is analysed by relating a rating and the corresponding priority to each organization with regard to each critical success factor and sub-factor. Evaluations are based on project executives' judgements. The results of the benchmarking analyses of Caribbean project management practices in the public sector are shown in Table 4.

Similarly, project management practices of the Indian petroleum sector, organizations involved in construction of high-rise buildings and highways in Thailand, and the infrastructure sector of UK are studied and their performances are tabulated. Appendix 2 shows analysis of the work in the AHP framework. Table 5 shows the relative position of each organization with respect to each factor as well as overall ranking (Table 5 has been generated by extracting data from Appendix 2).

Interpretation of Results

Caribbean executives emphasize appropriate feasibility analysis, planning for implementation, monitoring and controlling, and materials procurement for effective project management. They give more weightage to the involvement of project stakeholders in project feasibility study, scheduling and budgeting in implementation plan, controlling of scope and implementation methodology change along with completion of survey before construction, maintaining delivery schedule of all supplies, selection of quality contractors and suppliers, monitoring and controlling of projects through base line plan and earned value management, and appropriate termination using contract closeout, completion report, and project audit.

The benchmarking study (comparing the performance of project management practice of Caribbean public sector organizations with other developed and developing countries) reveals:

- Caribbean project management lacks involvement of project stakeholders in feasibility analysis and consumes considerable time in feasibility study compared to other organizations.
- Although Caribbean project management practices adequately plan for schedule, budget, and organization, little care has been given for communication, quality, risk, and procurement plan. On the contrary, Thailand and UK project management adequately emphasizes an integrated project plan using all the above components.
- Incidents of scope change are common for Caribbean and Indian project management owing to lack of planning.
- Selection of quality contractors and suppliers is the major concern in procurement and contract management in project management practices of Caribbean. Although the studied orgnizations of other countries also suffer from the same problem, they have reduced the problem by using strategic sourcing method.

Table 4: Project Management Performance of Caribbean in Public Sector Organizations

Factors	*Sub-factors*	*Ratings*
Feasibility study	Time for completing feasibility study	1 year or more
	Degree of disagreement	Medium
	Time between proposal and approval	3 months or more
	Time taken by statutory body to approve	3 months or more
	Involvement of project stakeholders	Low
Project planning	Schedule	Above average
	Budget	Above average
	Quality plan	Unsatisfactory
	Organization plan	Average
	Communication plan	Unsatisfactory
	Procurement plan	Below average
	Risk plan	Unsatisfactory
Design and detailed engineering	Changes in design	More than 5
	Revision in drawings	Less than 5
	Revision in specification	Less than 3
	Scope change	Frequent
	Implementation methodology change	Frequent
Availability work front	Completion of survey	Less than 50%
	Completion of soil testing	Less than 50%
	Statutory approval before implementation	80-50%
Materials procurement	Delivery problem	10-20%
	Shortage of materials	10-20%
	Quality problems	10-20%
	Inventory	Medium
	Surplus disposal method	Fuzzy
Contract management	No. of agreed variations	Between 5-10
	Quality contractor selection policy	Average
	No. of negotiation meeting	5-10
	Degree of disagreement among stakeholders	Medium
Monitoring and control	Managing project through base line plan	Unsatisfactory
	Use of earned value analysis	Below average
	Effectiveness of decision	Average
Termination	Contract closeout	90%
	Preparing as-built drawings	90% or less
	Preparing completion report	90% or less
	Commissioning problem	Medium

- Although various software is used by the Carib bean organizations for project monitoring and control, they lack use of base line plan and earned value management. This causes slow decision-making and delayed projects.
- Caribbean project management lacks contract closeout method, appropriate project documen tation (completion reports, as-built drawings etc.), and post-project evaluation. These help smooth transition of facilities from the project to operations phase.

Step 4: Define Enablers

Enablers are the processes, practices, and methods that facilitate the implementation of a best practice and help meet critical success factors or the characteristics that help to explain the reasons for the achievement of benchmark performance (Watson,

Table 5. Relative Positions of Organization with Respect to Each Factor

Factors	*Relative Position*			
	Caribbean Organizations	*Indian Organizations*	*Thai Organisations*	*UK Organizations*
Feasibility	0.04464	0.07344	0.07872	0.12624
Planning	0.03294	0.03618	0.06678	0.07776
Design and detailed engineering	0.02025	0.03663	0.03888	0.04734
Availability of work front	0.008	0.02656	0.02912	0.03456
Materials procurement	0.03636	0.03636	0.03636	0.06444
Contract preparation	0.023	0.0177	0.0406	0.0511
Monitoring and controlling	0.0084	0.0216	0.0534	0.0666
Termination	0.012	0.01564	0.02064	0.024
Overall	0.18559	0.26411	0.3645	0.49204
Rank	IV	III	II	I

1993). Enablers are then derived through brainstorming sessions among project executives with respect to each critical success factor.

The aim is to identify the processes, methods, practices, or characteristics that have helped an organization to achieve an outstanding performance level on a certain success factor. AHP is applied to support this step by using the hierarchy structured for the previous phase as a basis. However, the sub-factor and rating levels are removed from the hierarchy and replaced by a level consisting of the enablers. The enablers are identified for each critical success factor separately using the best practices of the organizations under study in various countries. AHP is used to analyse and prioritize the enablers of each benchmarked organization with respect to the critical success factors. By deriving priorities, understanding is gained about the importance of each identified enablers in creating superior project management practices.

By analysing the best organizations, the project executives of the Caribbean organizations are able to define six enablers that apply for each of the critical success factors: management systems, a process-based approach to integrating all functions of project management, effective information system, the effectiveness and flexibility of the project organization, usage of latest technology in design and detailed engineering and project control, and long-term relationship among all project stakeholders. The AHP-hierarchy for the analysis is presented in Exhibit 5.

The priorities of the critical success factors are the same as those derived for the model in Exhibit 4. The next step in the analysis of the enablers is to evaluate their importance with respect to each critical success factor by using pair-wise comparison according to the principle of AHP. The overall importance of the enablers as well as their importance with regard to each success factor is shown in Table 6.

Management systems, information systems, and process integration are clearly the most important enablers for superior performance.

Step 5: Derive Means for Improvement

Now, each of the critical success factors is studied to prioritize enablers. The strengths and weaknesses of Caribbean project management are identified through brainstorming sessions for each enabler in relation to each critical success factor. For example, management systems, process integration, and information system are prioritized for the critical success factor. The identified strengths and weaknesses are as follows:

Strengths

- Existing project policy
- Decision making structure
- Institutional capability

Weaknesses

- Project proposal seldom matches with organization's strategies
- Improper requirement analysis
- Fragmented approach to feasibility analysis
- Lack of stakeholders' involvement

Improvement measures suggested by executives in the brainstorming session are as follows:

- Aligning project goals with the strategic intents of the organization

Table 6: The Overall Importance of the Enablers

	Enablers	*Management Systems*		*Process Integration*		*Information System*		*Organization*		*Technology*		*Partnership*	
Factors	*Importance*	*LP*	*GP*	*LP*	*GP*	*LP*	*GP*	*LP*	*GP*	*LP*	*GP*	*LP*	*GP*
Feasibility	0.24	0.25	0.060	0.37	0.089	0.18	0.043	0.09	0.022	0.05	0.012	0.06	0.014
Plan	0.18	0.2	0.036	0.3	0.054	0.25	0.045	0.1	0.018	0.1	0.018	0.05	0.009
Design	0.09	0.14	0.013	0.06	0.005	0.15	0.014	0.22	0.020	0.28	0.025	0.15	0.014
Work front	0.08	0.15	0.012	0.19	0.015	0.06	0.005	0.12	0.010	0.25	0.020	0.23	0.018
Materials	0.12	0.15	0.018	0.2	0.024	0.22	0.026	0.1	0.012	0.1	0.012	0.23	0.028
Contract	0.10	0.25	0.025	0.1	0.010	0.1	0.010	0.1	0.010	0.1	0.010	0.35	0.035
Monitoring	0.15	0.16	0.024	0.23	0.035	0.27	0.041	0.1	0.015	0.11	0.017	0.13	0.020
Termination	0.04	0.21	0.008	0.12	0.005	0.13	0.005	0.23	0.009	0.23	0.009	0.08	0.003
Overall			0.196		0.237		0.189		0.115		0.123		0.141

LP: Local priority; GP: Global priority;

- Appropriate requirement analysis with the in volvement of project stakeholders
- Equal emphasis on all aspects of analysis (market and demand analysis, technical analysis, financial analysis, economic analysis, and impact assess ment)
- Use of logical framework
- Analysing risk
- Process integration in information technology framework.

Similar analysis has been done for all critical success factors and the suggested improvement measures are given in Table 7.

Table 7: Recommended Best Practices (phase-wise) for Caribbean Public Sector Organizations

Project Phases	*Recommendations*
Feasibility study	• Aligning the project goals with the strategic intents of the organization Appropriate requirement analysis with the involvement of project stakeholders Equal emphasis on all aspects of analysis (market and demand analysis, technical analysis, financial analysis, economic analysis, and impact assessment) • Use of logical framework Risk analysis of investment • Process integration in information technology framework
Implementation planning	• Process integration in project management body of knowledge framework • Implementation plan shall be supplemented by the preparation of risk plan, quality plan, organization plan, procurement plan, and communication plan
Design and detailed engineering	Strengthening • Technology selection • Implementation methodology selection • Consultant selection process for controlling scope change
Availability of work front	• Improved processes for all statutory approval
Effective materials procurement	• Process reengineering in information technology framework • Strategic sourcing (partnering)
Contract management	Contract type selection • Contractor selection • Long-term relationship with contractor
Monitoring and control	• Use of enterprise resource planning
Termination	Effective documentation • Post-evaluation using logical framework

Summary and Conclusions

This study demonstrates an application of the analytic hierarchy process for benchmarking project management practices of Caribbean organizations in the public sector with other organizations in developed and developing countries. AHP has been applied using the three-step approach with the involvement of project executives. First, the executives identify critical success factors, sub-factors, and ratings for each sub-factor, and prepare a hierarchical structure. Then they establish the importance of each critical success factor and sub-factor along with determination of utility of each rating in the AHP framework. Subsequently, through brainstorming, they determine the condition of each organization using the rating determined in the earlier step. They synthesize the result to establish the overall ranking of the organizations under study. Second, the factors enabling the companies to achieve superior project performance are determined and prioritized with respect to each success factor. Third, the strengths, weaknesses, and problems of the organization conducting the benchmarking process are analysed and prioritized with respect to each enabler. Then, the potential developmental actions for achieving superior project performance are defined.

AHP helps in conducting quantitative benchmarking and incorporating tangible and intangible factors. It facilitates communication with benchmarking partners through interviewing in a systematic way and provides a basis for making subsequent decisions for development projects.

Appendix 1: Project Phase-wise Issues and Problems in Caribbean Public Sector Organizations

Project Phases	*Issues and Problems*
Feasibility	Identification of projects without proper stakeholder analysis. Improper requirement analysis. Long approval processes. Bureaucratic approach. Fragmented approach to feasibility analysis. Excessive dependence on consultants. Impact assessment for the sake of statutory approval not to improve project's effectiveness.
Project planning	Lack of documentation. No risk planning. Very little communication planning. Lack of IT orientation in planning. Lack of trained manpower. Improper responsibility matrix. No quality planning for effective project management. Mostly planning done manually. Ineffective scheduling and budgeting.
Design and detailed engineering	Unclear technology selection process. Unclear implementation methodology selection process. Excessive dependence on consultants. Non-availability of technical personnel. Less application of information technology (IT). Not much interaction with responsible departments for review of design and drawings. Less competent manpower.
Materials procurement	Poor handling of materials. Obsolescence. Change in delivery schedule. Fast technology change. Receiving faulty materials. Piling up of inventory. No policy for surplus disposal. Lack of clarity in materials specification. Lack of clarity in contract type selection. Stringent selection procedure. Complicated terms of payment.
Works contract preparation	Lack of clarity in work specification. Lack of clarity in contract type selection. Stringent selection procedure. Many contract disputes and arbitration.
Project implementation	Scope change. Design change. Implementation methodology change. Fund problem. Acts of God. Labour productivity. Decision delay.
Termination	Managing commissioning activities. Poor contract closeout. Poor documentation.

Appendix 2: Prioritization of Critical Success Factors, Sub-factors, and Ratings in AHP Framework

Factors		*Sub-factors*		*Caribbean Organizations Public Sector*		*Indian Organizations Petroleum Sector*		*Thailand Infrastructure Sector*		*UK/Developed Countries*	
		LP	*GP*	*LP*	*GP*	*LP*	*GP*	*LP*	*GP*	*LP*	*GP*
	0.24	0.28	0.0672	0.2	0.01344	0.5	0.0336	0.5	0.0336	0.5	0.0336
		0.18	0.0432	0.3	0.01296	0.3	0.01296	0.1	0.00432	0.6	0.02592
		0.1	0.024	0.2	0.0048	0.2	0.0048	0.5	0.012	0.5	0.012
		0.12	0.0288	0.2	0.00576	0.5	0.0144	0.2	0.00576	0.3	0.00864
		0.32	0.0768	0.1	0.00768	0.1	0.00768	0.3	0.02304	0.6	0.04608
Feasibilty				**0.04464**		**0.07344**		**0.07872**		**0.12624**	
	0.18	0.22	0.0396	0.3	0.01188	0.3	0.01188	0.5	0.0198	0.5	0.0198
		0.25	0.045	0.3	0.0135	0.3	0.0135	0.5	0.0225	0.5	0.0225
		0.14	0.0252	0	0	0	0	0.2	0.00504	0.3	0.00756
		0.1	0.018	0.2	0.0036	0.2	0.0036	0.3	0.0054	0.5	0.009
		0.09	0.0162	0	0	0	0	0.2	0.00324	0.5	0.0081
		0.11	0.0198	0.2	0.00396	0.2	0.00396	0.3	0.00594	0.3	0.00594
		0.09	0.0162	0	0	0.2	0.00324	0.3	0.00486	0.3	0.00486
Planning				**0.03294**		**0.03618**		**0.06678**		**0.07776**	
	0.09	0.17	0.0153	0.2	0.00306	0.3	0.00459	0.3	0.00459	0.5	0.00765
		0.13	0.0117	0.7	0.00819	0.7	0.00819	0.7	0.00819	0.7	0.00819
		0.15	0.0135	0.3	0.00405	0.3	0.00405	0.3	0.00405	0.5	0.00675
		0.3	0.027	0.1	0.0027	0.4	0.0108	0.4	0.0108	0.5	0.0135
		0.25	0.0225	0.1	0.00225	0.4	0.009	0.5	0.01125	0.5	0.01125
Design and Detailed Engineering				**0.02025**		**0.03663**		**0.03888**		**0.04734**	
	0.08	0.42	0.0336	0.1	0.00336	0.3	0.01008	0.3	0.01008	0.4	0.01344
		0.26	0.0208	0.1	0.00208	0.3	0.00624	0.3	0.00624	0.4	0.00832
		0.32	0.0256	0.1	0.00256	0.4	0.01024	0.5	0.0128	0.5	0.0128
Work Front				**0.008**		**0.02656**		**0.02912**		**0.03456**	
	0.12	0.33	0.0396	0.3	0.01188	0.3	0.01188	0.3	0.01188	0.6	0.02376
		0.15	0.018	0.3	0.0054	0.3	0.0054	0.3	0.0054	0.6	0.0108
		0.25	0.03	0.3	0.009	0.3	0.009	0.3	0.009	0.6	0.018
		0.15	0.018	0.4	0.0072	0.4	0.0072	0.4	0.0072	0.5	0.009
		0.12	0.0144	0.2	0.00288	0.2	0.00288	0.2	0.00288	0.2	0.00288

Contd.

Factors	*Sub-factors*		*Caribbean Organizations Public Sector*		*Indian Organizations Petroleum Sector*		*Thailand Infrastructure Sector*		*UK/Developed Countries*	
	LP	*GP*	*LP*	*GP*	*LP*	*GP*	*LP*	*GP*	*LP*	*GP*
Mat. Procurement				0.03636		0.03636		0.03636		0.06444
0.1	0.12	0.012	0.3	0.0036	0.3	0.0036	0.3	0.0036	0.3	0.0036
	0.38	0.038	0.3	0.0114	0.2	0.0076	0.5	0.019	0.5	0.019
	0.15	0.015	0.3	0.0045	0.2	0.003	0.5	0.0075	0.5	0.0075
	0.35	0.035	0.1	0.0035	0.1	0.0035	0.3	0.0105	0.6	0.021
Contract			**0.023**		**0.0177**		**0.0406**		**0.0511**	
0.15	0.42	0.063	0	0	0.2	0.0126	0.5	0.0315	0.5	0.0315
	0.3	0.045	0	0	0.2	0.009	0.3	0.0135	0.5	0.0225
	0.28	0.042	0.2	0.0084	0	0	0.2	0.0084	0.3	0.0126
Monitoring Control			**0.0084**		**0.0216**		**0.0534**			**0.0666**
0.04	0.28	0.0112	0.3	0.00336	0.3	0.00336	0.3	0.00336	0.6	0.00672
	0.18	0.0072	0.3	0.00216	0.6	0.00432	0.6	0.00432	0.6	0.00432
	0.29	0.0116	0.3	0.00348	0.6	.0.00696	0.6	0.00696	0.6	0.00696
	0.25	0.01	0.3	0.003	0.1	0.001	0.6	0.006	0.6	0.006
Termination			**0.012**		**0.01564**		**0.02064**		**0.024**	
Overall			**0.18559**		**0.26411**		**0.3645**		**0.49204**	
Rank			IV		III		II		I	

LP: Local Priority; GP: Global Priority.

Exhibit 1: Hierarchy of Critical Success Factors and Sub-factors for Benchmarking Project Management

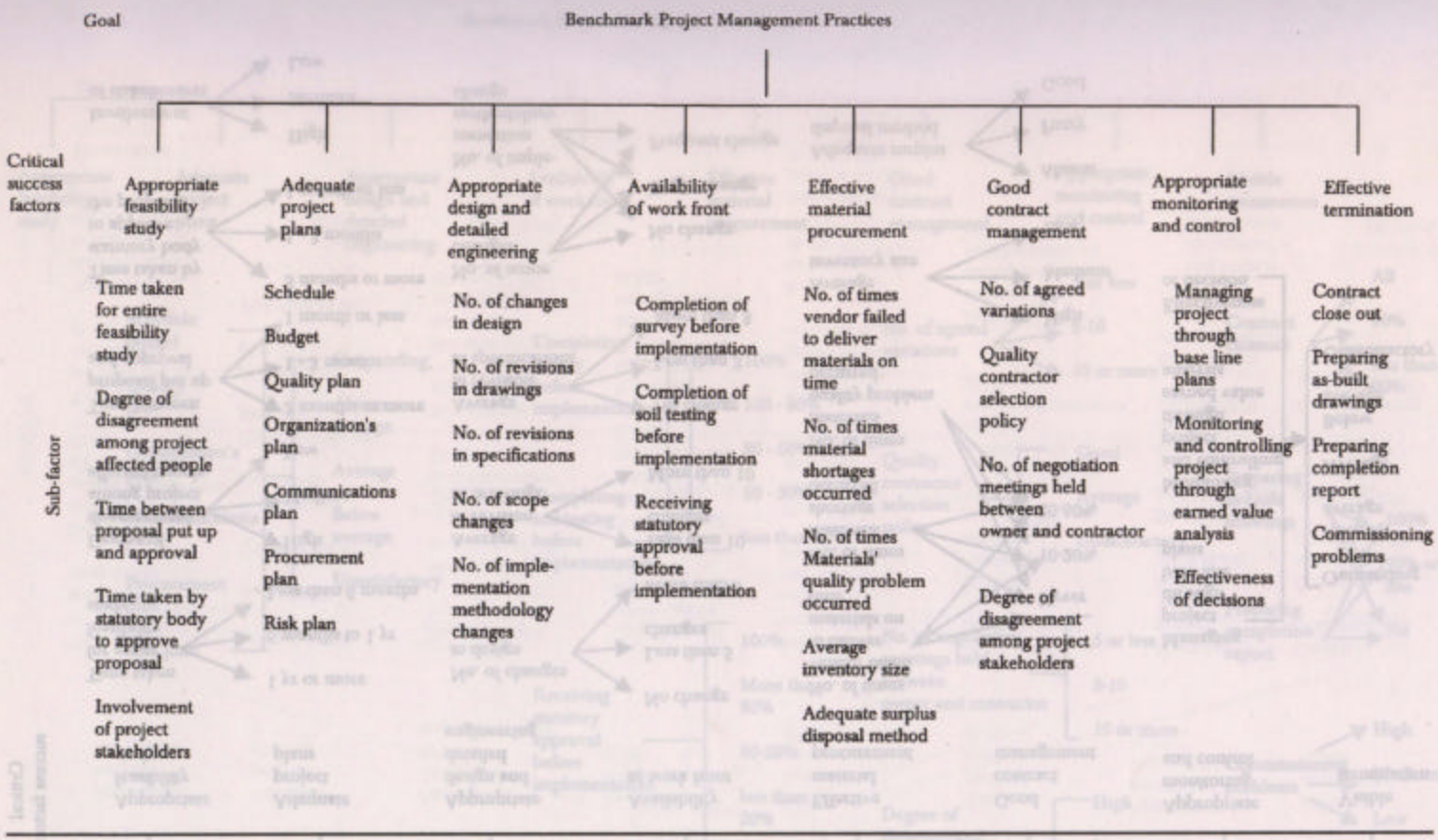


Exhibit 2: AHP Hierarchy for Project Management Performance Measurement

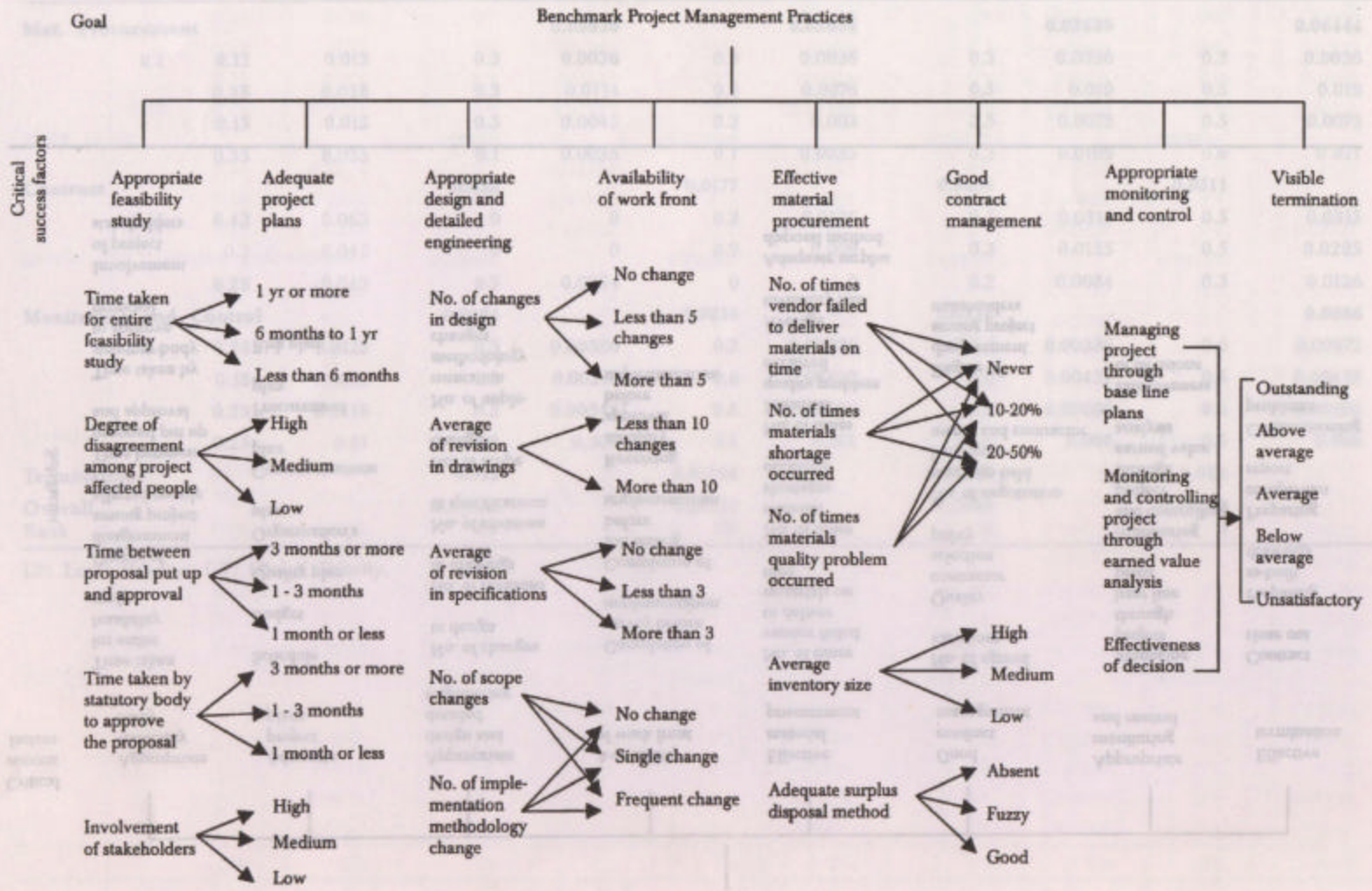


Exhibit 3: AHP Hierarchy for Project Management Performance Measurement

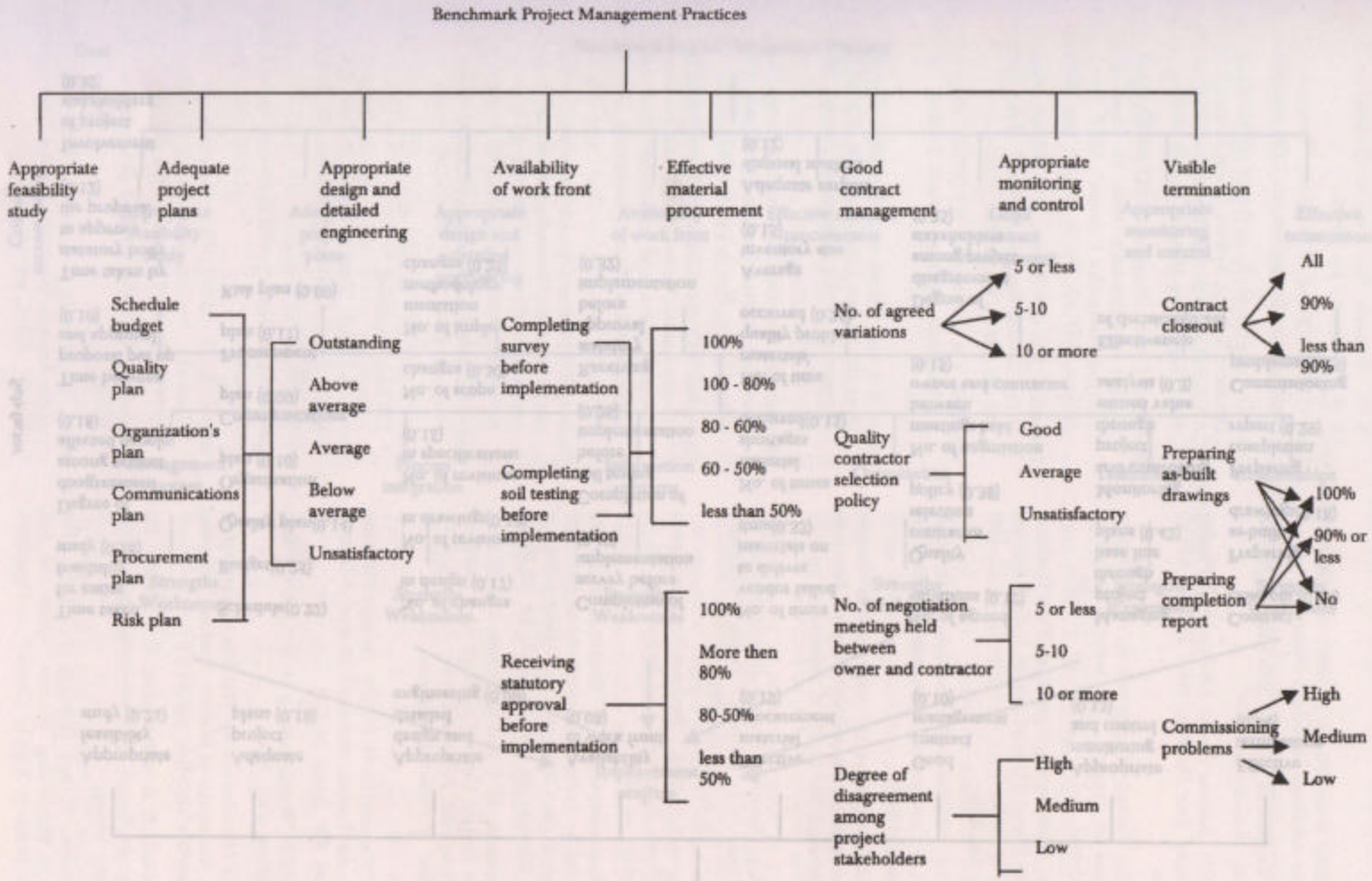


Exhibit 4: The Weightage of Critical Success Factors and Sub-factors in AHP

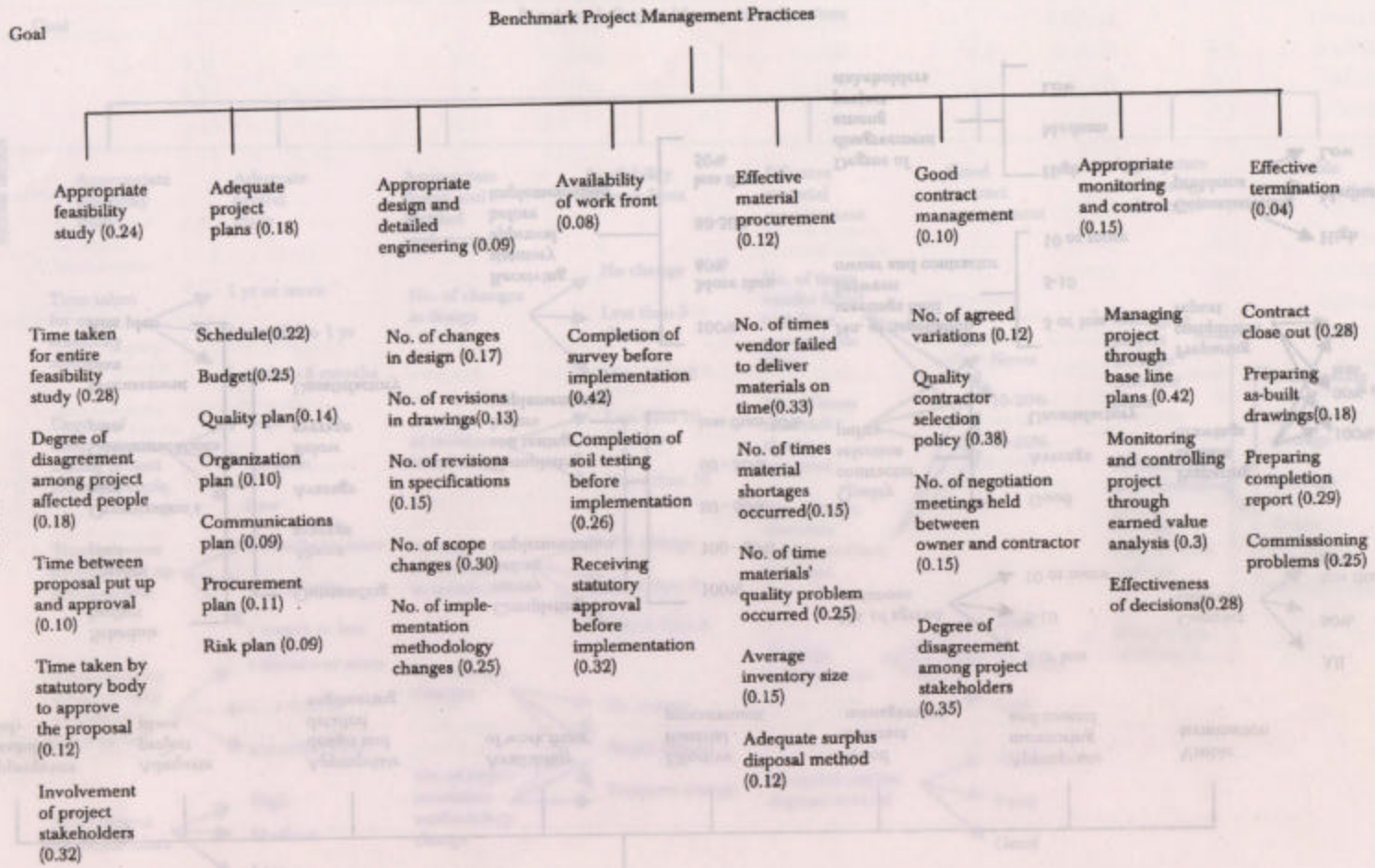
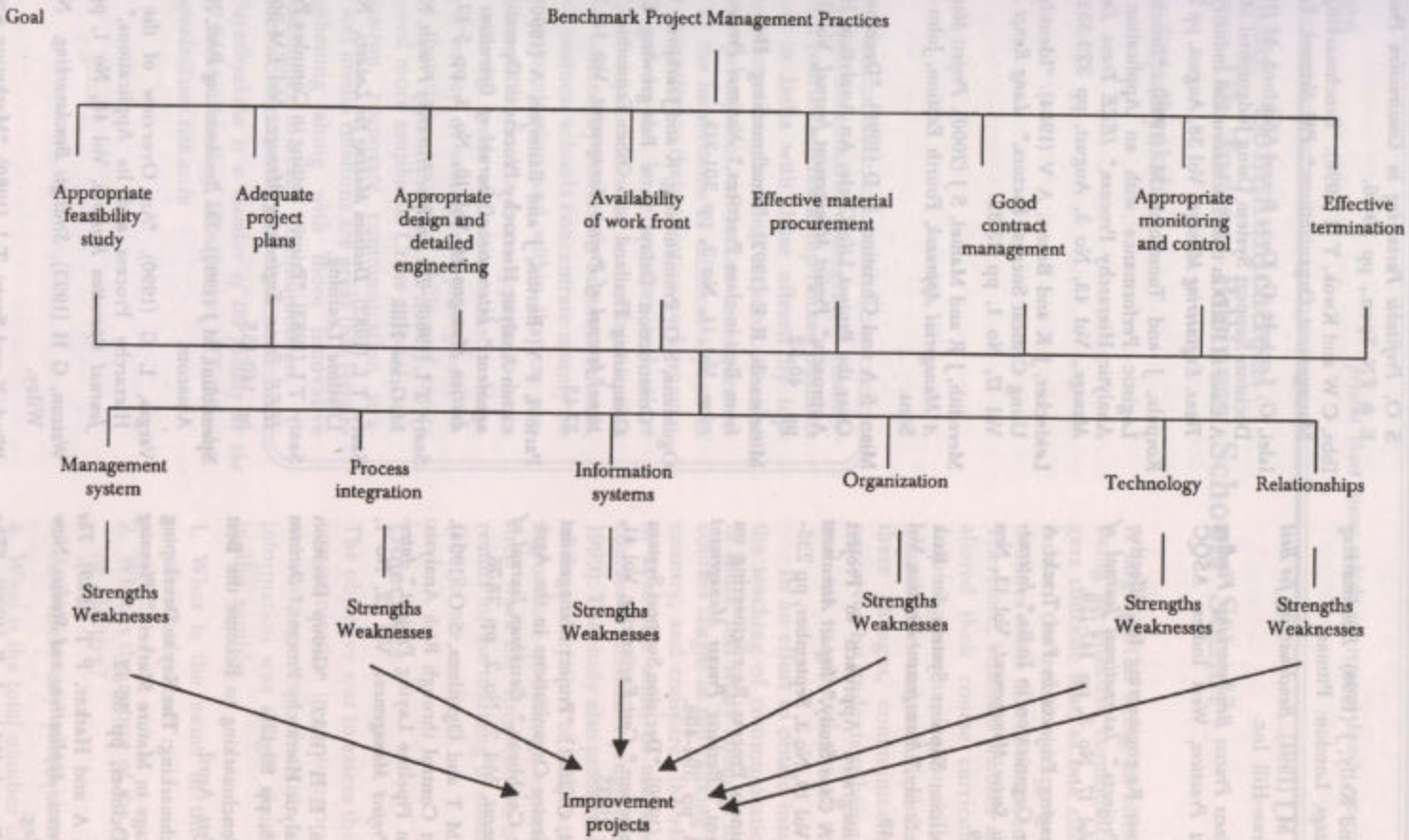


Exhibit 5: AHP Hierarchy with Enablers for Improved Performance



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