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Selection of project manager in a large-scale enterprise: an analytical hierarchy process approach

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Abstract: The success of large-scale businesses depends on choosing a qualified project manager. The paper identifies the important aspects and criteria that influence this process and provides a systematic framework for selection of suitable project manager. The Analytical Hierarchy Process (AHP), a multi-criteria decision-making process, was used as the research technique. Project managers working on ongoing projects across the country provided the data for this study. A total of 36 responses, complete in all forms is used for the study. The literature review shows that a project manager shall have three essential skills viz. technical skills, organisational skills and behavioural skills. The analysis shows that out of these skills, the technical skill is most important for success of a project manager followed by organisational skill and behavioural skill. The weights of skill set are combined with the competency of each project manager applicant to select the best suited project manager.

Keywords: project manager selection; AHP; analytical hierarchy process; multi-criteria decision making; criteria prioritisation; technical skill; organisational skill; behavioural skill.

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1 Introduction

Project management is an organised method for achieving particular goals within a predetermined time limit and with the available resources. A project, according to the Project Management Institute (PMI), is a brief undertaking made to provide a special good, service or outcome. It often entails a collection of coordinated actions, activities and stakeholders coming together to achieve a particular objective.

One of the most extensively used sources on project management, the PMBOK® (Project Management Institute, 2023) Guide (Project Management Body of Knowledge), defines a project as 'a temporary endeavour undertaken to create a unique product, service, or result'. By emphasising the fact that projects are temporary and have set beginning and ending dates, it emphasises this point. To produce good outcomes, projects need thorough preparation, execution, and monitoring. They involve a number of connected tasks, frequently with dependencies and call for efficient time, resource and risk management. Agile and Waterfall project management approaches, e.g., offer frameworks for planning and directing projects towards their targeted goals. In order to successfully complete the project and meet the project objectives, particularly those related to time, cost, scope and quality, project management requires applying skills and procedures to the project operations. Projects by their very nature are unique and can involve difficult decision-making processes. According to Afshari and Kowal (2018), selecting a project manager is one of the most important decisions that must be made. The need for selecting a highly experienced individual for such a position is highlighted by the fact that project managers make the majority of the decisions. The selection procedures follow various standards and must align with the company's policies, goals and particular initiatives. The Project Manager abilities have a significant impact on a project success. According to numerous previous studies Al Khalil (2002); Meade and Presley (2002); Kim and Huynh (2008) and Toor and Ogunlana (2008), one of the key success aspects of a project is having a knowledgeable and qualified project manager who can lead, direct and manage the project. However, a number of project sponsors and other stakeholders may be involved in the decision-making process for choosing a project manager. Additionally, because choosing a project manager entail evaluating potential candidates for multiple desirable competencies based on human judgement, all factors for project manager selection are not easily quantifiable. It is because one of the primary concerns of company management is enhancing organisational performance

(Heumann, 2020). As a result, the decision-making process for choosing a project manager takes into account a variety of factors, including both tangible and intangible qualitative and quantitative criteria. Therefore, a multi-criteria or multi-objective decision-aiding techniques that can be successfully used in such a decision-making environment is the Analytical Hierarchy Process (AHP) (Ünal and Güner, 2009; Tan et al., 2010; Vinodh et al., 2011).

Planning, organising and managing resources are all part of the discipline of project management, which is used to successfully achieve particular project goals and objectives. To provide desired results within the allotted time, money and scope, it requires excellent coordination of tasks, schedules and stakeholders. In order to identify and define project requirements, develop project plans, allot resources, track progress and reduce risks, project management relies on an organised methodology. It includes a number of procedures, including initiating, planning, carrying out, controlling and closing. The efficient use of resources and successful completion of projects on schedule and within budget are ensured by effective project management. In order to successfully complete the project and meet the project objectives, particularly those related to time, cost, scope and quality, project management requires applying skills and procedures to the project operations. Projects by their very nature are unique and can involve difficult decision-making processes. The project manager's abilities have a significant impact on a project's success. According to numerous previous studies Al Khalil (2002); Meade and Presley (2002); Kim and Huynh (2008) and Toor and Ogunlana (2008), one of the key success aspects of a project is having a knowledgeable and qualified project manager who can lead, direct and manage the project. However, a number of project sponsors and other stakeholders may be involved in the decision-making process for choosing a project manager. Additionally, because choosing a project manager entail evaluating potential candidates for multiple desirable competencies based on human judgement, all factors for project manager selection are not easily quantifiable. As a result, the decision-making process for choosing a project manager takes into account a variety of factors, including both tangible and intangible qualitative and quantitative criteria. Therefore, a multi-criteria or multi-objective decision-aiding techniques that can be successfully used in such a decision-making environment is the Analytical Hierarchy Process (AHP) (Ünal and Güner, 2009; Tan et al., 2010; Vinodh et al., 2011).

2 Literature review

The Analytical Hierarchy Process (AHP) methodology is specifically applied to the context of large-scale enterprise project manager selection in this paper. While AHP has been applied extensively in many decision-making contexts, choosing the suitable project manager is a relatively new use for it. Through the application of AHP in this particular context, the paper contributes to the body of literature by showcasing the efficacy and relevance of AHP in handling intricate project management decision problems. The paper acknowledges that choosing a project manager involves many factors, incorporating them into the decision-making process. Choosing a project manager entail taking into account a number of criteria, including domain knowledge, communication

prowess, leadership qualities and technical proficiency. This paper adds to the literature by offering a comprehensive set of criteria that goes beyond single-factor assessments in project manager selection. The study consists of the information about Project Managers A, B, C along with their respective skill sets required for the successfully completing any given project in an organisation. There is paired comparison of the priority level of skill usage used by the project managers.

2.1 Project and Project Manager

A project is a work effort that is made to provide a certain good, service or outcome. A successful project depends on the quality of people employed in it. According to Slevin and Pinto (1987) and Munns and Bjeirmi (1996), a project's fundamental features are its temporary nature, originality and progressive development. In order to produce the intended output within the limitations of time, cost and quality while also achieving other performance requirements, a project must be planned, organised, monitored and controlled (APM, 2012). In addition, customers have also placed higher demand on product and service quality. As organisations increasingly organise business activities as projects to fulfil their strategic objectives, the relevance and value of the project management discipline have shown an increasing trend (Midler, 1995; Whittington et al., 1999; Ekstedt et al., 2003). This has led to the higher restructuring of the organisation. Now organisations are focusing on recruiting skilled project manager in order to run successful projects. According to Crawford (2000) more organisation is adopting project management as regular task to deliver work and so the demands of the project manager grow as there is an increasing interest in the skills of the project managers. The competency and effectiveness of the employees present in the project mainly forms as the vital component for a successful project (Sommerville and Dalziel, 1998; Belout and Gauvreau, 2004; Duy Nguyen et al., 2004; Toor and Ogunlana, 2008). Apart from that the project manager's skills set, their contribution also matters to a higher standard (Kerzner, 1987; Sommerville and Dalziel, 1998; Chua et al., 1999; Odusami, 2002; Belout and Gauvreau, 2004; Duy Nguyen et al., 2004; Toor and Ogunlana, 2009). Because a particular project managers skills are correlated with the kind of project, he or she works on the approach suggests that the successful accomplishment of an organisational goals depends on three basic skills of the project manager. The three basic developable skills are human, conceptual and technical skills. These skills can be developed and used irrespective of interrelation among them. The above approach of Katz (1955, 1991) applied with some modification in the context of the projects. According to Katz (1991) and El-Sabaa (2001) provided an analytical framework for choosing project managers. Each of these key skill categories was broken down into smaller skill categories in research by El-Sabaa (2001). A project manager has various different perspective which influences their skills and abilities which reflects in their work. With a different perspective, Keil et al. (2013) created a list of 48 different skills for project managers and categorised them into 10 skill groups. Team administration, business expertise, communication, interpersonal skills, technical abilities, project management, personal characteristics, organisational, problem-solving skills and professionalism are among the skill categories for project managers identified by

Keil et al. (2013). He offered seven competency categories: personal qualities, communication, leadership, negotiating, professionalism, social skills and project management competencies.

However, this research follows Katz's (1991) methodology and makes use of El-Sabaa's (2001) conceptualisation of project management competencies. As a result, the study's critical or major project manager abilities extracted for the research work are Technical Skill set, Organisational Skill set and Behavioural Skill Set.

2.2 Technical skill set

Technical talent, as defined by Katz (1991), is the capacity to comprehend and use particular activities by applying particular tools, techniques, procedures, methods or tactics to carry out the work. Fotwe and McCaffer (2000) and Brill et al. (2006) highlighted various tools and techniques out of which they emphasised on the importance of business understanding and effective task management using appropriate techniques and usage of technology assets and computer usage in managing projects effectively. While Brill et al. (2006) stated that Proposal writing is one of the important skills. Walker (2006) said technical skill, when utilised in the context of a project, signifies the capacity of the project managers to comprehend and employ pertinent tools, methods, processes, procedures or techniques that correspond with the project's application area for effective project output. According to Badawy (1995), technical skills are essential for first-tier managers because they enable them to interact successfully with subordinates, verify the validity of their choices and make program-level choices based on their input. Technical expertise is seen as a very significant managerial trait, particularly in teams that perform well and in the beginning stages of a project. According to El-Sabaa (2001), the technical skill of a project manager may be divided down into specific expertise in the application of tools and techniques, project knowledge, understanding of methodologies, processes and procedures, required technology, and skills for utilising at work. Lampel (2001) and Britt et al. (2006) also emphasised on project estimate and project mission as important technical skills for a successful execution of a project.

2.3 Organisational skill set

According to Katz (1991), conceptual talent is the administrator's capacity to view an organisation as a whole. This ability is demonstrated within the framework of the project by the project manager's ability to view the project in its entirety, taking into account all of its components as well as its connections to the performing organisation. Fotwe and McCaffer (2000) understood the significance of creativity and innovation in project management by relating creativity and innovation to project management practices. Again, they along with Lampel emphasised the importance of effective task management, Handling Complex Situation and Dispute & Conflict Resolution, to be a decisive factor in project management. McCaffer (2000) foster the importance of reasoning ability and communication in effective project management decision-making. Additionally, the project is a holistic effort made up of various interrelated areas and services to customers.

As a result, the project manager's capacity to understand the interrelationships of various tasks and impact of those activities. El-Sabaa (2001), taking these factors into consideration, converted Katz's (1991) conceptual skill into a conceptual and organisational talent that helps the project manager advance the welfare of the project and enhancing the performance of the organisation. According to El-Sabaa (2001), a project manager's organisational skills can be broken down into planning, organising, strong goal orientation, ability to see the project as a whole, ability to visualise the project's relationship with the industry and community, and strong problem orientation skills. Fisher (2011) also emphasised the importance of effective dispute and conflict resolution in project management. It is further supported by the project manager's capacity to understand the connections between a specific project and the operating parent organisation. The ability to adapt and solve problems are two more important behavioural abilities for project managers.

2.4 Behavioural skill set

A project manager's ability to lead and manage teams, communicate with stakeholders and traverse challenging project dynamics relies significantly on their behavioural skills. The importance of behavioural skills in the context of project management has been explored by numerous journals and writers. Effective communication abilities are crucial for project managers to set clear goals, settle disputes and promote teamwork among team members, according to a study by Belout and Gauvreau (2004). When communicating project goals and objectives, they stress how crucial active listening, empathy, and clarity are. McCaffer (2000) emphasised on the significance of team building in project management while Fisher (2011) emphasised on building trust among project team members for successful project outcomes. El-Sabaa (2001) highlighted the importance of organising capabilities in managing project resources and activities effectively. Turner and Müller (2003) identified leadership abilities as crucial behavioural characteristics for project managers. They argue that project managers should exhibit transformational leadership like empowering team members, offering direction and fostering a healthy work atmosphere which are all vital aspects of effective leadership. In addition, managing stakeholders is a crucial behavioural competency for project managers. The ability to adapt and solve problems are two more important problem behavioural abilities for project managers. According to Kerzner (1987), project managers need to be able to handle ambiguity, adapt to shifting conditions and proactively recognise and solve project issues. Analytical thinking, decision-making and the ability to for coming up with innovative concepts are all necessary for effective solving. Thomas and Mengel (2008) give importance to the role of emotional intelligence in project management and team dynamics as well as understand the importance of building strong relationships across the organisation for successful project outcomes.

3 Project Manager selection criteria

For businesses, choosing a project manager is essential since it has an immediate impact on the success of initiatives. The primary factors that ought to be taken into consideration while choosing a project manager have been covered by a number of publications and

writers. According to Belout and Gauvreau (2004), technical proficiency should be a key consideration when choosing a project manager. They contend that project managers need to be technically skilled and knowledgeable about the project's industry. This covers knowledge of resource allocation, risk management, budgeting and project planning. The capacity to interact and work together with stakeholders is also recognised as a crucial criterion. Project managers, according to Turner and Müller (2003), should have excellent interpersonal abilities, such as active listening, empathy and the capacity to build professional relationship. Clear communication of project objectives and expectations, as well as consideration of stakeholders' concerns and opinions, are ensured by effective communication. For project managers, having excellent leadership qualities is a crucial selection criterion. Project managers should have leadership skills like the capacity to motivate and motivate people, make choices and manage problems. Team productivity and project results can be greatly influenced by a project manager's leadership style. Another crucial element is the capacity to handle risks and uncertainties. Project managers need to be adept at handling problems and navigating through difficulties and unknowns, according to Kerzner (2017). They should take the initiative to identify risks, create mitigation solutions and modify plans as needed. The project manager's organisational and time management abilities are an additional crucial factor. This involves knowledge on how to allocate resources, prioritise tasks and plan projects. In conclusion, different factors should be taken into account when choosing a project manager to ensure their appropriateness for the position. These requirements include technical proficiency, excellent communication and teamwork skills, leadership qualities, risk management expertise and time management and organisational skills. Organisations can identify people who have the skills needed to lead and complete successful projects by taking these criteria into account.

Table 1 Skill set with criteria list for project manager

Variable	*Skills Explanation*	*Reference*
	Technical skill set	
TSS1	Techniques & Tools	Lampel (2001); Fotwe and McCaffer (2000); Brill et al. (2006)
TSS2	Proposal Writing	Brill et al. (2006)
TSS3	Technology Assets	Lampel (2001)
TSS4	Computer Usage	El-Sabaa (2001)
TSS5	Project Estimates	Lampel (2001)
TSS6	Business Understanding	Fotwe and McCaffer (2000)
TSS7	Project Mission	Brill et al. (2006)

Table 1 Skill set with criteria list for project manager (continued)

Variable	*Skills Explanation*	*Reference*
	Organisational skill	
OSS1	Creativity & Innovativeness	Fotwe and McCaffer (2000); Kerzner (2017)
OSS2	Reasoning Ability	Fotwe and McCaffer (2000)
OSS3	Effective Task Management	Fotwe and McCaffer (2000); Lampel (2001)
OSS4	Guided by Goal	El-Sabaa (2001)
OSS5	Handling Complex Situation	Lampel (2001)
OSS6	Effective Communication	Fotwe and McCaffer (2000); Fisher (2010)
OSS7	Negotiation & Persuasion	
	Behavioural skill	
BSS1	Dispute & Conflict Resolution	Lampel (2001); Fisher (2010)
BSS2	Team Building	Fotwe and McCaffer (2000); Fisher (2010)
BSS3	Building Trust	Fisher (2010)
BSS4	Emotional Intelligence	Thomas and Mengel (2008)
BSS5	Build Organisational Relationship	Thomas and Mengel (2008)
BSS6	Organising Capabilities	El-Sabaa (2001)

3.1 Project management and multi criteria decision making (MCDM)

Making decisions that affect a project's success and consequences is a common part of project management. Project managers can benefit from using the Multi-Criteria Decision Analysis (MCDA) method to help them make wise and sensible decisions. Numerous publications and writers have explored the relationship between project management and MCDA, highlighting its advantages and uses. Vaidya and Kumar (2006) cover the integration of MCDA in project management in their research study. They promote the use of MCDA approaches, such as the Analytic Hierarchy Process (AHP) and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), to prioritise project objectives, weigh the pros and cons of different alternatives and agree on the best course of action. Project managers can methodically evaluate choices and make decisions based on in-depth analysis by taking into account different criteria and allocating weights to them. For assessing project proposals, analysing their relative merits and allocating resources to maximise portfolio value, MCDA offers a structured framework. There are multiple MCDM methodologies which can be applied to a wide variety of decision problems in various application areas (Kahraman et al., 2003; Kulak et al., 2005; Gaudenzi and Borghesi, 2006; Hwang and Yoon, 2012).

Belton and Stewart's (2002) second study investigated the use of MCDA in project risk management. They contend that project managers may evaluate and reduce project risks using decision analysis approaches, such as MCDA. Project managers can reduce project risks and increase project success by taking into account a variety of factors, such as likelihood of occurrence, impact on project goals and available risk mitigation measures. Additionally, the writers of a study work by the name of Brans and Vincke (1985) examined the application of MCDA in project scheduling. For project scheduling

and resource allocation, they suggest a multi-criteria technique known as Preference Ranking Organisation Method for Enrichment Evaluations (PROMETHEE). In order to optimise project timelines and resource allocation choices, PROMETHEE enables project managers to take into account a variety of factors, including project duration, resource requirements and stakeholder preferences. So, MCDA integration in project management gives project managers a disciplined and methodical approach to decision-making. Project managers can prioritise goals, assess alternatives, manage risks, distribute resources and streamline project schedules by taking into consideration a variety of criteria and applying various MCDA methodologies.

3.1.1 Analytical hierarchy process (AHP)

Thomas L. Saaty is credited with developing the AHP, a strategy for assisting decision-making (Saaty, 1990a, 1990b). It is a systematic strategy that, using a decision-maker's judgement, quantifies relative priorities for a given set of possibilities. It is used to resolve dilemmas involving choices where some of the factors are qualitative and challenging to quantify explicitly (Saaty, 1990a, 1990b). AHP offers an efficient solution to such problems for a number of reasons that can be emphasised in the context of your previous research paper on the subject. First of all, an organised and methodical approach to decision-making is made possible by AHP. Additionally, AHP emphasises consistency when evaluating options during the decision-making process. The advantage of AHP is that it may systematically take both tangible and intangible variables/factors into account. In AHP, pairwise comparison judgements are made after a structured breakdown of the decision problem that descends from top to bottom (Ahire and Rana, 1995; Al-Tabtabai and Thomas, 2004; Banuelas et al., 2006). AHP has been used to solve a variety of choice issues with great acceptance. Additionally, by logically segmenting a problem into smaller and smaller pieces, one can connect the little to the large by taking straightforward steps (Cheng et al., 2002; Dey and Ogunlana, 2004; Daim et al., 2012). Saaty and Vargas's (2012) studied used AHP to choose project managers for building projects based on attributes like experience, technical expertise, leadership and communication skills. The most appropriate project managers were found through the comparison and weighting of these criteria made easier by the AHP methodology. Akincilar and Isiksal (2014) investigated the application of AHP in the selection of project managers for IT projects in a different research study. Technical competencies, project management skills, and team management abilities were among the criteria that the study took into consideration. Decision-makers were able to select project managers with the necessary qualifications by using AHP to objectively evaluate and rank the candidates. Furthermore, AHP permits sensitivity analysis, which aids in evaluating the decision results' robustness (Vargas,1990). Decision-makers can investigate how modifications to the judgements and criteria weights affect the final decision outcome by using sensitivity analysis. This analysis helps address uncertainties or potential biases and offers insights into the stability and reliability of the decision. So precisely The Analytic Hierarchy Process (AHP) method divides complex problems into a hierarchical structure of criteria and sub-criteria, offering an organised approach to decision-making. This enables decision-makers to examine and assess the options in a methodical manner using a variety of criteria. Using AHP, decision-makers can prioritise or give the criteria different weights according to how important they are. This aids in determining each criterion's relative importance during the decision-making process. By doing this, it guarantees that all pertinent variables are taken into account and that no important criteria

are missed during the selection process. Pairwise comparisons, in which decision-makers weigh each criterion or alternative against others according to relative performance or importance, are the foundation of AHP. This procedure aids in the quantification of personal preferences and judgements, offering a more rigorous and reliable foundation for decision-making. AHP has a consistency analysis step that verifies the decision-maker's conclusions made during the pairwise comparisons are consistent. In order to increase the validity and reliability of the decision-making process, this analysis assists in locating and resolving any contradictions or inconsistencies in the decision-maker's conclusions.

AHP aggregates the ratings and weights given to every criterion and option using a mathematical model. The final ranking or prioritisation of the options is the result of this aggregation process, which offers a precise and impartial foundation for choosing the best project manager or methodology.

AHP distinguishes itself in project manager selection by employing a mathematical model to compile evaluations and rankings of criteria and alternatives, enabling the generation of a final ranking or prioritisation. This aggregation process ensures a clear and objective basis for choosing the most suitable project manager. In contrast, other decision-making processes may lack a systematic aggregation mechanism, resulting in arbitrary or unclear decision outcomes.

AHP's structured approach utilises a hierarchical framework, allowing decision-makers to break down the problem into criteria and sub-criteria for thorough analysis. Pairwise comparisons are employed to quantify subjective judgments and preferences, promoting a rigorous and consistent decision-making process. Furthermore, AHP includes a consistency analysis step, identifying and resolving any inconsistencies in judgments to enhance the reliability and validity of the decision.

By assigning relative weights to criteria, AHP captures the importance of each criterion and avoids overlooking critical factors. The mathematical model employed in AHP aggregates these evaluations and rankings, facilitating a comprehensive assessment of the alternatives. In contrast, other decision-making processes may lack explicit weight assignments, leading to difficulties in prioritising criteria and potentially neglecting essential aspects of project manager selection.

The aggregation process in AHP allows decision-makers to objectively compare and rank the alternatives, ensuring clarity in the final decision. In contrast, decision-making processes without a methodical aggregation mechanism may yield subjective or ambiguous results, hindering the selection of the most appropriate project manager.

In summary, AHP's mathematical model-driven aggregation process sets it apart from other decision-making processes, offering clear and objective outcomes in project manager selection. Its structured approach, pairwise comparisons, consistency analysis and consideration of relative weights contribute to a more rigorous and comprehensive decision-making process.

The use of a judgement scale to give pairwise comparisons numerical values is a crucial aspect of the AHP approach. Saaty's fundamental scale, which gives verbal descriptions for each numerical value, is frequently used to represent the scale. As an illustration, a value of 1 denotes equal importance, a value of 3 denotes moderate importance, a value of 5 denotes great importance, and so forth. The scale enables decision-makers to communicate their choices in a clear and consistent manner. An AHP diagram is a hierarchical structure that is frequently used to visually describe the AHP process. The figure shows how the primary objective, criteria and options are arranged in a hierarchy. Typically, it is organised in the shape of a tree, with the main goal at the top,

the criteria branching off from it, and the alternatives branching off from the criteria. Each criterion or alternative's priority weights may be represented by the branches' thickness or length. As a decision-making technique, the Analytic Hierarchy Process (AHP) facilitates the structured and methodical evaluation of criteria and alternatives. AHP assists decision-makers in making well-informed decisions based on a combination of subjective judgements and objective information by doing pairwise comparisons and determining priority weights. The aggregation procedure establishes the overall precedence of alternatives, and the consistency check verifies the accuracy of the judgements. Project management is one of the many areas where the AHP technique, combined with its process, algorithm and diagram, offers a useful tool for making complicated decisions.

Table 2 Pairwise comparison scales for AHP preferences

	The fundamental scale	
Intensity of importance on an absolute scale	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Moderate importance of one over another	Experience and judgment strongly favour one activity over another
5	Essential or strong importance	Experience and judgment strongly favour one activity over another
7	Very strong importance	An activity is strongly favoured and its dominance demonstrated in practice
9	Extreme Importance	The evidence favouring one activity over another is of the highest possible order of affirmation
2,4,6,8	Intermittent values between the 2 adjacent judgements	When compromise is needed
Reciprocals	If activity *i* has one of the above numbers assigned to It when compared with activity *j*, then j has the reciprocal value when compared with *i*	
Rational	Ratios arising from the scale	If consistency were to be forced by obtaining '*n*' numerical values to span the matrix

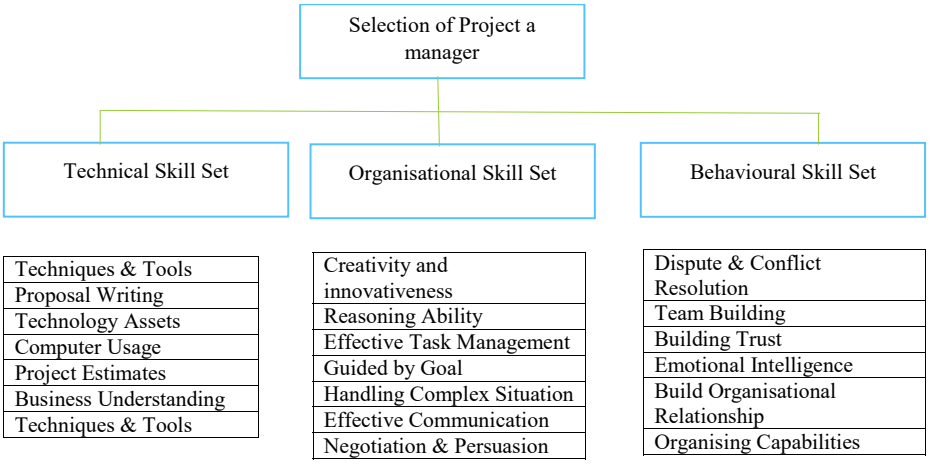
Source: Saaty (1990a, 1990b).

4 Conceptual framework for the study

The mentioned study takes help from AHP methodology for selection of the most suitable project manager from a pool of candidates. It is constructed majorly into a three-level hierarchical structure:

The first level, 'major criteria for selection for project manager,' highlights the significance the primary abilities that make up the major selection criteria that are related to each other. It consists of technical skill, organisational skill and behavioural skill. The second level, 'sub-selection criteria for project manager,' analyses the relative weightage given to each secondary skill that is a sub-selection criterion for each primary ability that is a major selection criterion. The third stage, or 'choice level,' evaluates prospective managers based on both major selection criteria and sub selection criteria. The Figure 1, shows the Important skill set and sub-criterion under the study.

Figure 1 Criteria for technical, organisational, behavioural skill sets



5 Research methodology

The questionnaire was developed as per the conceptual framework of the study as described above. The initial questionnaire consisted of pairwise comparison of items to be filled by the participants. In the first segment, which dealt with 'major selection criteria for project manager' as technical skills, organisational skills and behavioural skill were to be compared in pairs. The second part of the questionnaire asked about 'sub-selection criteria for project manager' under the heading of 'technical skill', which was the first important selection criterion and required pairwise comparisons between sub-skills. Same is repeated for 'organisational' and 'behavioural skills'. The third section of the questionnaire asked for 'sub-selection criteria for project manager' under the second main selection criterion of organisational skill, where pairwise comparisons between subskills organisational skill were to be made. The fourth section of the questionnaire asked for 'pairwise comparisons between behavioural sub-skills'. The preliminary questionnaire was validated by 6 project professionals. The respondents were asked to compare major skills and sub-skills under each major skill in a pairwise using their professional judgement. A 9-point relational importance scale was also used to indicate the relative preference/importance of one skill compared to another in a pairwise

comparison (9-point's relational importance scale (9: extremely preferred; 8: very strongly to extremely; 7: very strongly preferred; 6: strongly to very strongly; 5: strongly preferred; 4: moderately to strongly; 3: moderately preferred; 2: equally to moderately; 1: equally preferred).

The study's data was gathered from active project professionals around the nation. For the purpose of gathering data, 100 questionnaires in total were issued. After the data is collected 36 responses were used for the study, rest were discarded for its incompleteness. The simple average method is used to consolidate the responses.

6 Data analysis and interpretation

The Table 3, below shows the comparison matrix of three important criterions identified for the study.

Table 3 Criteria wise comparison

	Technical skill set	*Organisational skill set*	*Behavioural skill set*	*Priorities*	*Rank*
Technical Skill Set (LSS1)	1	5	8	0.751041	1
Organisational Skill Set (LSS2)	0.2	1	2	0.161807	2
Behavioural Skill Set (LSS3)	0.125	0.5	1	0.087151	3
Consistency Ratio CR = 0.005781					
Principal Eigen Value (PEV) = 3.006					

The above table show the list of skill set (LSS) at higher level and their weightage. The technical skill set is ranked as the most important criterion, with a priority weight of 0.751. The organisational skill set is ranked second in importance, with a priority weight of 0.162, followed by the behavioural skill set which is ranked as the least important criterion, with a priority weight of 0.087.

The Consistency Ratio (CR) is a measure of the consistency of judgments made during the pairwise comparisons. A lower CR indicates a higher level of consistency. In this case, the CR is 0.005781, which is considered low and acceptable. The consistency indices is given by the following formulae:

$$CI = (\lambda \max - n) / (n - 1) \tag{1}$$

where '$\lambda \max$' represents the maximum eigenvalue of the pairwise comparison matrix. 'n' denotes the number of criteria or alternatives being compared. The principal eigenvalue is a measure of the overall priority of the criteria. In this case, the principal eigenvalue is 3.006, suggesting a reasonable consistency in the judgments made.

The Table 4, below shows the comparison matric for sub-criterions of technical set.

Table 4 Technical skill set comparison matrix

	TSS1	*TSS2*	*TSS3*	*TSS4*	*TSS5*	*TSS6*	*TSS7*	*Priorities*	*Rank*
TSS1	1	2	5	4	3	7	9	0.349007	1
TSS2	0.5	1	3	7	2	6	7	0.263285	2
TSS3	0.2	0.333333	1	4	2	5	4	0.14337	3
TSS4	0.25	0.142857	0.25	1	1	6	4	0.083397	5
TSS5	0.333333	0.5	0.5	1	1	3	8	0.103891	4
TSS6	0.142857	0.166667	0.2	0.166667	0.333333	1	2	0.032783	6
TSS7	0.111111	0.142857	0.25	0.25	0.125	0.5	1	0.024267	7

Principal Eigen Value (PEV) = 7.695

Consistency Ratio CR= 0.086473

In the given technical skill set matrix, we have a pairwise comparison of various criteria related to technical skills using the Analytic Hierarchy Process (AHP) method. Techniques & Tools are ranked as the most important criterion, with a priority weight of 0.349. It is observed that proposal writing holds the second position in the priority weightage. While computer Usage, Project Estimates, Business Understanding and Project Mission hold lower importance in comparison. It is interesting to note that Project Mission is considered the least important with priority weight 0.024 in the technical skill set aspect. In this case, the CR is 0.086, which is considered low and acceptable. Principal Eigenvalue in this case, the principal eigenvalue is 7.695, suggesting a reasonable consistency in the judgments made.

Table 5 Organisational skill set comparison matrix

	OSS1	*OSS2*	*OSS3*	*OSS4*	*OSS5*	*OSS6*	*OSS7*	*Priorities*	*Rank*
OSS1	1	2	3	6	7	8	9	0.372753	1
OSS2	0.5	1	5	3	5	7	6	0.272292	2
OSS3	0.333333	0.2	1	2	3	8	3	0.130403	3
OSS4	0.166667	0.333333	0.5	1	4	7	6	0.117683	4
OSS5	0.142857	0.2	0.333333	0.25	1	2	4	0.052265	5
OSS6	0.125	0.142857	0.125	0.142857	0.5	1	1	0.026109	7
OSS7	0.111111	0.166667	0.333333	0.166667	0.25	1	1	0.028495	6

Consistency Ratio CR = 0.079

Principal Eigen Value (PEV) = 7.635

Given organisational skill matrix, we have a pairwise comparison of various criteria related to organisational skills. Creativity & Innovativeness is ranked as the most important criterion, with a priority weight of 0.373. Reasoning ability holds the second position in the priority list. While effective task management, guided by goal, handling complex situation, effective communication and Negotiation & Persuasion hold lower importance in comparison. Effective communication is ranked seventh, with a priority weight of 0.026. In this case, the CR is 0.079, which is considered low and acceptable. The principal eigenvalue is 7.635, suggesting a reasonable consistency in the judgments made.

Table 6 Behavioural skill set comparison matrix

	BSS1	*BSS2*	*BSS3*	*BSS4*	*BSS5*	*BSS6*	*Priorities*	*Rank*
BSS1	1	2	4	6	5	9	0.39178	1
BSS2	0.5	1	6	3	6	8	0.311486	2
BSS3	0.25	0.166667	1	2	4	6	0.12434	3
BSS4	0.166667	0.333333	0.5	1	2	9	0.098149	4
BSS5	0.2	0.166667	0.25	0.5	1	3	0.050651	5
BSS6	0.111111	0.125	0.166667	0.111111	0.333333	1	0.023594	6
Consistency Ratio CR = 0.087957								
Principal Eigen Value (PEV) = 6.551								

In the given behavioural skills matrix, we have a pairwise comparison of various criteria related to behavioural skills. Dispute & Conflict Resolution is ranked as the most important criterion, with a priority weight of 0.392. Team Building holds the second position with 0.311 weight in the list. While Emotional Intelligence, Build Organisational Relationship and Organising Capabilities hold lower importance in comparison. The Organisational capability of the project manager is considered the least important in the Behavioural Skill set aspect. In this case, the CR is 8.8%, which is considered low and acceptable. The principal eigenvalue is 6.551, suggesting a reasonable consistency in the judgments made.

Table 7 Behavioural skill set for Project Manager A

	BSS1-A	*BSS2-A*	*BSS3-A*	*BSS4-A*	*BSS5-A*	*BSS6-A*	*Priorities*	*Rank*
BSS1-A	1	4	3	4	9	9	0.430341	1
BSS2-A	0.25	1	3	3	8	9	0.245905	2
BSS3-A	0.333333	0.333333	1	2	8	9	0.159931	3
BSS4-A	0.25	0.333333	0.5	1	6	8	0.112552	4
BSS5-A	0.111111	0.125	0.125	0.166667	1	2	0.029238	5
BSS6-A	0.111111	0.111111	0.111111	0.125	0.5	1	0.022033	6
Consistency Ratio CR = 0.082831								
Principal Eigen Value (PEV) = 6.519196								

In the behavioural skill set matrix for Project Manager A, we have a pairwise comparison of various criteria related to behavioural skills. Dispute & Conflict Resolution is ranked as the most important criterion for Project Manager A, with a priority weight of 0.430. The Team Building skill set is considered the second most important with a weightage of 0.245. While the Emotional Intelligence & Building Organisational Relationship holds the lower importance in the comparison. And the skill of Organisational Capabilities holds the least important position with a minor weightage of 0.022. In this case, the CR is 0.0828, which is considered low and acceptable, and, the principal eigenvalue is 6.519, suggesting a reasonable consistency in the judgments made.

Table 8 Behavioural skill set for Project Manager B

	BSS1	*BSS2*	*BSS3*	*BSS4*	*BSS5*	*BSS6*	*Priorities*	*Rank*
BSS1	1	4	3	4	5	4	0.405926	1
BSS2	0.25	1	2	4	8	3	0.242507	2
BSS3	0.333333	0.5	1	2	4	3	0.145765	3
BSS4	0.25	0.25	0.5	1	4	3	0.104659	4
BSS5	0.2	0.125	0.25	0.25	1	2	0.049419	6
BSS6	0.25	0.333333	0.333333	0.333333	0.5	1	0.051725	5

Consistency Ratio CR = 0.098395

Principal Eigen Value (PEV) = 6.616753

In the behavioural skill set matrix for Project Manager B, we have a pairwise comparison of various criteria related to behavioural skills. Dispute & Conflict Resolution is ranked as the most important criterion for Project Manager B, with a priority weight of 0.406. While the Team Building skill comes at the second position in this comparison. The skills like Building Trust, Emotional Intelligence & Organisational Capability hold lower importance in the comparison. Building Organisational Relationship skill holds the least important position with a weightage 0.049. The CR is 0.098, which is considered low and acceptable. The principal eigenvalue is 6.617, suggesting a reasonable consistency in the judgments made.

Table 9 Behavioural skill set for Project Manager C

	BSS1-C	*BSS2-C*	*BSS3-C*	*BSS4-C*	*BSS5-C*	*BSS6-C*	*Priorities*	*Rank*
BSS1-C	1	1	5	3	7	8	0.341418	2
BSS2-C	1	1	2	7	8	7	0.347264	1
BSS3-C	0.2	0.5	1	2	2	7	0.132096	3
BSS4-C	0.333333	0.142857	0.5	1	2	9	0.101999	4
BSS5-C	0.142857	0.125	0.5	0.5	1	3	0.051835	5
BSS6-C	0.125	0.142857	0.142857	0.111111	0.333333	1	0.025388	6

Consistency Ratio CR = 0.080691

Principal Eigen Value (PEV) = 6.505777

In the behavioural skill set matrix for Project Manager C, we have a pairwise comparison of various criteria related to behavioural skills Team Building is ranked as the most important criterion for Project Manager C, with a priority weight of 0.347. While the Dispute and Conflict Resolution hold the second position in the priority list. The skill sets like Building Trust, Emotional Intelligence, Build Organisational Relationship hold comparatively lower position in the priority list. The Organising Capabilities hold the least important position with the weightage of 0.0253. The CR is 0.0806, which is considered low and acceptable. The principal eigenvalue is 6.506, suggesting a reasonable consistency in the judgments made. The table-10 shows consolidated priority table for behavioural skill set for all the prospective project manager candidates under consideration.

Table 10 Consolidated priority table for behavioural skill set for all the prospective project manager candidates

Item	*Candidate-A Priority*	*Rank-A*	*Candidate-B Priority*	*Rank-B*	*Candidate-C Priority*	*Rank-C*
BSS1	0.430341	1	0.405926	1	0.341418	2
BSS2	0.245905	2	0.242507	2	0.347264	1
BSS3	0.159931	3	0.145765	3	0.132096	3
BSS4	0.112552	4	0.104659	4	0.101999	4
BSS5	0.029238	5	0.049419	6	0.051835	5
BSS6	0.022033	6	0.051725	5	0.025388	6
	PEV=6.519196 CR=0.082831		PEV=6.616753 CR=0.098395		PEV=6.505777 CR=0.080691	

The priority weights and ranking of the three prospective project managers were calculated in the similar way and shown in Tables 11 and 12.

Table 11 Consolidated priority table for technical skill set for all the prospective Project Manager candidates

Item	*Candidate-A Priority*	*Rank-A*	*Candidate-B Priority*	*Rank-B*	*Candidate-C Priority*	*Rank-C*
TSS1	0.409291	1	0.448551	1	0.259794	1
TSS2	0.139927	3	0.206057	2	0.215278	2
TSS3	0.144659	2	0.12213	3	0.171742	3
TSS4	0.118689	4	0.095083	4	0.170125	4
TSS5	0.091173	5	0.056056	5	0.08712	5
TSS6	0.057483	6	0.040065	6	0.047349	7
TSS7	0.038778	7	0.032058	7	0.048593	6
	PEV=7.681964 CR= 0.084843		PEV=7.81409 CR=0.101693		PEV=7.735037 CR=0.091445	

Table 12 Consolidated priority table for organisational skill set for all the prospective Project Manager candidates

Item	*Candidate-A Priority*	*Rank-A*	*Candidate-B Priority*	*Rank-B*	*Candidate-C Priority*	*Rank-C*
OSS1	0.347405	1	0.46967	1	0.415458	1
OSS2	0.260532	2	0.178916	2	0.187748	2
OSS3	0.13145	3	0.111216	3	0.158974	3
OSS4	0.109945	4	0.07168	5	0.055141	6
OSS5	0.06185	5	0.050015	6	0.057667	5
OSS6	0.057097	6	0.086153	4	0.094272	4
OSS7	0.03172	7	0.032349	7	0.030739	7
	PEV= 7.790262 CR= 0.098316		PEV= 7.62432 CR= 0.077671		PEV= 7.667684 CR= 0.083066	

The Table 13 shows the consolidated comparison of criteria, sub criteria and weight

Table 13 Consolidated comparison of criteria, sub-criteria & weight

LSS	*TSS*	*OSS*	*BSS*	*TSS-A*	*OSS-A*	*BSS-A*	*TSS-B*	*OSS-B*	*BSS-B*	*TSS-C*	*OSS-C*	*BSS-C*
	0.35	0.37	0.39	0.41	0.35	0.43	0.45	0.47	0.41	0.26	0.42	0.34
0.75	0.26	0.27	0.31	0.14	0.26	0.25	0.21	0.18	0.24	0.22	0.19	0.35
0.16	0.14	0.13	0.12	0.14	0.13	0.16	0.12	0.11	0.15	0.17	0.16	0.13
0.09	0.08	0.12	0.10	0.12	0.11	0.11	0.10	0.07	0.10	0.17	0.06	0.10
	0.10	0.05	0.05	0.09	0.06	0.03	0.06	0.05	0.05	0.09	0.06	0.05
	0.03	0.03	0.02	0.06	0.06	0.02	0.04	0.09	0.05	0.05	0.09	0.03
	0.02	0.03		0.04	0.03		0.03	0.03		0.05	0.03	

Weighted Score for Project Manager A = 0.75*(sum product(TSS,TSS-A)) +0.16*(sum product(OSS, OSS-A)) + 0.09*(sum product(BSS, BSS-A))

So, Weighted Score for Project Manager A = 0.75*(0.35*0.41+0.26*0.14 + 0.14*0.14+0.08*0.12+0.10*0.09+0.03*0.06+0.02*0.04)+ 0.16*(0.37*0.35+0.27*0.026+ 0.13*0.13+0.12*0.11+0.05*0.06+0.03*0.06+0.03*0.03)+ 0.09*(0.39*0.43+0.31*0.25+ 0.12*0.16+0.10*0.11+0.05*0.03+0.02*0.02) = 0.229647 Similarly, the Weighted Score for Project Manager B and C can be calculated as below:

Weighted Score for Project Manager B= 0.75*(sum product (TSS, TSS-B)) +0.16*(sum product (OSS, OSS-B)) + 0.09*(sum product (BSS, BSS-B)) = 0.24747

Weighted Score for Project Manager C= 0.75*(sum product (TSS, TSS-C)) +0.16*(sum product (OSS, OSS-C)) + 0.09*(sum product (BSS, BSS-C)) = 0.211094

The above calculation consists of the criteria, sub criteria and weightage of the skills for the prospective position of project manager. From the above calculation it is inferred that the Candidate B has the highest score and ranks as first followed by Candidate A and Candidate C in second and third position. So, the candidate B is most suitable for the position of project manager.

7 Conclusion

The paper examines the references from various publications to check the practical implications of selecting the suitable project manager using the Analytic Hierarchy Process (AHP) technique. The paper uses AHP methodology to select the most suited project manager among the three potential candidates for a large-scale enterprise. Three most important skills required for a good project manager is identified as technical skills, organisational skills and behavioural skill. It is observed that the technical skill set is most important skill required for a successful project manager followed by organisational skill and behavioural skill set. At the second level of analysis the importance of dimensions of each of the three-skill set is calculated. At the fourth level of calculation the competency of the three prospective candidates for the project manager position on the different dimensions of the three-skill set is calculated. Finally, the weightage of three skill set is combined with weightage of each dimension of skill set and competencies of the candidates on these skill set to arrive at final conclusion. It is observed that candidate 'B' is most suitable for the job followed by candidate 'A' and 'C', respectively. The paper provides a structured methodology for evaluating and prioritising the key criteria

involved in this decision-making process. The findings of the study highlight the multifaceted nature of project management roles and the diverse skill sets required for success. The paper suggests AHP framework as a systematic approach that can enables decision-makers to weigh the relative importance of each selection criterion based on organisational objectives and project requirements to select the suitable project manager. The methodology not only enhances the transparency of the selection process but also ensures alignment with strategic goals.

8 Implication of practice

The AHP technique is a methodology for making decisions that assists organisations in assessing and ranking alternatives according to a number of criteria. Using the AHP approach when choosing a project manager can have a big impact on how practises are run. Al Khalil (2002) and Meade and Presley (2002) studied the application of AHP in project management contexts, particularly in the selection of project managers. Al Khalil (2002) asserted that the objective evaluation of potential project managers' abilities, competencies and characteristics is made possible by the AHP technique. Decision-makers can quantify the relative relevance of multiple aspects by decomposing the selection criteria into a hierarchical structure and giving weights to each criterion. This strategy makes sure that the decision-making process is grounded in analysis rather than judgement. Meade and Presley (2002) emphasised that the AHP technique offers a methodical framework for assessing and contrasting potential project managers. It enables decision-makers to take leadership potential, relevant experience and technical and interpersonal skills into account. Decision-makers can rank applicants according to their proficiency in disciplines including project planning, risk management, communication and team leadership through pairwise comparisons. According to Kim and Huynh (2008), using the AHP technique to select a project manager has a variety of practical implications. First and foremost, it helps employers locate the ideal candidate with the necessary training and skills. Projects perform better and have a higher chance of success as a result. Second, by enhancing openness and impartiality during the selection process, the AHP approach reduces biases and potential favouritism. This promotes equity and meritocracy throughout the firm. The AHP approach, according to Toor and Ogunlana (2008), influences the overall project outcomes in addition to helping choose the best project manager. They contend that a capable project manager can efficiently coordinate project operations, manage resources and limit risks when they are selected using the AHP method. Project deadlines are therefore more likely to be met, spending is better managed and stakeholder satisfaction is increased. The AHP method's practical ramifications, according to Ünal and Güner (2009), go beyond the current project. They contend that employing AHP to choose a qualified project manager can benefit the organisation as a whole. A talented project manager can advance organisational learning, develop project management procedures and promote knowledge transfer. A project-oriented culture and increased project management maturity can both arise as a result of having competent project managers on the team. So, choosing a project manager using the AHP technique has important practical implications. Organisations can make wise judgements by using a structured and analytical approach that is based on objective standards. The AHP approach aids in the identification of qualified project managers, boosts the success of organisational endeavours, and

improves project outcomes. This approach, as demonstrated by a number of researchers including Al Khalil (2002); Meade and Presley (2002); Kim and Huynh (2008); Toor and Ogunlana (2008) and Ünal and Güner (2009), provides insightful information for organisations looking to improve the efficiency of their project management procedures and project results.

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