



A Review of Recent Skills Required as Engineering Project Managers

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Abstract: Most of the project engineers are presumed to be promoted as the project manager after certain period of services. However, they are required to attain certain qualities in order to manage the project effectively. Hence, this paper summarised several recent skills required for an engineering project managers. This paper relates the role of the engineering project manager with the skills required to accomplish the managerial jobs. The skills are divided into six categories, which are conceptual skills, human skills, political skills, technical skills, negotiating skills and budgeting skills. Each of these skills were discussed with several examples as the reference. It was believed that these skills are needed for the project managers to boost up the management performance, in the real engineering project field, and the findings of this paper could become the appropriate guidelines for the young engineers as the motivation to climb up the promotional ladder as some successful project managers.

Keywords: Engineering skills, project managers, conceptual, human, political, technical, negotiating, budgeting

1. Introduction

Engineering projects require the best quality of project managers to overcome the crisis, ambiguity, and potential risk events. These are the challenges that the project managers need to solve by utilizing the skills and information needed to control the project effectively. Their job is to get everything done by managing a group of people with varieties of backgrounds and behavior [1].

Most of the engineering jobs in the industry will adopt project management as the pillar of a successful project. Nevertheless, the challenge will become more unpredictable and intricate with recent advances in technology. More profound changes required more detailed characteristics of the project managers and engineers, with complicated business correlations, innovative technologies, dissimilar group members, and more diverse stakeholders. The triumph of a project must be realized through the gratification of the budgetary, specification of the performance, and project scheduling. Not only that, mastering the knowledge areas is vital to put a recognized standard in project management information and practice [2].

The responsibility of a project manager is to integrate and coordinate the project, whereby they are the ones who determine the failure or success of certain engineering projects. The control of cost, time, and quality are conventionally influential towards the project's performance [3]. Therefore, it is important to evaluate and acknowledge the skills required of the project manager to be implicit both by those engineers who aspire to become project managers and the personnel responsible for promoting project managers [4].

2. Skills of Engineering Project Managers

Based on some previous findings related to effective managerial skills, six categories of skills are proposed specifically for engineering project managers: conceptual skills, human skills, political skills, technical skills, negotiating skills, and budgeting skills [5-13]. Table 1 summarizes the selected sources of skill assessed for this particular paper. The following subtopics discussed more details about each skill for further reference. Nonetheless, all skills are imperative in all industries. Hence, more explanation was needed to review and analyze other skills required for a project manager, specifically for an engineering project.

Table 1- Skill assessed source

No.	Skill Assessed	Selected Sources	Ref.	
1	Conceptual	Che Ibrahim, C. K. I., Belayutham, S., Mohammad, M. Z., & Ismail, S. (2022).	[6]	
2	Human	Emotional intelligence	Bradberry, T., & Greaves, J. (2009).	[7]
3		Interpersonal skill	Willmot, P & Colman, B., (2016).	[8]
4	Transformational leadership	Carless, S. A., Wearing, A. J., & Mann, L. (2000).	[9]	
5	Political	Ferris, G.R., Perrewé, P.L., Anthony, W.P., and Gilmore, D.C. (2005)	[10]	
6	Technical	Gillard, S. (2009).	[11]	
7	Negotiating	Cohen, Steven P. (2002)	[12]	
8	Budgeting	Kemp, S., & Dunbar, E. (2003).	[13]	

2.1 Conceptual Skill

The importance of conceptual skills was essential for a project manager due to the uniformity of the system with the integration of all elements of a project. Top-notch manager will portray their conceptual skills during management activities. Conceptual skill was defined as “the ability to see the enterprise as a whole and recognize how the organization’s various functions depend on one another and how changes in any one part affect the other” [5].

A typical project manager should be able to conceptualize all elements of the project situation and the extent to which the elements interact with each other. The essential aspect of the executive process is the sensing of the organization as a whole and the situation relevant to it. Through some specific conceptual skills, the strategic manager will be able to detect the dependency of various functions and how small alterations could affect all the other elements of the project. Managers with a high degree of conceptual skills will also have the ability to strategize and resolve management problems. For instance, an automotive company project manager will emphasize the quality and design of their automotive part. During marketing, they can contribute by creating a creative conceptual design because they have more understanding of the automotive parts. For example, a project manager works in the automotive industry that focuses their effort on improving the design and quality of their automotive product. Many of the agency’s creative directors have struggled to turn marketing concepts into campaigns that generate returns on their investments. The problem was linked back to a lack of technical knowledge among the marketing staff and directors, specifically related to the issues in the automotive industry. By thinking creatively and delivering an innovative solution, the project manager with an automotive engineering background could come up with a way to submerge the company’s creative directors into the marketing of automotive products to gain new insights into how to best market its products [2].

Some of the research had proposed an approach to applying conceptual skills among engineering project managers. For instance, a project about the development of a conceptual designer’s knowledge, skills, and experience index for prevention through design practice in construction was carried out in the year 2022 by adopting the Delphi method to obtain a consensus from 59 experts on the key attributes of knowledge, skills, and experience. The conceptual designer’s knowledge, skills, and experience index for the prevention through design practice in construction was then developed based on the hierarchical ranking list of 18 key attributes and their relative weightings [6]. The index of these findings could be beneficial for engineering-related companies to monitor their project manager’s effectiveness, specifically related to conceptual skills.

2.2 Human Skill

There was a debate regarding the relationship between the project manager's dependency on the activities of individuals over whom they have in a project management system and their role as the project manager. The debate emphasizes more the part of resolving conflicts to integrate the project and their task to lead and motivate their team members. Their effectiveness, therefore, pivots the potential to enhance cooperative efforts both among the team members and the stakeholders of the project. As mentioned in a literature review of one journal, it was

expected that project managers were professed to lead some different members with a little control over their subordinates [14]. This condition fits the definition of human skills, “the ability to work effectively as a group member and to build cooperative effort within the team” [5].

The research was conducted to see which skills are the most important among three projects: agricultural, electricity, and information systems. Table 2 shows the percentage of a score of these three main projects related to engineering. The result displays the average score, showing that the most important skills are human skills based on the average score of 85%. The second and third skills are conceptual and organizational (80%) and technical (51%) [1]. Therefore, it can be concluded that human skill is very important in engineering projects.

Table 2 - The percentage average score of most important skills by project [1]

Type of project / Type of skills	Agricultural	Electricity	Information systems	Average score
Human	86%	84%	86%	85%
Conceptual and organizational	77%	83%	79%	80%
Technical	48%	51%	53%	51%

For an engineer, having more human skills is also important as acquiring wide-ranging technical knowledge or specific competencies in technological fields. A project engineer needs to handle management, administration, and team leadership responsibilities. Interpersonal human skills are indispensable for hierarchical relationships. According to Table 1, human skills are divided into three categories: emotional intelligence, interpersonal skills, and transformational leadership.

In terms of emotional intelligence, the engineer project managers must be able to control their emotions and control their subordinates, such as their technicians, line leaders, and operators. They should be able to understand, recognize and manage their emotion to achieve the production target [7]. Interpersonal skills are one of the human skills defined as the behaviors and tactics a person uses to interact with others effectively. It ranges from communication and listening to attitude department. In other words, interpersonal skills are also known as communications skills that need to communicate and interact with other people [8]. Transformational leadership is defined as motivating people by appealing to higher ideals and moral principles. Transformational leaders must be able to communicate and establish a vision for their companies, and followers must believe in the leader's credibility. Six transformational leader behaviors have been identified and expressed by researchers, including recognizing and articulating a vision, providing an appropriate model, cultivating group goal acceptance, high-performance exceptions, providing individual support to employees, and intellectual stimulation [9]

2.3 Political Skill

Some researchers define political skill as “the ability to understand others at work and use that knowledge to influence others to act in ways that enhance one’s personal or organizational objectives.” Political skill-related behaviors include thinking before speaking, managing up, interpersonal encouragement, social wisdom, networking aptitude, and honesty [10].

Based on a book entitled “Project management best practices: Achieving global excellence,” the domination of politics in construction was an example of the need for political skills in projects with multi-stakeholder characteristics. A project manager had a limited base of power. Therefore, they need to have support and guidance from other departments and stakeholders to succeed in achieving the objectives of a project. Political skills are required to strategize and negotiate with others, such as team members, customers, and stakeholders, even with limited resources and power [15].

A recent study of the impact of political skills had discovered that political skill was positively related to self-efficiency, work satisfaction, commitment to the organization, work productivity, career success, and organizational citizenship behavior (OCB), and though negatively related to physiological strain. They also stated that political skills were strongly associated with task performance, which measures the individual's reputation and self-efficacy, indicating partial mediation [16].

2.4 Technical Skill

The demands of infrastructure work require in-depth technical knowledge. It is hard for non-engineering managers to adapt to the technical requirements without a substantial engineering component in their training. Thus, having a readily technical manager will promote an added value for a project. By definition, technical skill is "an understanding of and proficiency in a specific activity, particularly one involving methods, processes, procedures, or techniques. It involves specialized knowledge, the analytical ability within the specialty, and facility in using tools and techniques of the specific discipline"[5].

Technical skills entail specialized knowledge and analytical ability in using tools and techniques specific to a discipline, such as construction engineering or information systems. At the highest levels of management, technical skills are used to develop project plans and make conceptual decisions and focus on the individual decision-making process. Lower-level managers with technical capabilities have the intellectual and practical competence to complete projects and govern duties as if they were employees in that sector [17].

To guarantee that the project system is properly integrated, project managers should thoroughly understand the interplay between the technological system and other project elements. For example, the project manager should understand how different design options would affect the budget, the type of materials, raw material delivery time, the minimal skill level of the operation crew, and other critical areas. Projects are planned and managed by all management. Some projects have a limited scope and are completed by a single department. For example, a marketing plan for a new product may be created by a single person or by members of a single department. Larger initiatives, such as a merger, may include many employees from both inside and outside the company. When the project's scope necessitates forming a project team, members are generally recruited based on their technical knowledge. The field of information technology (IT) is a good example. The requirement for technical skills in systems analysis and design and subject matter experience from functional area departments led to the formation of project teams in the IT industry. Because the initiative's main goal was to design, create, and deploy an information system, project management was generally given to a technical specialist rather than a functional area expert, regardless of leadership abilities [11].

As the field of project management study expands, it is becoming clear that success in project management cannot be achieved solely by technical skills. One of the basic minimum criteria for a project manager is technical knowledge. Although some may disagree, others argue that great interpersonal, or soft skills, are critical requisites for success. These abilities can be taught (and learned) rather than intrinsic or genetic talents. Furthermore, research shows that leading a project team is preferred over managing one and that the project manager's leadership style directly impacts the project's outcome [11].

2.5 Negotiating Skill

The current interest in industrial relations has created a demand for training in the skills of negotiations. Negotiation skills are innate talents that aid two or more parties in reaching an amicable agreement on a rational solution. Agreements, often informal, usually define terms and conditions under which personnel from other functional departments provide inputs to the project. Because of the many expectable situations and condition changes that arise after the project plan has been formulated, almost every term and condition need to be renegotiated during the implementation of the project [12].

The goal of negotiation is to reach an agreement. It's a method for people with different ideas to agree on reconciling their differences of opinion. Because it is assumed that those engaging in a negotiation have some power that they can use, potentially in a disruptive manner, to the disadvantage of others, negotiation is intrinsically related to power. As a result, bargaining can be useful for reaching an agreement between parties with opposing agendas based on their power bases and vested interests to defend. The nature of the bargaining process and the numerous negotiating methods that might be used are well-documented in the literature. "Negotiators aim to increase shared interest and expand cooperation to enlarge the area of an agreement to cover the item under dispute," according to a previous researcher. Negotiating skills can also be demonstrated in the workplace in situations such as negotiating a salary increase with the HR manager after a promotion or first time working at the company, negotiating a project deadline with a client when a problem arises, negotiating a day off for holiday time with the managers, and negotiating contract terms with potential clients or customers [1].

2.6 Budgeting Skill

Budgeting abilities refer to a person's ability to take a proactive approach to manage their personal or company's money. Budgeting abilities entail making conscious decisions regarding money allocation so that expenses do not exceed income. A budget is a tool for keeping track of how much money is spent. Budgeting skills are extremely beneficial in managing money and gaining a better understanding of businesses with sufficient income (incoming funds) to cover expenses. Budgeting skills may aid in setting short- and long-term business growth goals and tracking income, expenses, and cash flow. Aside from that, it aids in cost-cutting to avoid overpaying, planning for busy seasons and slowdowns, and keeping track of funds. The first step in budgeting is to prepare it; the second is to write it, and the third step is to monitor it. Engineers must comprehend what they have been informed about the project's budget. Engineering managers must understand the logical difficulty of project cost overrun to integrate into budgeting effectively. Engineering managers can manage budget efficiency by developing this crucial skill [13].

3. Conclusion

In conclusion, this paper explains the role of the engineering project manager with the skills required to accomplish managerial jobs. The skills are divided into six categories: conceptual skills, human skills, political skills, technical skills, negotiating skills, and budgeting skills. Each of these skills was discussed with several examples as further reference. These skills are believed to be needed for the project managers to boost the management performance in the entire engineering project field. The findings of this paper could become the appropriate guidelines for the young engineers as the motivation to climb up the promotional ladder as some successful project managers.

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