

## Explaining the Competencies of Project Managers According To PMCDF Model

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### Abstract

Today, editing a pattern to evaluate the project management competency based on professional values and principles in order to select, evaluate, and elevate the project manpower will be very effective in the professional excellence and growth in the specialized field regarding project-oriented organizations. For a project manager to perform successfully in a particular area of management, he or she must have the qualifications required in that area. In this regard, this study has tried to explain the model and assess the competencies of the project managers of Mapna Locomotive Engineering and Manufacturing Company based on Project Manager Competency Development Framework (PMCDF) with the aim of developing their competencies. This study conducted in four phases. First, designing and explaining the model of competencies of project managers; second, evaluating the competencies of 17 projects managers of the company based on the model explained; third, identifying the existing gaps; and fourth, presenting improvement programs, training and developing strategies. The results of the study indicate that the statistical population of the research is lower than the ideal level in all areas of competency including knowledge, skill, behavior, organization, and industry and at various project levels 1, 2 and 3 except the industrial competency.

**Keywords:** Project managers competency development framework (PMCDF); Project management body of knowledge (PMBOK); Project managers; Competency.

### 1. Introduction

Overall business success in project-based organizations is tensely related to the project success of the organization (Ekrot & Kock, 2016). One of the main problems in the successful implementation of national projects leading to the loss of many financial and human resources is the lack of qualified managers and project-based organizations to use project management techniques. For a manager to perform well, he/she must acquire the competency and skills required in that field (Teichter, 2007). Project management provides a means to escape mundane operations and move into management (McKevitt et al., 2017). Experience has shown that most managers are very eager to build a framework or model of competency in their organizations but do not know what parameters are needed to build it (Sanghi, 2007).

Project managers always play a vital role in project-oriented organizations. Today, the contribution of prominent managers to organizational revenue, profit, and success are obvious. On the other hand, rapid response to the threats and opportunities of the present era has made project managers a vital resource in resolving organizational problems. In this regard, organizations need project managers and competent senior managers more than ever. For a manager to perform successfully and be considered fit, he/she must acquire the competency and skills required in that field. The relative success rate of each project is directly related to the level of project management skills of the project manager. As the importance of projects grows, the level of individual and group skills of the project management team must also be strengthened (Cohen, 1995). Successful organizations maintain their competitive advantage by developing managerial competencies. Project management competency has a direct, or indirect, impact on the success of the projects (Tabasi et al., 2016).

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As mentioned in the section on literature review, Project Managers' Competency Development Framework (PMCDF) is a guide that helps to develop project managers' competencies. The previous studies have not addressed the issue of how using PMCDF model, project managers' competencies may be evaluated in the first step, and gaps in each of the competency areas and in each of the competency criteria may be identified in the next step, and then a mechanism may be created to not only meet the above needs, but also categorize the required educational courses for the development of project managers based on the identified gaps for each project manager, in a way that each project manager's competencies are developed based on his/her needs, and finally, a methodology may be developed to designate project managers to various levels of the projects based on a proper structure.

In other words, the present research has been conducted with the aim of realizing the following goals, which distinguish it from other studies conducted in this field.

- Evaluating project managers' competencies and identifying the existing gaps
- Creating a systematic mechanism for categorization of the required educational courses based on the conducted gap analysis
- Creating an appropriate structure for designating project managers at various levels of projects

Lack of attention to managers' competencies and uncertainties during different stages of project management is one of the main factors in projects failure to achieve their predetermined goals. The types of competencies defined in the field of project management are similar and differ only in terms of terminology and classification. However, this difference is different from the one in the necessary competency level for the managers. That is, the two types of project managers may require a specific competency in different roles, but the level of competency may vary for each manager (PMI, 2000). The most important point in determining the project managers' competency is that the managers' competencies vary depending on the nature, type, size, or complexity of the projects they are involved in.

Six main goals have been considered to implement the framework of project managers' competencies development model in MAPNA Locomotive Engineering and Construction Company: preparing for systematic and targeted growth of project managers, preparing for the purposeful promotion of project managers, organizing and targeting a comprehensive project management training program, establishing a system for recruiting people to jobs and positions related to project management, establishing a system for evaluation of project managers' performance and getting meeting the International Railway Industry Standard. The present study has no hypothesis and includes questions that will be answered. The main research questions are as follows:

- 1) What is the project manager competency model of MAPNA Locomotive Engineering and Construction Company based on the PMCDF framework?
- 2) What are the complications and implications for the development and competency plans of MAPNA Locomotive Engineering and Construction Company project managers based on the PMCDF framework?

In what follows, first, a review of theoretical and academic discussions about project managers' competencies will be presented. The purpose of this section is to introduce the basics of this field of study to the readers. Then, the existing gaps in project managers' competencies are examined based on the evaluations of each of the competency criteria. Then, by adopting a proper method, the selected model is assessed, tested, and analyzed, which will be presented in detail in the following.

## **2. Theoretical Framework**

In Western literature, competency first came into the management field in 1973 and in the article by MacLand, shortly after the entry into the business environment of organizations (Bayati and Asadi Gharabaghi, 2005). McLand Boyatzis introduced the first competency pattern in the book "Competent Manager" in 1982 (Boyatzis, 1982). The first official standards of competency have been gradually established since 1966. One of the first steps in this regard was the development of an Australian project management competency standard developed by the Australian Institute of Project Management (AIPM) as a performance-based competency standard. Since then, the national standard of project management competency has been designed and developed in many other developed countries such as England, South Africa, Canada, Japan, and New Zealand.

The competence of the project managers is in itself a factor in the successful delivery of projects. On the other hand, the project managers need to have competency in those areas that have the most effect on successful outcomes (Crawford, 2000). Abraham et al. (2001) also define competency as a range of different characteristics, behaviors, and traits that are required for effective job performance (Abraham et al., 2001). According to another definition, ICB.4 (2017) stated that individual competence is the application of knowledge, skills, and abilities to achieve the desired results (ICB4, 2017).

PMCD.3 (Project Manager Competency Development framework) also mentioned that competent project managers consistently apply their project management knowledge and personal behaviors to increase the likelihood of delivering projects that meet the stakeholders' requirements (PMCD.3, 2017). In this paper, the adopted definition is that competency means the capability to use skills, knowledge, and personal characteristics that enhance the efficiency and effectiveness of project managers in their job performance and subsequently increase the likelihood of project success.

Competence is a set of knowledge, individual mindset, expertise, and appropriate understanding required to be victorious in a certain role (IPMA, 2006). A competent project manager is one who is "wise" and acts "rightly" or performs "good" action (Bredillet et al., 2015). A competent project manager can execute a project successfully by adopting and applying different dimensions of competencies. In the literature, different competence models are suggested for project managers to successfully complete projects. For example, Crawford (2000) developed a profile of competent project managers. Project Management Institute presented a Project Manager Competency Development (PMCD) framework in 2002, consisting of three dimensions, i.e. knowledge, performance, and personal competence. Each dimension is further divided into units. Similarly, the International Project Management Association (IPMA) has also developed a competency model known as IPMA Competence Baseline (ICB). According to this model, the project manager's competences are described in three ranges (IPMA, 2006), i.e. technical, behavioral, and contextual competences. Clarke (2010) developed four competence measures, i.e. communication, teamwork, attentiveness, and conflict management. Crawford and Nahmias (2010) concluded that the competencies required for managers to effectively manage change on change projects (IT Project Management Competencies Project Complexity Project Performance implementations in different types of organizations) are leadership, stakeholder management, planning, team selection/team development, communication, decision making and problem-solving, cultural awareness skills, and project management skills. Giammalvo (2012) presented 33 different traits of project managers and classified these traits into essential traits, desirable traits, and killer attributes by using behavioral profiling. Ortiz-Marcos et al. (2013) developed the competence profile of project managers for development and international cooperation projects with seven personal competence dimensions, i.e. result orientation, initiative and problem solving, leadership, cooperative teamwork, interpersonal relations, organizational awareness and commitment, and negotiation and conflict management.

One of the most prominent models in the field of managerial competence is PMCDF in the PMBOK standard framework (PMI, 2002). The model was designed in 1997 and incorporated three areas of project management, knowledge competency, skills competency, and behavioral competency, but in 2006 the PMCDF model was developed with the addition of two dimensions of industrial and organizational competence (Crawford, 2006). Other well-known models of managerial competence include the Slocum et al. model, which includes self-management competency, planning and management competency, strategic action competency, communication competence, teamwork competency, and multicultural competence in the main components of the model (Slocum et al., 2008).

The American Project Management Institute is one of the institutions that has done a lot of research in this area. The institute has designed a guideline entitled project management competency development framework for the general use of all organizations regardless of nature, type, size, or the complexity of their projects. In this guideline, technical competencies are defined in accordance with the nine areas of the project management body of knowledge, business and leadership competencies in four categories, and finally personal competency in six types (PMI, 2007). Besides, in another attempt, International Project Management Association designed and formulated the basis of the international association competency. The Association sets out the expected competencies of project management staff in three dimensions: professional, behavioral, and contextual competence (IPMA, 2006 & Carvalho, 2015). The PMCD standard has developed project management competencies within the PMI and PMBOK standards. This model encompasses all the knowledge, skills, attitudes, and behaviors that the project manager is required to possess to effectively manage projects (Boyatsis, 1982).

There are many definitions of competence and other keywords in this article. Selected definitions can be stated as follows: "Competency" is a combination of knowledge, behavior, and implicit and explicit skills that gives individuals the ability and capacity to perform tasks effectively (Carmendo, Rahoveanu & Vlahov, 2015).

**Project Management Knowledge Competency:** What each project manager provides through his/her project management knowledge and understanding of a project or project-related activity, that is, what they know about project management.

**Project Management Performance Competency:** What each project manager can demonstrate in their ability to successfully manage a project or complete project-related activities; that is, what they are capable of doing or completing by applying their project management knowledge.

**Project Management Personal Competency:** Main personality traits that highlight a person's ability to perform a project or project activities, that is, how they behave, and what their main personality or behavioral characteristics are.

**Project Management Organizational Competency:** The need for project managers to understand the patterns, values, and organizational culture and to strive to achieve them.

**Project Management Industrial Competency:** Project managers' familiarity with related industries and a general understanding of the components of products and services related to that field.

The background of the research on project managers' competencies in organizations can be seen in Table 1:

**Table 1.** Research background of project managers' competencies

<b>Organizational and management competencies</b> (Alam & Gsle, 2010), (Crawford, 2005), (Muzio & Deborah, 2007), (PMI, 2002)	<b>Technical Competencies/projects management competencies</b> (Alam & Gale, 2010), (Crawford, 2005), (Stevenson & Starkweather, 2010), (PMI, 2012)	<b>Human skills /behavioral competences</b> (Alam & Gale, 2010), (Cerimagic, 2010), (Clark, 2010), (Crawford, 2005) (Stevenson & Starkweather, 2010), (PMI, 2012) (Briere, 2014)
Planning and organizing Strong problem orientation Delivering results Strong goal orientation Ability to see the project as a whole Ability to visualize the relationship of the project to industry and community Deciding and initiating action Project orientation programming Orientation portfolio orientation	Project knowledge Special knowledge in the use of tools and techniques Understanding methods, processes, and procedures Skills in the use of computer Project management framework The standard for project management of a project Project management success Interested parties Project requirements and objectives Risk and opportunity Quality project organization Project structure Scope and deliverables Time and project phase Resources, cost, and finance Procurement and contract Control and report Information, documentation Communication PMP certification Technical expertise	Communication Leadership Motivation Negotiation Creativity Ethics Managing group process and team building Mobilizing Coping with the situation Delegating authority High self-esteem Enthusiasm Self-control, assertiveness, relaxation Openness Consultation Conflict and crisis management Personal accountability Attitude and the ability to deal with ambiguity and change Ability to escalate Length of a prior engagement Intuition and imprecision Emotional intelligence Cross-cultural management Problem-solving Adaptation of tools Seeking the commitment of a wide range of stakeholders Empowerment of local population Sustainable development

**2.1. Research Model**

It is worth mentioning that most project management competency standards have been edited regardless of the size, complexity, type of projects, and organizations. Therefore, local standards of competency are required for different environments. In this study, the PMCDF standard of the American PMI Institute has been used as one of the basic assumptions. Accordingly, the areas of project managers' competencies in MAPNA Locomotive Engineering and Manufacturing Company are adapted in five areas including project management knowledge, project management skills, behavioral (individual) characteristics, organizational competencies, and railway industry competencies and explained as follows:

Competency levels in project managers' knowledge: areas of project defining, scheduling and budgeting, scheduling and budgeting management, problem and obstacle management, change management, communication management, risk management, human resources management, quality management, metric management, and procurement management. Competency levels in project managers' skills include project defining, scheduling and budgeting, change management, communication management, risk management, human resources management, quality management, and procurement management. Competency levels in individual and personal characteristics of project managers include characteristics of

achieving goals (fighting for goals), observing discipline at work, accuracy, accountability, opportunism, pioneering in solving the problems, willingness to know more, understanding project partners, adaptation, team-work ability, attempts to improve the project team ability, leadership ability, venture and utilizing power and job authority, analytical thinking and problem solving, conceptual thinking, emotion control, and self-confidence. These competencies refer to inherent traits and are required for all employees, not just individuals engaging in project management. They are essential attributes for any job. (Hanna, et al., 2016) (Dziekondki, 2017). Organizational competency levels of project managers include acting to preserve the patterns and values of the employees, competitors, stakeholders, environment, suppliers, contractors, customers, and citizens. Levels of industrial competencies of project managers include general knowledge of various types of locomotives, general components of locomotives, tensile forces, types of bogies, and types of brake systems in rail vehicles. Designing and explaining the conceptual model of MAPNA Locomotive Engineering and Manufacturing Company project managers' competencies is considered as the basis of this study.

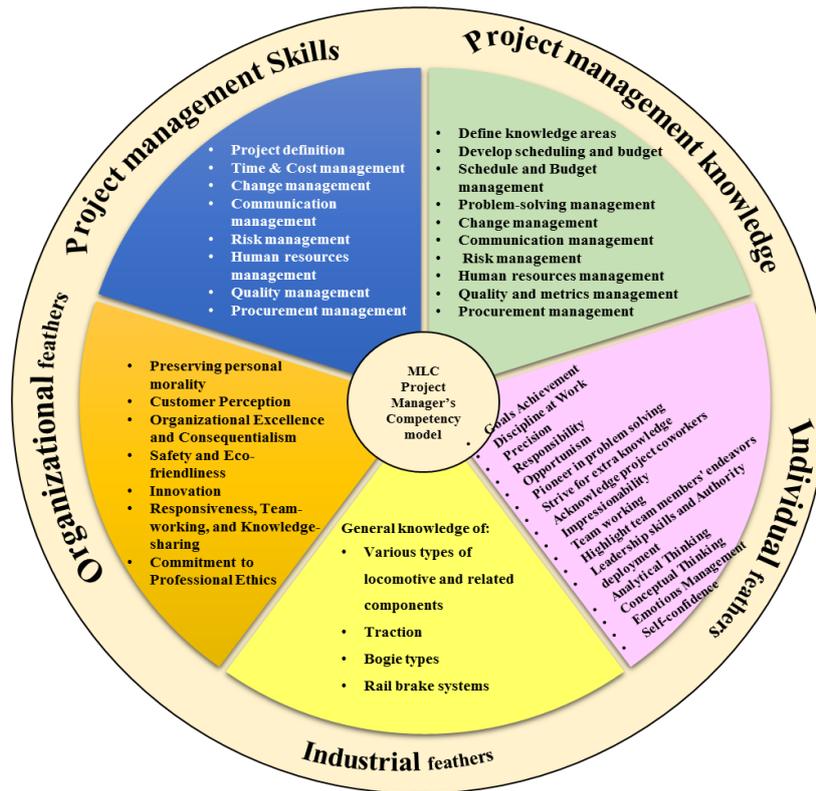


Figure 1. Model of project managers' competency of MAPNA Locomotive

### 3. Research Methodology

The framework presented in this study is in line with the national and international frameworks and standards. In fact, it is localized and developed and its output can be used in project-oriented organizations. Accordingly, given the purpose, the methodology is developmental-applied. Considering the use of questionnaires and interviews during the study for modifying the first competency framework and also editing the general guidelines, the research method is descriptive-survey in terms of data collection.

The statistical population of the study consists of 15 project managers in MAPNA Locomotive Engineering and Manufacturing Company, of whom two are independent project managers and 13 are headquarters' project managers and 2 are interested in project management who are allowed to enter the final evaluation among 18 participants after taking the exam. The research steps are as follows:

- 1) Designing and elaborating project managers' competency model based on the project manager competency development framework (PMCDF)
- 2) Evaluation of project managers' competencies based on the explained competency model

- 3) Troubleshooting and identifying the existing gaps
- 4) Designing improvement programs, training programs, and presenting the development competency strategies

### 3.1. Rating of Projects

To evaluate and determine the degree of importance of projects, some criteria have been determined and the evaluation of the factors of each project with the existing criteria will give a specific score for that factor and eventually determine the degree of value of the project. These criteria are as follows:

- ✓ The nature of the project
- ✓ Project scope
- ✓ Project executive domain
- ✓ Budget
- ✓ Time
- ✓ Mean of man/hour during a month of the project
- ✓ The strategic importance of the project
- ✓ Risk of achieving goals
- ✓ External restrictions and dependencies
- ✓ Degree of instability and transparency in requirements and necessities
- ✓ Number of stakeholders (main suppliers)
- ✓ Number of stakeholders (other stakeholders)

Rating projects in MAPNA Locomotive Engineering and Manufacturing Company is classified into three levels:

**Table 2.** Project Levels

Point Score	Project Levels
Over 70 points	Project level 1(complex)
Between 50-70 points	Project level 2(average)
Less than 50 points	Project level 3 (small)

Project managers in MAPNA Locomotive Engineering and Manufacturing Company are classified into three levels: project manager level 3 (for small project management), project manager level 2 (for medium project management), and project manager level 1(for complex project management). The criteria for accepting project managers' competencies at each level are described as follows:

**Table 3.** The level of acceptance of project managers' competencies at various levels

Project manager competency	Acceptance criterion (project manager level 1)	Acceptance criterion (project manager level 2)	Acceptance criterion (project manager level 3)
Knowledge	8	7	6
Skill	8	7	6
Behavioral	8	8	8
Organizational	9	9	9
Industrial	7	5	5

## 4. Data Analysis

### 4.1. Designing and explaining the project managers' booklet of competencies

After explaining the project managers' competency model, the booklet of project managers' competencies has been designed and determined and includes competency domains, competency clusters, elements and performance criteria in all areas of project managers' competency with the purpose of applying tools and criteria for evaluating project managers based on the booklet. For example, in clustered knowledge and skills competencies, the scope of project risk management competency is as follows:

**Table 4.** A sample of the booklet of project managers' competencies/project risk management competency area (PMI, 2002)

<b>Unit of competence-Project risk management</b>	
<b>Competency Cluster: Initiating</b>	
Elements	Performance Criteria
1-1 Conducting risk planning firstly	1- Identifying and reviewing organizations 'risk
	2- Identifying risk tolerance of stakeholders
	3- Identifying preliminary risk
<b>Unit of competence-Project risk management</b>	
<b>Competency Cluster: Planning</b>	
Elements	Performance Criteria
2-1 Developing a risk management plan	1- Identifying roles, responsibilities, and levels of authority for risk management decision making
	2- Reviewing and expanding preliminary risk appraisal matrix development
	3- Developing risk management plan
	4- Developing the process by which risk identification and quantification will be maintained
2-2 Conducting risk identification	1- Identifying potential project risk events
	2- Identifying the sources of possible internal/external risk events
	3- Developing flowcharts to determine the causes and effects or risks
	4- Classifying potential risk events and the ranges of possible outcomes
	5- Identifying risk symptoms tigers
2-3 Conducting qualitative risk analysis	1- Documenting the risk events
	2- Confirming stakeholders risk tolerances
	3- Estimating risk event probability, consequence, and frequency
	4- Estimating risk event value and related range of possible project cost
	5- Developing probability impact risk rating matrix
	6- Developing the list of prioritized risks
	7- Determining overall risk ranging for projects
2-4 Conducting quantitative risk analysis	1- Conducting risk interviews with project stakeholders and subject matter experts to support quantitative risk analysis
	2- Conducting sensitivity analysis on probable risk events
	3- Utilizing simulation to analyze the behavior/performance of the project system
	4- Developing decision tree analysis to depict key interactions
	5- Communicating the limitations or risk quantification to avoid false impressions or risk assessment reliability
	6- Preparing a probability risk analysis for projects
2-5 Conducting risk response planning	1- Working with stakeholders to develop risk responses
	2- Determining procumbent feasibility as a risk reduction tool
	3- Developing contingency, implementation criteria, and alternative strategies
	4- Determining insurance coverage needs
	5- Determining risk events
	6- Assigning risk owners
	7- Identifying other processes by risk planning interactions
	8- Estimating the price of non-conformance to identified risk
	9- Determining contingency reserve amount needed
	10- Developing a risk response plan

Table 4. Continued

<b>Unit of competence-Project risk management</b>	
<b>Competency Cluster: Controlling</b>	
Elements	Performance Criteria
3-1 Conducting risk response plan	1- Implementing risk response plan including preventive actions as necessary
	2- Initiating and managing change requests as a response to risk events
	3- Managing change to risk response plan as a result of evolving circumstances
<b>Unit of competence-Project risk management</b>	
<b>Competency Cluster: Controlling</b>	
Elements	Performance Criteria
4-1 Conducting risk monitoring and control	1- Implementing workarounds for unplanned risk events
	2- Quantifying actual risk events
	3- Completing risk event updates as part of the projects control process
	4- Completing risk response plan updates, including adjustment to risk probabilities and risk values
<b>Unit of competence-Project risk management</b>	
<b>Competency Cluster: Closing</b>	
5-1 Conducting project closure with regard to risk management	1- Reviewing project outcomes to determine the effectiveness of risk management processes and procedures
	2- Identifying document and report risk issues to recommend improvement to a higher project authority for application in future projects

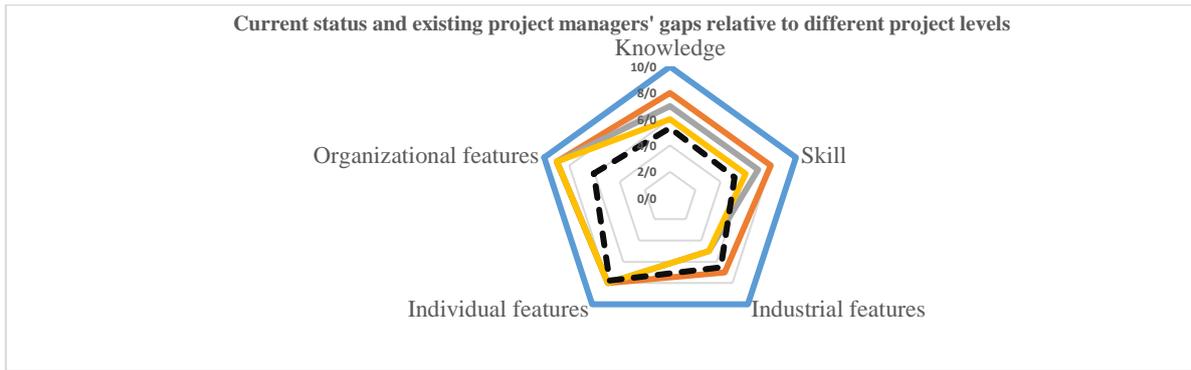
4.2. Assessment and Results

After editing the model and booklet of project managers' competencies, a written test was conducted to evaluate the areas of knowledge, skill, organization, and industry competency in the statistical population of 17 project managers. Questions of project management knowledge competency were designed descriptively based on PMBOK standard. Questions of skills competency were designed as a case study in the format of a small project by PMO experts. Questions of industrial competency were multiple-choice questions designed based on the book "Electric Diesel Locomotive" by specialists in the engineering and research department. Questions of organizational competency were multiple-choice questions extracted from the book of "MAPNA Group Behavioral Codes" by specialists at the human resources department in MAPNA Locomotive Engineering and Manufacturing Company. Regarding the evaluation of project managers' behavioral competency, due to the importance of this field, disk character type, emotional intelligence, and coaching communication tests were first conducted on the statistical population and then during two-day workshops held by a proficient consultant outside the organization and with the purpose of real validation and realizing the project managers' character types, considering the model explained in MAPNA Locomotive Engineering and Manufacturing Company.

After evaluating the areas of project managers' competencies, the results of each person were extracted based on the maximum scores of 10 and the status of each individual was calculated according to the following worksheet, which included the results of the individual in five areas of competencies in the form of tables and radar graphs (spider graphs). Based on the results, the gap analysis associated with each individual can be extracted in the areas of competencies commensurate with the position of the individual.

Table 5. Achieved points of the project manager in five areas of competencies

Evaluated field	Individuals' total score	The highest achieved score	The lowest achieved score	score
Knowledge	47.1	91.3	22.5	Out of 120
Skill	38.75	70.5	24.2	Out of 80
Individual features	148	152	0	Out of 180
Organizational features	8	8	3	Out of 10
Industrial features	33.3	35	13.3	Out of 40

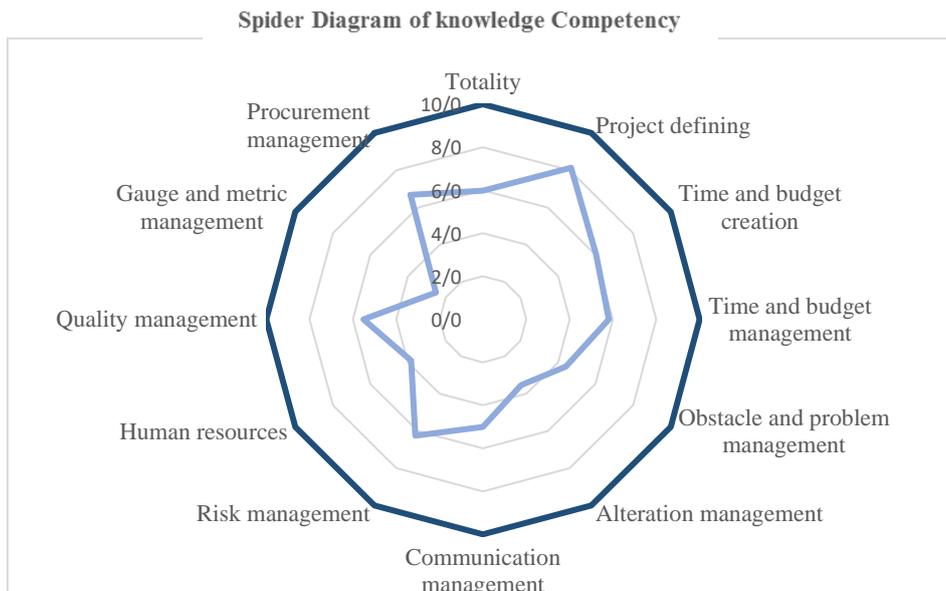


**Diagram 1.** Current status and existing project manager's gaps relative to different project levels

The results show that the project manager did not achieve a satisfactory score in the knowledge, organizational, skill, and individual competencies at any of the levels of the projects, but in industrial competency got the acceptable score at the project levels 2 and 3.

**Table 6.** Achieved points of the project manager in Project Management Knowledge

Knowledge Competency	Achieved points of project managers
Totality	6.0
Project defining	8.1
Scheduling and budget creation	6.0
Scheduling and budget management	5.8
Problem-solving management	4.4
Change management	3.5
Communication management	5.0
Risk management	6.3
Human resources	3.8
Quality management	5.5
Metric management	2.5
Procurement management	6.7

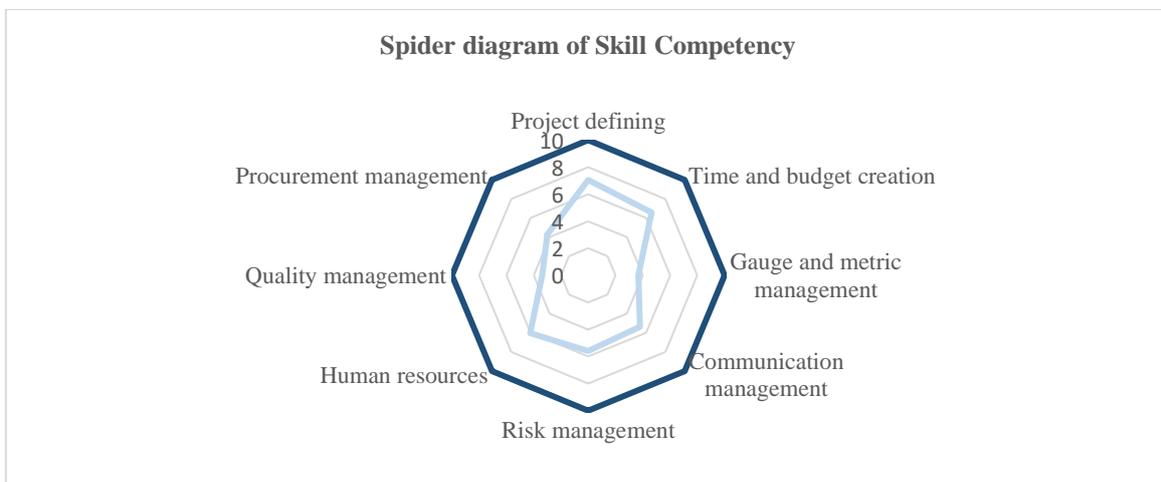


**Diagram 2.** Achieved points of the project manager in Project Management Knowledge

In the knowledge competency clusters, the acceptable level of project 1 is 8, project 2 is 7, and project 3 is 6. As a result, the project manager in all cases, except totality, project defining, scheduling and budgeting, risk management, and procurement management related to the acceptable level in all levels of projects has gaps and has not been able to achieve the acceptable level.

**Table 7.** Achieved points of the project manager in Project Management Skill

Skill Competency	Mean of achieved points
Project defining	7.1
Scheduling and budget creation	6.6
Metric management	3.7
Communication management	5.4
Risk management	5.6
Human resources	6.0
Quality management	3.4
Procurement management	4.3

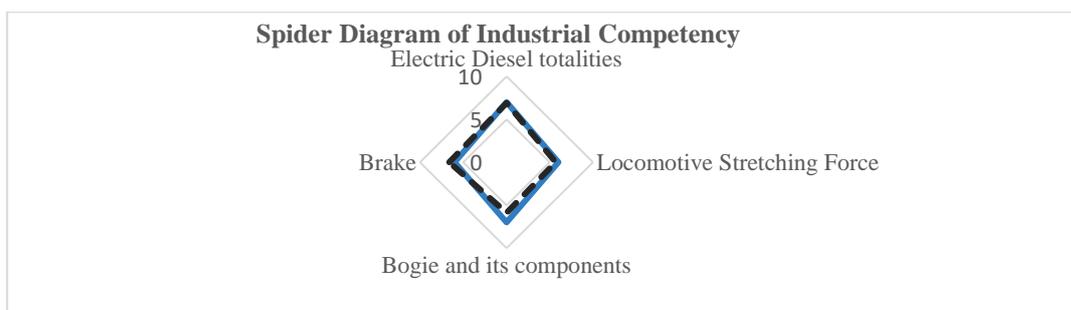


**Diagram 3.** Achieved points of the project manager in Project Management Skill

The results show that the project manager who achieved an acceptable level in project defining at all levels of the project, scheduling, and budgeting, human resources, has only obtained the acceptable level in 3 levels of the project and has not been able to score in other clusters.

**Table 8.** Achieved points of the project manager in Industrial competency

Industrial competency Area	Achieved point
Electric Diesel totalities	6.9
Locomotive Stretching Force	5.7
Bogie and its components	5.9
Brake	6.6

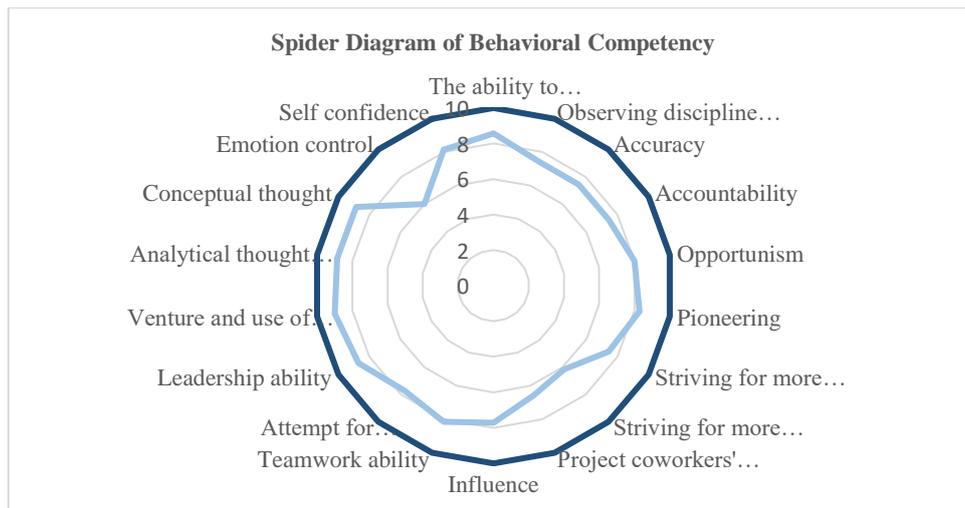


**Diagram 4.** Achieved points of the project manager in Industrial competency

The results indicate that the project manager has gained acceptable level of Electric Diesel totalities and Locomotive Stretching Force clusters in Level 2 and Level 3 projects and the brake cluster at all different levels of the project, and has not been able to achieve an acceptable level of the Bogie and its components cluster.

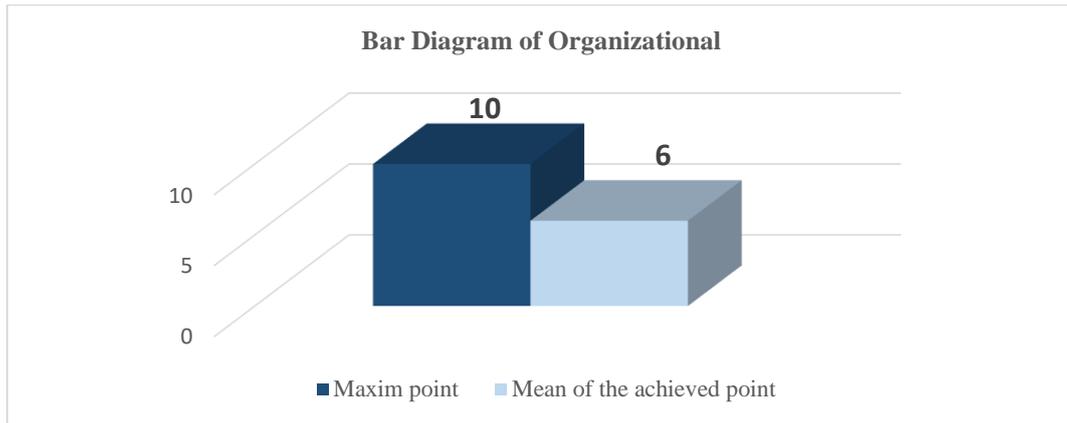
**Table 9.** Achieved points of the project manager in Behavioral competency

Behavioral Competency	Mean of the achieved points
The ability to achieve the goals	8.6
Observing discipline at work	7.4
Accuracy	7.4
Accountability	7.4
Opportunism	8.0
Pioneering	8.3
Striving for more knowledge (depth)	7.4
Striving for more knowledge (surface)	6.1
Project coworkers' understanding	6.6
Influence	7.7
Teamwork ability	8.1
Attempt for flourishing the coworkers' ability	7.7
Leadership ability	8.7
Venture and use of power	9.0
Analytical thought and problem-solving	8.9
Conceptual thought	8.9
Emotion control	6.0
Self-confidence	8.1



**Diagram 5.** Achieved points of the project manager in Behavioral competency

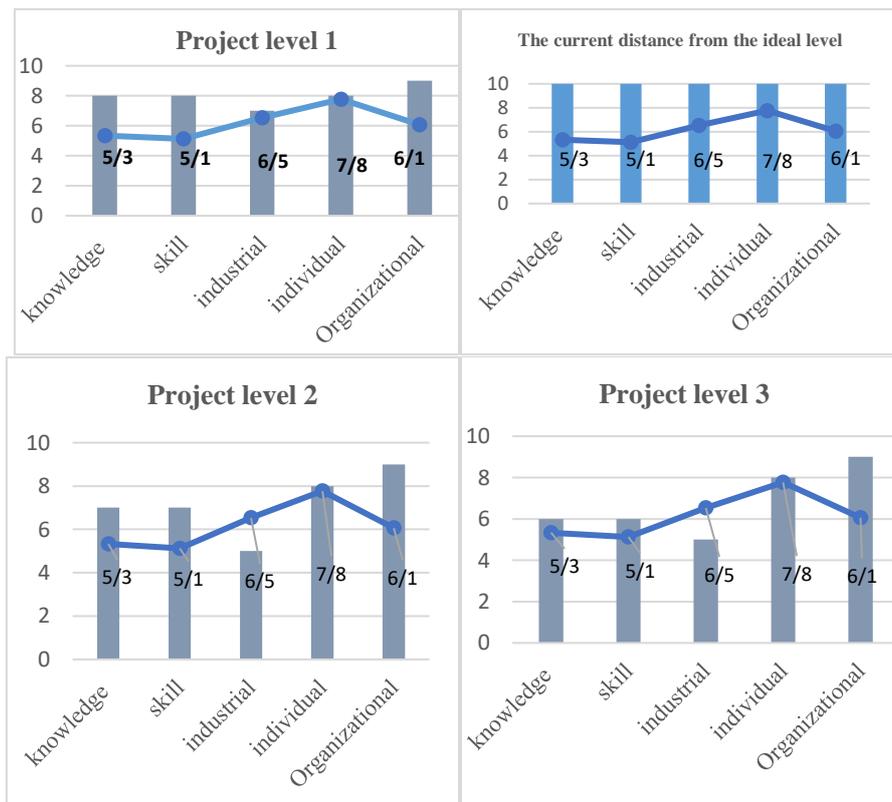
The results indicated that the project manager has been able to gain the acceptable level in all cases except accuracy, accountability, opportunism, pioneering in solving problems, willingness to know more, understanding project partners, adaptation, team-work ability, attempt to improve the project team ability, leadership ability, venture and utilizing power and job authority, analytical thinking and problem solving, conceptual thinking, emotion control, and self-confidence.



**Diagram 6.** Achieved points of the project manager in organizational competency

The result shows that the project manager scored 6 out of 10 in organizational competency and did not achieve the acceptable level.

The current condition of the research population concerning different levels of projects and their acceptable levels can be seen in the following graphs. These results clearly explain the current status of the project managers of MAPNA Engineering and Manufacturing Company in each of the areas of competencies and even in each of the domains of competencies that are averaged from the statistical population assuming that the weight of each is equal. Based on these results, gaps analysis related to each area can be extracted, and based on it, training and improvement programs for the promotion of different areas can be presented.



**Diagram 7.** The condition of the population in competency areas

As can be seen, the project managers of the company are weak and below the acceptable level in terms of the ideal level in all areas of competency and at different levels of the project level 1, 2, and 3 except for industrial competency.



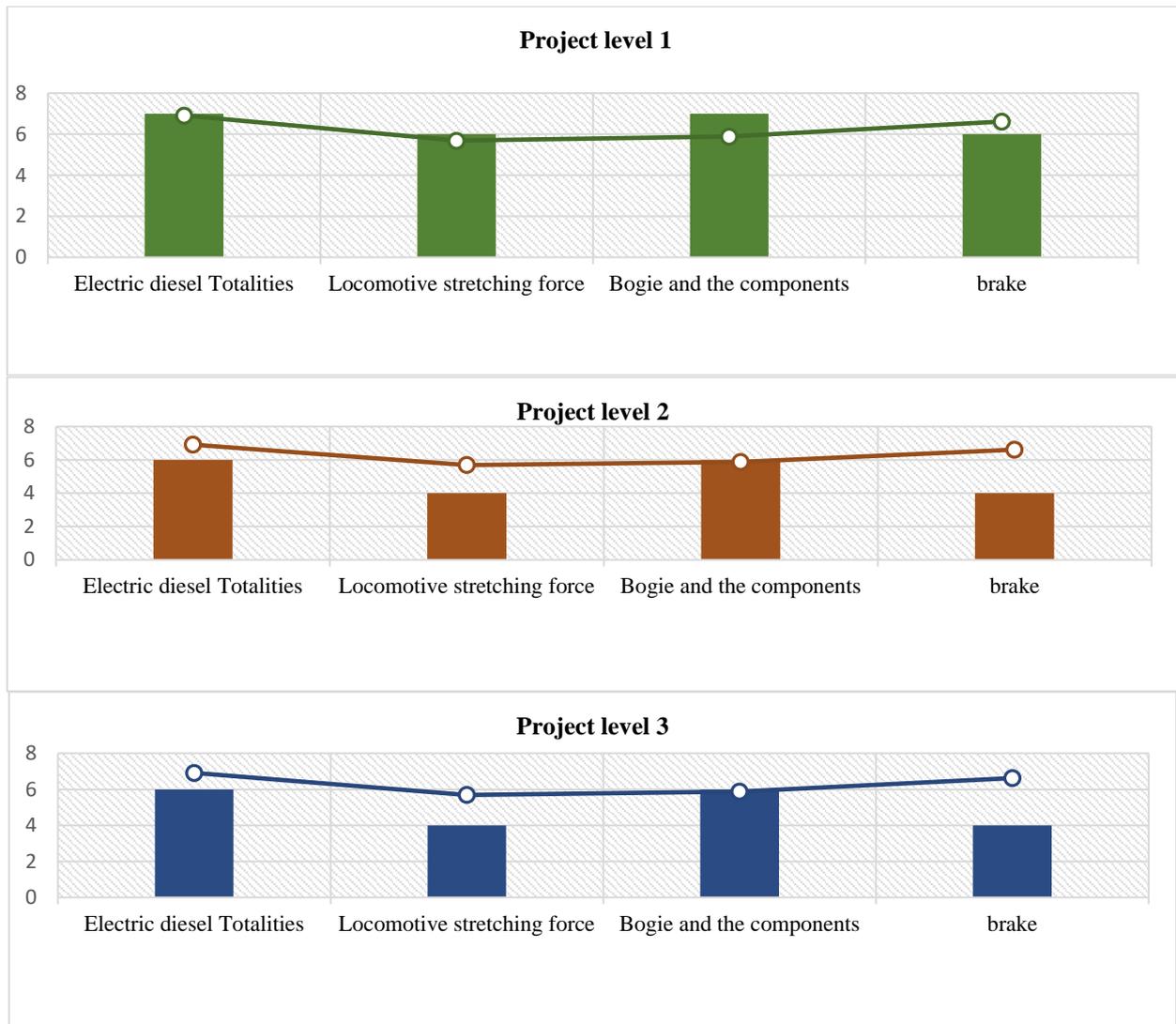
Diagram 8. The condition of the population in knowledge competency

In the field of knowledge competency, the project managers of the company are weak in terms of the projects level 1 and 2 except for the project definition in other areas and in terms of the project level 3, except for project definition, scheduling and budgeting, and human resources.



**Diagram 9.** The condition of the population in skill competency areas

In the field of skill competency, project managers are weak and below the acceptable level in terms of projects level 1 and 2 except for project definition in other areas and in terms of project level 3 except for project definition, scheduling and budgeting, and human resources.



**Diagram 10.** The condition of the population in the industrial competency areas

In the field of industrial competency, project managers are strong in terms of project levels 1, 2, and 3 except for Bogie and its components.

In the field of behavioral competency, project managers are weak at all areas in terms of the ideal level and in terms of the ability to achieve goals, observing discipline at work, willingness to know more, understanding project partners, team-work ability, and emotion control.

### 4.3. Troubleshooting and Identifying Existing Gaps

After the evaluation phase, the gap analysis phase was performed in a way that each project manager's score was compared to the acceptable score developed for each area of competency, and therefore the level of each person's competency was determined at each level of the project. For example, a project manager who has not achieved the required score in the field of risk according to the standard should participate in the appropriate training course to achieve the desired qualification. The results of the gap analysis in five areas of knowledge, skill, behavioral, organizational, and industrial competency were designed and prepared for each individual in a separate worksheet as follows. "Green" indicates acceptable score, "Yellow" indicates acceptable score but with ignorance, and "Red" is a non-acceptable score which means the individual must necessarily participate in the educational program at an appropriate level. Project managers' existing gaps in each of the knowledge areas were identified according to the following table after the completion of the evaluation phase for each project manager.

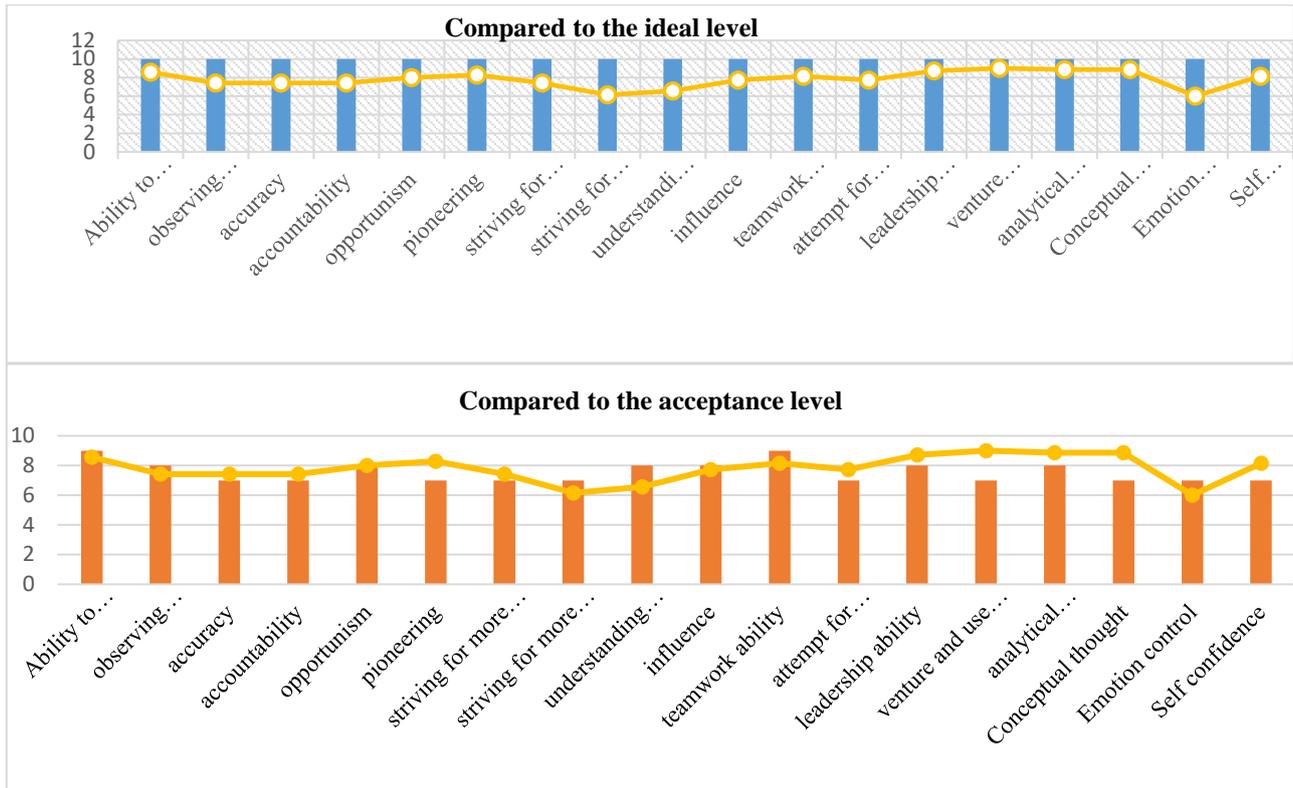


Diagram 11. The condition of the population in behavioral competency areas

Table 10. The gap analysis of the individuals' results in knowledge competency

Gap analysis of the individuals' results in knowledge competency					
No	Competency Cluster	Project Level 1	Project Level 2	Project Level 3	Result
1	Totality	8	7	6	4.2
2	Project definition	8	7	6	9.2
3	Scheduling and Budget creation	8	7	6	2.5
4	Budget and scheduling management	8	7	6	3.8
5	Problem solving management	8	7	6	2.5
6	Change management	8	7	6	2.5
7	Communication management	8	7	6	2.5
8	Risk management	8	7	6	1.3
9	Human resources	8	7	6	3.8
10	Quality management	8	7	6	6.3
11	Metric management	8	7	6	0.0
12	Procurement management	8	7	6	8.8
<b>Total</b>		<b>96</b>	<b>84</b>	<b>72</b>	<b>47.1</b>

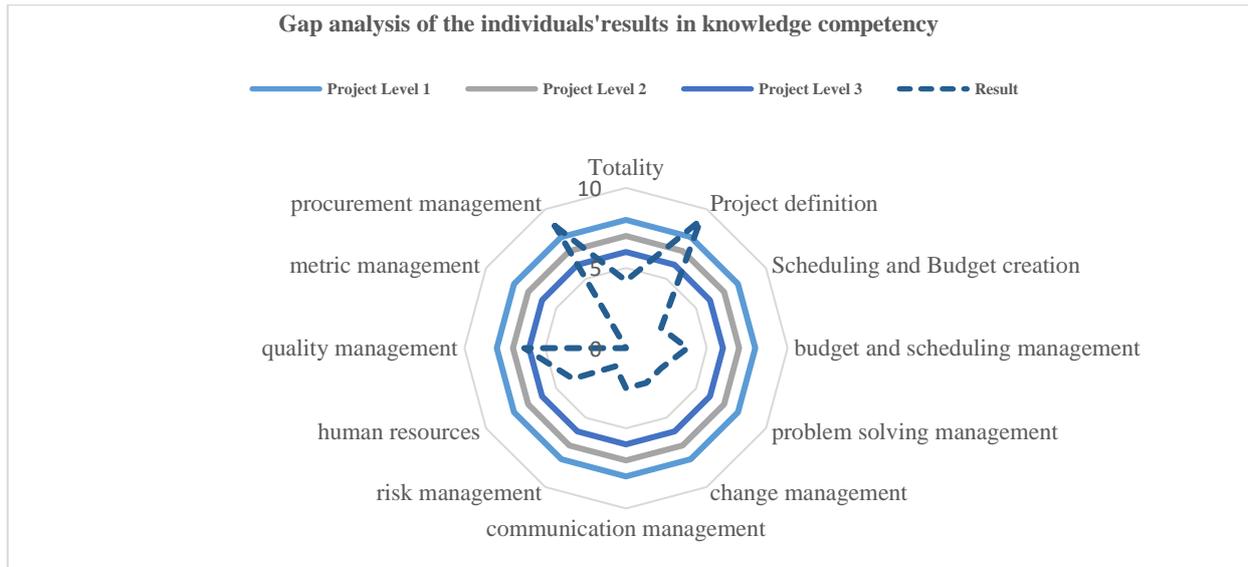


Diagram 12. The gap analysis of the individuals' results in knowledge competency

Table 11. The gap analysis of the individuals' results in skill competency

Gap analysis of the individuals' results in skill competency					
No	Competency Cluster	Project Level 1	Project Level 2	Project Level 3	Result
1	Project definition	7	6	6	10.0
2	Scheduling and Budget creation	10	8	6	6.7
3	Change management	7	6	6	0.0
4	Communication management	7	6	6	5.0
5	Risk management	9	8	6	2.5
6	Human resources	7	7	6	5.0
7	Quality management	7	7	6	2.5
8	Procurement management	10	8	6	5.0
<b>Total</b>		64	56	48	36.7

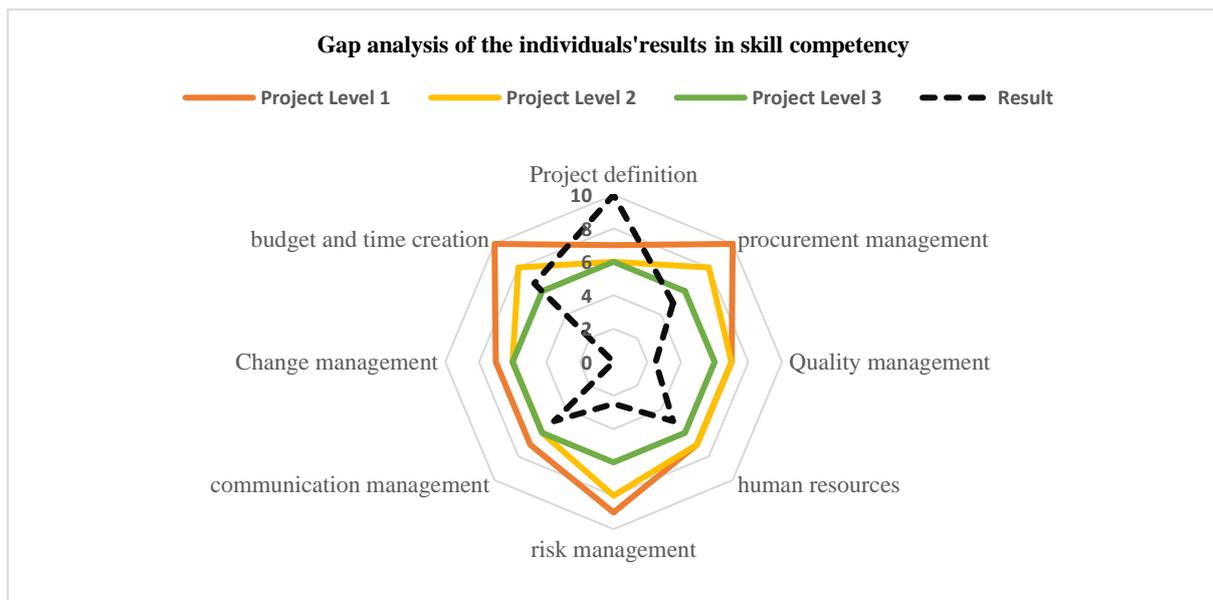
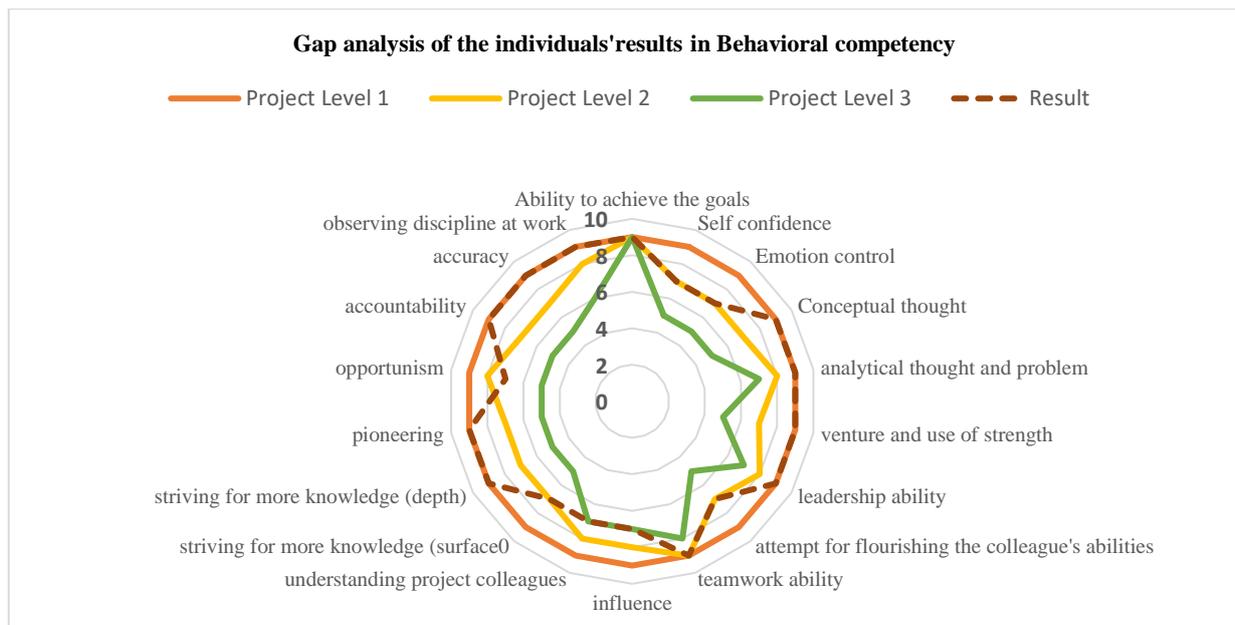


Diagram 13. The gap analysis of the individuals' results in Skill competency

**Table 12.** The gap analysis of the individuals' results in behavioral competency

Gap analysis of the individuals 'result in Behavioral competency					
No	Competency Cluster	Project Level 1	Project Level 2	Project Level 3	Result
1	Ability to achieve the goals	9	9	9	9.0
2	Observing discipline at work	9	8	6	9.0
3	Accuracy	9	7	5	9.0
4	Accountability	9	7	5	9.0
5	Opportunism	9	8	5	7.0
6	Pioneering	9	7	5	9.0
7	Striving for more knowledge (depth)	9	7	5	9.0
8	Striving for more knowledge (surface)	9	7	5	7.0
9	Understanding project colleagues	9	8	7	7.0
10	Influence	9	8	7	7.0
11	Teamwork ability	9	9	8	9.0
12	Attempt for improving the colleague's abilities	9	7	5	7.0
13	Leadership ability	9	8	7	9.0
14	Venture and use of strength	9	7	5	9.0
15	Analytical thought and problem	9	8	7	9.0
16	Conceptual thought	9	7	5	9.0
17	Emotion control	9	7	5	7.0
18	Self-confidence	9	7	5	7.0
	<b>Total</b>	<b>162</b>	<b>136</b>	<b>106</b>	<b>148</b>



**Diagram 14.** The gap analysis of the individuals' results in Behavioral competency

**Table 13.** The gap analysis of the individuals' results in industrial competency

Gap analysis of the individuals 'result in Industrial competency					
No	Competency Cluster	Project Level 1	Project Level 2	Project Level 3	Result
1	Electric diesel Totalities	7	6	6	10
2	Locomotive stretching force	6	4	4	10
3	Bogie and the components	7	6	6	6.7
4	Brake	6	4	4	7.5
	<b>Total</b>	<b>28</b>	<b>20</b>	<b>20</b>	<b>34.2</b>

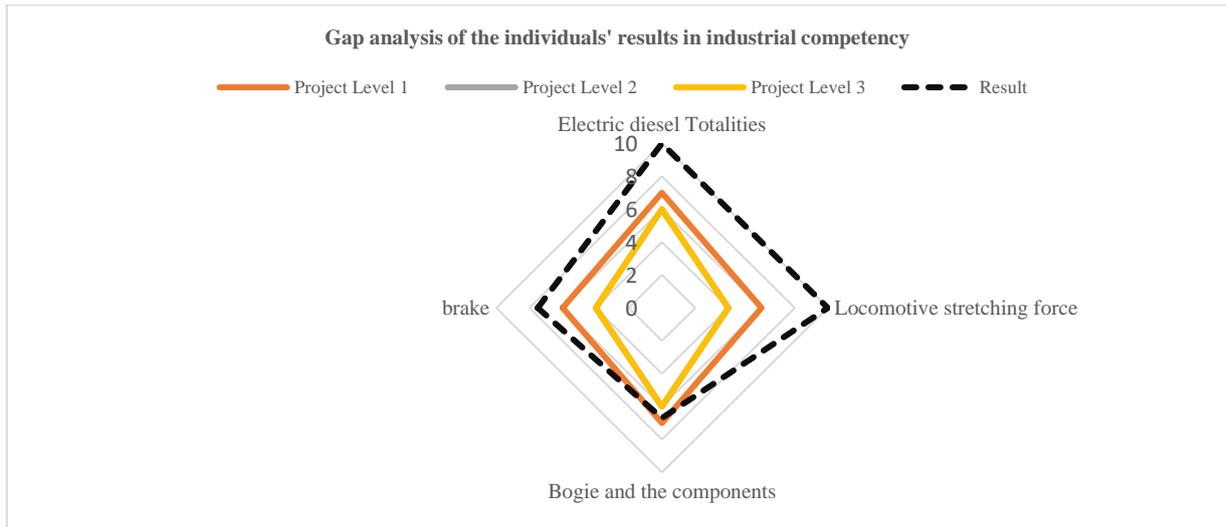


Diagram 15. The gap analysis of the individuals' results in industrial compete

Table 14. The gap analysis of the individuals' results in organization competency

Gap analysis of the individuals 'result in Industrial competency					
Row	Competency Cluster	Project Level 1	Project Level 2	Project Level 3	Result
1	Organization competency	9	9	9	6
	Total	9	9	9	6

#### 4.4. Designing Improvement Plans and Providing Development Solutions

After identifying the gaps in the last phase of the PMCDF model implementation, training and improvement courses are required. Courses are called gap analysis courses that are designed directly by analyzing gap areas of competency. A separate worksheet was designed and developed for each person, like the following worksheets, which indicated the path to the job of the project manager's level 1, 2, and 3. For example, if a person is designated for the "level 1 project manager" job, after evaluating the scores and performing a gap analysis, she/he needs to pass the problem and obstacle management training course and for the "level 2 project management", he/she needs to attend "Project Scheduling Basics" course based on project manager comparison. According to the following tables, for each project manager, the training plans have been presented that have been taken in all competency areas and by the gap analysis. It is worth mentioning that these training plans have been developed to get the project managers to higher levels of the project based on realizing goals. For example, the project manager must participate in the "Project Scheduling Basics" course for 16 hours to achieve a quantitative objective goal (8).

Table 15. A sample of the improved program in knowledge competency areas

Knowledge courses for reaching project Level 1					
No	Course	Hours	Requirements	Course Objectives	Quantitative objective
1	Project Chartering	4	In this course, the participants ought to be able to prove a project charter in an average dimension by means of a project and definition basis	Knowing different features	8
		PDU number		Knowing different dimensions and project charter features in projects with the average dimensions	
				Knowing the process of providing and various responsibilities in project chartering	
2	Project Time Scheduling Basis	16	In this course, the participants ought to know the primary principles as well as the process of project time scheduling.	Knowing the main processes of time management in projects	8
		PDU		Providing project time network	
		16		Ability to create relationships among project activities	

Table 15. Continued

Knowledge courses for reaching project Level 1					
No	Course	Hours	Requirements	Course Objectives	Quantitative objective
3	Problem-solving management	8	In this course, the user ought to solve any problems and obstacles in projects by systematic and process methods	Knowing the techniques of problem-solving to make alternative responses to the problem	8
		PDU number		Knowing the task description and common responsibilities in problem and obstacle project management	
		8			

Table 16. A sample of improvement programs in skill competency areas

Skill improvement programs for reaching project level 1		
No	Course	KPI improvement
1	Project definition	The ability to supervise the process of appropriate project definition The ability to supervise the appropriate structure of the project chart The ability to supervise the process of allocating various responsibilities in the project chart
2	Scheduling and budget creation	The ability to supervise the project management appropriately The ability to supervise the real scheduling of programs The ability to supervise the process of work failure structure and project network The ability to supervise the project scheduling during the performance
3	Change management	The ability to supervise the creation of a homogenous system requesting alteration in project The ability to supervise the design and integration of project alteration management program The ability to supervise the creation of a project body management program The ability to supervise the integration of alteration of the management system in a project The ability to supervise the analysis of the required alteration and its subsequent effects on the various dimension of the project The ability to supervise the identification of peripheral and communicative project

Table 17. A sample of improvement program provided in behavioral competency area

No	Description	Educational workshop	Coaching	Mentoring
1	Acceptance of weak points		∞	
2	Assisting for help from others in case of necessity		∞	
3	Sympathy	Emotional intelligence		

According to the gap analysis, the project manager needs to improve clusters such as weaknesses and seeking help from others in case of necessity by participating in coaching courses also to improve the empathy cluster in the emotional intelligence workshop.

Table 18. A sample of improvement program provided in organizational competency areas

Organizational courses		
No	Course	Requirement
1	Introduction and recognition of MAPNA Group behavioral codes	This course helps the participants to gain enough information about the MAPNA Group values regarding customer, innovation, progress, safety, accountability, and morality

According to the project manager’s weaknesses in organizational competency, the project manager needs to participate in MAPNA Group behavioral codes introduction and recognition course.

**Table 19.** A sample of improvement program provided in the industrial competency area

Industrial courses		
No	Course	Requirements
1	Recognizing different types of Bogies and their components	This course helps the participants to know the concepts of Bogie types, their components, bogie suspense system, suspense system springs, contacts of rail and wheel, wheel and shaft as well as bearings.
No	Course	Requirement
2	Rail brake systems	This course helps the participants to know the concepts of different types of brakes in rail vehicles, pneumatic brake equipment in automatic pneumatic brake system, brake and pipe system, electro-pneumatic brake, and electro-pneumatic control system.

## 5. Conclusions

Designing and explaining project managers' competency model in MAPNA Locomotive Engineering and Manufacturing Company based on PMCDF can be a good model for the systematic and purposeful development of company project managers. Considering that most of the existing training programs are based on "job" rather than "employee", and given that people with different abilities are at different levels of the project, this can lead to wasted training costs and lack of productivity in training. Therefore, Project Management Office (PMO) evaluated project managers' competencies to identify existing gaps and design development plans, and the results are fully documented and contain over 100 reports. The results of the study indicate that the statistical population of the research is lower than the ideal level in all areas of competency including knowledge, skill, behavior, organization, and industry, and at various project levels 1, 2, and 3 except the industrial competency.

Also, it is worth mentioning that despite the project management development, this model can be a good pattern for upgrading main occupations of organization, establishing and organizing the general training programs, and an appropriate context for evaluating the function in the whole organization.

## 6. Future Research

Project management competencies may be depending on cultural background. This study was conducted in an Iranian context and does not involve a cross-cultural sample. Currently, few studies have explored cultural influences on project management competencies. Thus, further studies may benefit from integrating cultural practices into project management competency research. Also, it is suggested that the degree of importance of the dimensions of competency and each of the elements within them be determined by multi-criteria decision-making methods, including hierarchical analysis methods, to provide a more accurate basis for assessing competency levels in organizations.

## References

- Abraham, S.E., Karns, L.A., Shaw, K. and Mena, M.A. (2001), Managerial competencies and the managerial performance appraisal process, *Journal of Management Development*, Vol. 20(10), pp. 842-852.
- Alam, M., Gale, A., et al., (2010). The importance of human skills in project management professional development. *Int. J. Manag. Proj. Bus.* Vol.3 (3), pp. 495-516.
- Bayani, A., Asadi, M. (2005). Project Management Competency Standard, Improvement Performance of Managers in Project Environments, *Second International Project Management Conference*, Tehran. (In Persian).
- Briere., M (2014). Competencies of project managers in international NGOs: Perceptions of practitioners. *Journal of International Journal of Project Management*. JPMA-01649; No of Pages 10.
- Carmendo, I and Rahoveanu, a. (2014). Project Management Competencies for Regional Development in Romania: Analysis from "Working with People" Model. *The journal of Finance*. Vol. 2014, pp. 614-621.
- Carvalho, M.M.D., Patah, L.A., Bido, D.D.S., (2015). Project management and its effects on project success: Cross-country and cross-industry comparisons. *Int. J. Proj. Manag.* Vol. 33 (7), pp. 1509-1522.
- Cerimagic, S., (2010). Influence of culture on project practices. *Educ. Bus. Soc.* Vol.3 (4), pp. 277-288.
- Clarke, N., (2010). Emotional intelligence and its relationship to transformational leadership and key project manager competences. *Proj. Manag. J.* Vol. 41 (2), pp. 5-20.

- Crawford, L., (2005). Senior management perceptions of project management competence. *Int. J. Proj. Manag.* Vol.23 (7), pp. 7-16.
- Crawford, L. (2000). Profiling the competent project manager, Proceedings of PMI Research Conference, Project Management Institute, Newton Square, PA, pp. 3-15.
- Dziekonski, K (2017). Project Managers' Competencies Model for Construction Industry in Poland. *7th International Conference on Engineering, Project, and Production Management*. Procedia Engineering, Vol. 182, pp. 174 – 181.
- Ekrot, B., Kock, A., Gemünden, H.G., (2016). Retaining project management competence Antecedents and consequences. *Int. J. Proj. Manag.* Vol. 34 (2), pp. 145–157.
- Giammalvo, P. (2012), Using 'behavioral profiling' to identify 'successful' project managers, *PM World Journal*, Vol. 1 No. 1, pp. 1-16.
- Hanna, A.S., Ibrahim, M.W., Lotfallah, W., Iskandar, K.A., Russell, J.S., (2016). Modeling Project Manager Competency: an Integrated Mathematical Approach. *J. Constr. Eng. Manag.* Vol. 142 (8), pp. 401-429.
- IPMA, Competency Baseline (2006). *International Project Management Association* (third edition). Netherlands: IPMA Publications.
- Likamaa, (2015). Developing a project manager's competencies: A collective view of the most important competencies. *6th International Conference on Applied Human Factors and Ergonomics (AHFE 2015) and the Affiliated Conferences*, pp. 681 – 687
- McKevitt, D., Carbery, R., Lyons, A., ( 2017). A profession but not a career? Work identity and career satisfaction in project management. *Int. J. Proj. Manag.* Vol. 35 (8), pp. 1673–1682.
- Muzio, E., Deborah, J.F., (2007). Soft skills quantification (SSQ) for project manager competencies. *Proj. Manag. J.* Vol. 38 (2), pp. 30-38.
- Ortiz-Marcos, I., Cobo Benita, J.R., Aldeanueva, C.M. and Colso, Á.U. (2013), Competency training for managing international cooperation engineering projects, *Project Management Journal*, Vol. 44(2), pp. 88-97.
- Project Management Institute, Project Management Professional (PMP®) Role Delineation Study, First edition, Newtown Square (PA, USA), Project Management Institute, (2000).
- Project Management Institute, (2002), project manager competency development (PMCD) Framework, Pennsylvania Project Management Institute Inc.
- Project Management Institute (2017a), Project Manager Competency Framework (PMCD.3), Project Management Institute. Project Management Institute
- Sanghi, S. (2007). *The Handbook of Competency Mapping*. Published by Vivek Mehra, India: Sage Publication.
- Stevenson, D., Starkweather, J., (2010). PM critical competency index: IT execs prefer soft skills. *Int. J. Proj. Manag.* Vol. 28 (7), pp. 663-679.
- Solhmiraie, A., (2012). *Electric locomotive electric components and concept*", Pandar Pars Publications .(In Persian)
- Tabassi, A.A., Argyropoulou, M., Roufechaei, K.M., Argyropoulou, R., (2016). Leadership Behavior of Project Managers in Sustainable Construction Projects. *Procedia Computer Science*. Vol. 100, pp. 724–730.
- Teichler, U. (2007). *Higher Education in Globalization World*. London: Springer Publisher.
- Vlahov teal (2015) the influence of cultural diversity on project management competence development – the Mediterranean experience. *29th World Congress International Project Management Association (IPMA) 2015, IPMA WC 2015, 28-30 September – 1 October 2015, Westin Playa Bonita, Panama.*