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COMPETENCY-BASED SELECTION AND ASSIGNMENT FOR PROJECT MANAGER IN IRANIAN RAILWAYS PROJECTS BY GENETIC MULTIGENIC PROGRAMMING

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Abstract: *As a part of human resource management, active companies in Iran's railway industry must determine the qualifications for appropriate project managers in railway construction. This research aims to consider the importance of Iran's railway construction projects due to the lack of staff with expertise and their high economic impact and budget. A decision-making model is presented. The project manager's qualifications are determined through questionnaires answered by experts in the field. The numerical model is created to determine the qualifications for project management in the railway industry. Therefore, Competency-Based Selection by Genetic Programming Multigenic Regression (CSPR) is proposed for project-oriented human resource management. Decision-making is done in three phases: Hierarchical analysis process for evaluating and determining the qualifications based on the questionnaires. The model is trained and validated by creating optimal coefficients and genes to determine the contribution of each of these qualifications in determining each candidate's final qualifications based on experts' questionnaires. Finally, the model's accuracy with optimal coefficients will be tested based on the questionnaires not used in the model training phase. The CSPR model provides a qualitative method and numerical optimization to evaluate and grade the project manager in Iran's railway construction projects based on the metaheuristic method.*

Keywords: *Project management, active personnel in the railway industry, competency-based selection, genetic programming, multigene regression.*

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1. Introduction

Human resource management (HRM) is the process that organizes, manages, and directs the project team (Project Management Institute, 1996). The selection of responsible people has a significant impact on the success of large projects (Nozari et al., 2022, 2022a) and creates a competitive advantage for the organization (Farndale et al., 2023; Nimmi et al., 2023). Policies, processes, and methods of identifying and evaluating human resources in active companies in Iran's railway industry should be project-oriented and different from the older processes and methods of evaluating human resources (Macchi Silva & Ribeiro, 2022). Improving organizational performance is a fundamental concern in the management of construction companies (Huemann, 2020).

Various factors affect the performance of construction projects, including human resources, specific conditions of each project, the instructions, communication and implementation process, activities and functions of project management, and environmental conditions outside the project (Ingle & Mahesh, 2020; Mutlu, 2020). Yang et al. showed that teamwork statistically affects project performance (Ali et al., 2021). Kellner et al. (2023) found a strong correlation between human resource management and personnel performance at the workplace as well as between the attitudes of workers and employees and their performance at the workplace. Based on the correlational analysis, Belout & Gauvreau (2004) demonstrate that human resource management significantly impacts project performance. Pfeiffer defines that companies who know the correlation between human resources and organizational performance are usually more successful in implementing long-term projects. Therefore, it can be concluded that progress in project performance, planning, the success of the previous work and organization of the company depend on the growth of the performance of the employees of that company (Stevens, 2001). The project's team consists of qualified personnel with assigned roles and responsibilities to complete the project. Researches demonstrate that team development improves the skills and technical ability of the company's human resources in the team environment and project performance (Nozari et al., 2021). Therefore, effective and efficient human resource development is a vital factor for the success of a construction project (Ng & Tang, 2010; Park, 2009). Effective and efficient human resource development will improve the team's performance, increasing the probability of achieving the project goals (Tabassi & Bakar, 2009). The degree or extent of this effect depends on certain factors such as project type, organizational context, and different specifications. If the project team members do not have the required qualifications, Human resource performance can be decreased. Human resource effectiveness depends on the knowledge, skills, and behavior that a person must have to fulfill his role (Liu et al., 2005). Accurate assessment of human resource skills, abilities, recognition of individual characteristics, and key behavior of individuals increase the chances of choosing a team that has the potential to succeed (Nozari et al., 2021).

Traditionally, an expert, such as the head of a company's human resources department, interviews the candidates and, after analyzing the capabilities of each person, chooses the best candidate. By evaluating each candidate's test scores and progress criteria, the decision to select and assign candidates is made. However, this process often lacks precision and may be inaccurate (Bowen et al., 1999). The analytical Hierarchy Process (AHP) is one of the complex decision-making methods that makes it possible to assign priorities and qualifications in the decision-making process (Nozari & Szmelter-Jarosz, 2023).

Lai (1995) investigated the employee selection process as a decision problem with multiple objectives. In other research, Iwamura and Lin showed that the selection process of employees requires a detailed evaluation of the history and the sum of various factors (Iwamura & Liu, 1998). Labib et al. (1998) proposed a model for selecting employees based on AHP, which has four stages. Another modern method in employee selection is artificial intelligence techniques. Over the past 25 years, many real-world issues and problems, including selecting the right employees, have been solved using Fuzzy logic. Petrovic-Lazarevic (2001) proposed a two-level phased model of employee selection to minimize personal judgments in distinguishing between suitable and unsuitable employees for a job position. The process of adapting an employee to a specific job is done through the phased model (Golec & Kahya, 2007).

Korkmaz et al. presented an AHP and a two-way compliance decision support system (DSS) to assist the diagnostician. Polychroniou & Giannikos (2009) presented a phased multicriteria decision-making method for selecting employees, which is the order of priority through similarity to the optimal solution multicriteria selection tool (TOPSIS) and the algorithm presented by (Ertugrul Karsak, 2001). Kelemenis & Askounis (2010) also presented a phased TOPSIS for ranking personnel recruitment options. Lin (2009) developed a suitable personnel selection program for each job, according to phased evaluation and linear programming model, to make an adequate and effective fit of the company's policy in determining new people. Güngör et al. (2009) proposed a personnel selection system based on phased AHP. The proposed phased AHP uses the ranking of qualitative and quantitative criteria to evaluate the best-qualified personnel.

Active employees of construction projects and especially railway projects of the Islamic Republic of Iran, specifically concerning project managers who have a larger impact, have not been studied. Soft computing in information systems in project management has also gained a special position and has found various uses. As a result, developing decision-making systems based on computer reasoning in the railway transportation industry is also necessary for the optimal use of managers and decision-makers. This research seeks to present the correlation between the qualifications of a project manager based on meta-exploratory algorithms in Iran's railway construction projects. So it can be used to create a system to evaluate the qualifications of project managers in contracting and consultants. The presentation of this model and its development led to the diminishing of interviewers' personal opinions and the making of logical decisions in hiring project managers. In this research, first, with the help of questionnaires and interviews with experts, the criteria of competence in the selection of human resources were identified, and it was evaluated the difference between the project manager in the projects of the target community of the Islamic Republic of Iran Railway Company and other civil engineering projects.

The structure of this article is as follows. In the second part, the research methodology is presented. Classification of project manager criteria is presented in the third part. The development of Detailed criteria related to qualifications is discussed in the fourth section. The fifth section presents Competency-Based Selection by Genetic Programming multigenic regression. Finally, the conclusion is presented in the last part.

2. Methodology

Regression (CSPR) aims to provide a method that can be a simple framework for the selection of project managers in Iran's railway industry and allow them to develop a method based on data from the questionnaires by entering the interview information of the evaluation index and logically present the candidate. CSPR, with the help of Genetic Programming Multigenic Regression, generates different models to determine optimal structure and coefficients. By investigating the questionnaires and with the help of CSPR, the project manager's competency accomplishes the process of extracting hidden and meaningful relationships from data in symbolic equations. Genetic programming is used for this method. Genetic programming is a biologically inspired machine learning method that evolves computer programs to perform an optimal task. It performs this process by randomly generating a population with the help of a computer program. By utilizing Darwinian evolution, this process repeats until the population contains the coefficients that provide the competency-based equation that best predicts the qualifications.

In successful organizations, employee selection is a complex decision-making process that relies on assigning the right employees to the right jobs at the right time. This process solves the challenging task of the decision-making process. As seen in the existing research, there are two problems: the type of decision-making method for selecting candidates and the process of reviewing the selection of candidates that will be used in the competency-based method. Most of the research done to investigate the issue of employee selection is based on job analysis.

In the current research, a model based on meta-heuristic optimization methods and nonlinear regression with the allocation of optimal coefficients is used to select the most qualified personnel in the construction industry of Iranian railway projects.

To prepare the decision support system in selecting the project manager, attention must be paid to some preliminary steps: A set of four main competency criteria is determined for project managers in Iranian railway projects, and the sub-factors are summarized by reviewing articles and asking experts in railway projects.

A survey involving railway industry experts was used to evaluate the importance index based on interviews of each factor, and unimportant factors were rejected.

A questionnaire survey with active experts in the railway industry was used to evaluate the importance index based on interviews for each factor. Furthermore, unimportant factors were rejected. Table 1 describes the project manager's main qualification factors.

Table 1. The project manager's main qualification factors

Principles of competency criterion	Technical competencies	Behavioral competencies from the employer's point of view	Competencies and ability of the person to work in the organization	Competencies based on experience and structuring ability in project management
number of factors	21	15	11	6

A detailed comparison set with meta-heuristic optimization methods is used to evaluate essential qualifications factors from the data collected through the interviews. Various competencies are effective in determining the selection of a project manager. According to 4 general and 53 partial indicators, traditional

methods cannot determine the structure, type, and manner of the relationship to project manager selection. Therefore, the mentioned parameters are modified through meta-heuristic calculation techniques. In addition, the hybrid learning algorithm is used to train the system. When the final model is developed, its prediction accuracy is validated using a part of the real data obtained from the sets of interviews. Finally, statistical analysis of output and data based on test data from interviews is accomplished.

3. Classification of Project Manager Criteria

According to the UDL/ETA standard, a project manager is responsible for carrying out and achieving the goals of the railway project. The key responsibilities of project management include creating recognizable and attainable goals, determining project requirements, and managing the three constraints of the project, which include cost, time, and quality. Employees or volunteers are evaluated based on their resumes to match an employee with an appropriate job. A resume is a written document to convince an employer that an applicant's needs, skills, and qualifications match the position. It usually includes work experience, specific skills, education, and achievements. The interview may be the only tool used for evaluation and selection, or it may be a step in evaluating and eliminating candidates. These items include ability and qualifications evaluations, health checks, information related to education, references, etc. Therefore, the correct assessment is vital and should mean that both the interviewee and the interviewer are satisfied with the evaluation process. As a result, the right decision is made.

4. Development of Detailed Criteria Related to Qualifications

Qualifications are a group of items related to a person's knowledge, attitudes, skills, and characteristics that: affect the main part of a person's job; they are related to a person's performance in that job which can be measured by acceptable standards and can be upgraded through training and experience. It can be broken down into smaller dimensions of qualifications (Project Management Institute, 1996). Competency-based factors are provided for each job class at this stage according to a selection system.

4.1. Identification of Qualifications Criteria

Qualification models are valuable tools to ensure that human resources systems facilitate and support a company's strategic goals in selecting the right person (Sanghi, 2007). In order to determine the qualifications criteria of the project manager in Iranian railway construction projects, four main factors of technical ability, behavioral, criteria and experience, and structuring ability in project management related to the project and sub-factors of competence were determined through the review of articles and a series of interviews with experts. Therefore, a questionnaire was created based on the literature review and the collection of expert ideas and opinions. There are two parts to the questionnaire. The first part is a short introduction to the questionnaire. In the main part of the questionnaire, respondents are asked to answer the sub-factors of personnel qualifications listed in Table 1 according to the level of importance. Importance is measured on a 5-point scale

(Likert scale). On the Likert scale, five indicates extreme significance, 4 indicates high importance, three is neutral, two is unimportant, and one is negligible.

A brief explanation for some factors is also provided to ensure a better understanding of the competency factors in the questionnaire and reduce the chance of misinterpretation. Then, in addition to university professors and research activists, the questionnaire was sent to 120 people involved in design, supervision, and implementation, who were randomly selected from among the companies involved in the railway construction field. The questionnaires were requested to be completed by the head of the human resources department or a senior expert in the organization who can express opinions from that company's general point of view. After library research and interviews with elites, the questionnaire was sent to 120 Islamic Republic of Iran Railway Company managers and grade one and two railway companies' active companies.

The questionnaire was sent in September 2020; 48 valid answers were received from the project managers or the senior person of the company, and 72 valid responses were received from other returning classes. The questionnaire will be used to train and adjust the model, and fifteen questionnaires will be used to evaluate the accuracy and efficiency of the created model. The selection of these models was utterly random. Furthermore, according to several questionnaires completed by senior members of companies involved in designing, monitoring, and implementing railway construction projects, there is a satisfactory response rate in this research. As shown in the articles, Cronbach's coefficient alpha was tested to determine the internal consistency among the competencies. The alpha coefficient in this research is 0.91 for the project manager grade, which shows the relatively high consistency of the competence coefficients. Based on Cronbach's alpha coefficient, which was based on SPSS software.

4.2. Hierarchy of Project Manager Competency Criteria

Qualifications for project managers can be explained as a combination of four separate dimensions: specialized and technical qualifications, behavioral qualifications of the project manager from the employer's point of view, criteria of qualifications and the individual's ability to work in the organization, and criteria of competencies and experimental ability of the project manager. According to the International Project Management Association, related series of competency grades are determined for each criterion that correlates the characteristics of employees to each dimension. Fifty-three parameters have been selected based on the suggestions of experts, which are among the influencing factors on the productivity of the project manager in the projects under the supervision of the Islamic Republic of Iran Railway Company. These parameters include the following factors: training, motivation promotion factors, employee participation in the organization's decisions, job cycle and systemic promotion, attention to personal life, professional and technical abilities, related history of people in similar projects, mutual trust of employees and Management. Tables 2 to 5 show the qualifications criteria of project managers. Also, the average of the obtained indicators and Cronbach’s coefficient alpha have been reported.

Table 2. Professional criteria and technical qualifications of the project manager

Item	Criteria	Mean Score	Cronbach's coefficient alpha
C1	a person's ability to provide solutions to solve problems, project failure structure, and issues created in similar projects	4.43	0.89
C2	the personal success records of the project manager in the projects in which he worked	4.41	0.86
C3	a person's ability to choose the number of work fronts, equip the workshop and provide a schedule based on the project conditions at the beginning	4.41	0.73
C4	the level of experience of the project manager in various fields of project implementation	4.39	0.81
C5	a person's ability to identify and allocate and manage expenses and financial issues based on the determined financial flow	4.39	0.76
C6	a person's ability to determine the scope of the project and the appropriate timing for it	4.38	0.72
C7	a person's ability to answer questions related to the work group and divide responsibilities	4.36	0.76
C8	a person's ability to identify and distribute human resources and equipment in the project based on the allocation of resources	4.24	0.71
C9	a person's ability to manage financial resources until the completion of the project and deliver all phases in a suitable period and identify its special conditions	4.23	0.79
C10	the ability of the project manager to recognize the algorithm of the criteria that determines the project failure structure	4.22	0.92
C11	a person's ability to identify the number and type of contracts required and related legal issues	4.21	0.86
C12	the ability of a person to manage unforeseen changes in railway projects in terms of finance and time and to provide corrective solutions for problems	4.17	0.79
C13	the applicant's ability to form an organizational chart and pay attention to its compliance	4.16	0.81
C14	the person's experience in similar railway projects with the current project in terms of real dimensions and project sensitivity	4.09	0.91
C15	knowledge about organization charts suitable for railway projects	4.09	0.84
C16	individual feedback on threats and opportunities (swot) questions	4.03	0.85

Item	Criteria	Mean Score	Cronbach's coefficient alpha
C17	the physical ability and age conditions of the person to attend the office and workshop according to the work pressure	4	0.73
C18	presenting periodic reports of the project and his ability to identify the positive and negative points of these reports	3.97	0.91
C19	the ability concerning the specialized parent company and other companies and organizations is effective in identifying and interacting with the similar projects	3.67	0.81
C20	validity of academic and university degrees related to the job	3.52	0.81
C21	ability and knowledge of the individual in the field of management and identification of iso requirements	3.45	0.84

Table 3. Behavioral qualifications criteria of the project manager from the employer's point of view

Item	Criteria	Mean Score	Cronbach's coefficient alpha
C22	the commitment and motivation of the person in the role of project manager	0.85	0.85
C23	individual behavioral indicators in project team leadership	0.87	0.87
C24	a person's ability to determine creative and specific solutions in dealing with solving problems or deficiencies within the project	0.91	0.91
C25	maintaining calmness in making decisions and speaking during criticism and special circumstances (engineering ethics)	0.71	0.71
C26	the ability to accept criticism, patience, and self-control in identifying problems and making logical decisions	0.79	0.79
C27	the ability of the project manager to deal with and manage situations in the face of conflict and crisis	0.86	0.86
C28	the ability of a person as a project manager to show personal characteristics in conversations, writing, and negotiations	0.76	0.76
C29	a person's ability to determine and change solutions in special situations by considering the criticisms of people under observation or orders from superiors in selecting managers.	0.81	0.81
C30	a person's ability to review periodic reports, draw conclusions from them and determine future	0.86	0.86

Item	Criteria	Mean Score	Cronbach's coefficient alpha
	solutions based on their results in project direction		
C31	in determining the efficiency and level of performance of the project manager, the ability to provide appropriate answers and suggest correct solutions	0.84	0.84
C32	in critical cases and specific project conditions, how much to answer the questions related to the person's ability to negotiate and convince the other party	0.85	0.85
C33	answers of the interviewee regarding how the project manager deals with engineering ethics and social custom	0.89	0.89
C34	answers of the person in the field of attention to organizational values and maintaining the project and brand of the employer or company	0.92	0.92
C35	solutions provided in response to questions related to project problems and conflicts, and crises and individual responses	0.96	0.96
C36	the project manager's personal use of the consultant in answering the relevant questions	0.91	0.91

Table 4. The criteria of qualifications and the ability of a person to work in the organization

Item	Criteria	Mean Score	Cronbach's coefficient alpha
C37	the level of a person's ability to manage and interact with subordinates and other related colleagues in the organization	4.26	0.81
C38	the importance of the individual to organize and act according to your company's values	4.16	0.75
C39	the individual's mastery of the internal regulations and the regulations of the program and budget organization	4.04	0.72
C40	acquaintance and suggestions of the project manager with new systems, products, and technologies in the construction and operation of the railway line	4	0.76
C41	To what extent do the person's answers in the field of organizational work convince you based on project-oriented and project advancement?	3.9	0.78
C42	the person's answers align with the questions related to the railway project and its conditions, to what extent are they based on the program-	3.88	0.86

Item	Criteria	Mean Score	Cronbach's coefficient alpha
	oriented and general movement of the employer.		
C43	compared to other factors, one's health, safety, and environmental (hse) solutions and suggestions in railway construction	3.86	0.81
C44	a person's ability to identify investors, influential factors in their selection, and how to invest in the organization	3.72	0.73
C45	a person's ability to determine and comment on the railway route to create a future business on the axis of railway operation and development	3.68	0.86
C46	working based on the person's previous work conditions in your company's structure as a project manager	3.6	0.91
C47	individual's ability to identify and participate in public and private PPPs	3.35	0.72

Table 5. Criteria of qualifications and experience of the project manager

Item	Criteria	Mean Score	Cronbach's coefficient alpha
C48	experience working with CCTV, online (central monitoring) daily, weekly, and monthly reports	4.16	0.89
C49	individual solutions to reduce project operation time to prevent cost increases in railway projects	4	0.85
C50	the project manager's ability to interpret the results of the MSP software and determine the critical path and use its facilities	3.92	0.84
C51	individual solutions to increase the quality of the project to prevent the increase of costs in the construction projects of the railway company	3.85	0.91
C52	mastery of project management standards such as Prince Two and Pmbok	3.74	0.76
C53	solutions to prevent the prolongation of the project time due to the increase in the quality of construction of railway lines	3.67	0.74

By examining the results, it is clear that the results of project manager qualifications in Iran, especially the Iranian Railway Company, have different criteria compared to the first glance of the project and the PMBOK indicators. Examining the results of the expert questionnaires show that the most valuable qualifications of the project manager are all the technical qualifications of the project manager, and the criteria of work in the organization and experimental and structuring are not included in the first ten criteria. The first five criteria compared to other criteria are as follows:

1. The ability of a candidate to provide solutions to problems, the structure of project failure, and issues encountered in similar projects.
2. The success of the project manager in the projects in which he has worked.
3. The candidate's ability to choose the number of work fronts, equip the workshop and provide a schedule based on the conditions of the project at its beginning.
4. Project manager's experience in various fields of civil engineering.
5. The candidate's ability to identify and allocate costs and financial issues based on the breakdown structure and type of the project.

On the other hand, according to experts, the least valuable criteria in selecting the project manager are familiarity with ISO and quality standards and the place of academic education.

1. Individual's ability to identify and participate in public and private PPPs
2. Ability and knowledge of the individual in the field of management and identification of ISO requirements
3. The quality of academic and university degrees
4. Working based on the person's previous work conditions in your company's structure as a project manager
5. The candidate's ability and information about the specialized parent company and other companies and organizations

The interesting point in examining the results is the absence of the project manager's qualifications criteria from the employer's point of view and the project's competence from the empirical point of view in less essential points. In the general evaluation of the project manager's technical indicators, it can be said that the most crucial general indicator for hiring a project manager from the experts' point of view is the priority of the person's technical ability index and the manager's abilities from the employer's point of view (Table 6).

Table 6. The relative importance of the main criteria of the project manager

The Mean of factor importance	Competency Criteria
83%	behavioral qualifications criteria of the project manager from the employer's point of view
83%	professional criteria and technical qualifications
77%	the criteria of qualifications and the ability of a person to work in the organization
78%	criteria of qualifications and experience of the project manager

5. Competency Based Selection by Genetic Programming multigenic Regression (CSPR)

To eliminate personal judgments and minimize errors, CSPR is proposed to consider the impact of various qualification items obtained in library research and interviews. For this purpose, the data of the questionnaires are divided into three parts:

One hundred eleven valid questionnaires have been received. Among these questionnaires, 81 questionnaires were used for model training, 15 were used to verify and adjust the model coefficients, and 15 were used to test the CSPR model.

The model's parameters are the 53 project manager qualification items mentioned in the questionnaires, which are mentioned in Tables 2 to 5. For this case, 53 independent genes have been predicted.

This gene determines the effects of each criterion is to the final competency of the project manager candidate. The program is written so that any operators of addition, subtraction, multiplication and division, power and logarithm, absolute magnitude, sine and cosine, tangent, cotangent, etc., can be used. Sixty-four different operators can be selected to convert the variable to the final result of the relationship. The CSPR code was programmed to determine the best operator relative to the output for that quantity. After that, using optimal coefficients, it suggests 53 optimal coefficients for each of the operators and a fixed optimal number for addition or subtraction.

Similar to all meta-heuristic algorithms, the larger the initial population, the more accurate the CSPR model. On the other hand, the large number of parameters will also lead to a time-consuming analysis time. For this purpose, 2000 numbers have been considered for the initial genetic programming population. A maximum of 200 repetitions of the algorithm is considered. The program is executed twice in parallel, and the results are combined at the end. Forming the combined optimal statistical population dramatically reduces the probability of falling in the local optimal points. Therefore, by utilizing the data suggested for model training, the CSPR trains and adapts the gene parameters and optimal coefficients for the project manager's competency. CSPR uses the hybrid algorithm to train gene parameters and coefficients. The hybrid algorithm consists of forward and backward paths. The method (forward path) is used to optimize the resulting operators along with the fixed parameters. When the desired operators are obtained, the backward path is immediately started and used to set the optimal coefficients of the relation in the preferred form. The combination of these optimal quantities and optimal operators in the third run of the program results in the optimal relationship with trial and error.

5.1. Training, Validation, and Testing of CSPR Evaluation

Employees can be evaluated by observation through interviews. Therefore, we need to determine the importance of qualification indicators to measure whether employees will fit the job well. We use linguistic indicators to evaluate employees with each factor. The fitness function is to minimize the distance of the project manager candidate's competency between the questionnaires' results, and the CSPR predicted model from 100%. The graphs show that the presented method can predict the same results as the questionnaires with a suitable percentage. Figure 1 compares the possibility of selecting a project manager candidate in CSPR model output and questioner data after training. Due to the similarity of results between the output of the model and the questionnaires, the CSPR is trained satisfactorily. The R^2 factor of CSPR is achieved, which is in the acceptable range. Figure 2 shows the project manager's competency level in the validated models compared to the questionnaires. The model's output results are compared with the actual data based on the interviews. The horizontal axis is the number of sample data in the training record, and the vertical axis is their corresponding predicted qualification scores. As shown in Figure 2 and through the findings of Table 7, it is proved that the results of the CSPR model are in good agreement with the results of the real questionnaire.

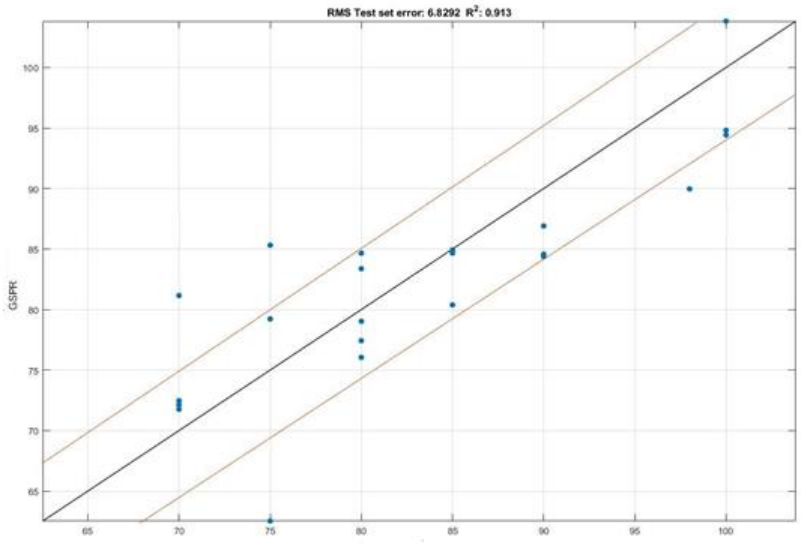

Figure 1. Comparison between CSPR-trained model output and real data for the competency of project manager candidate

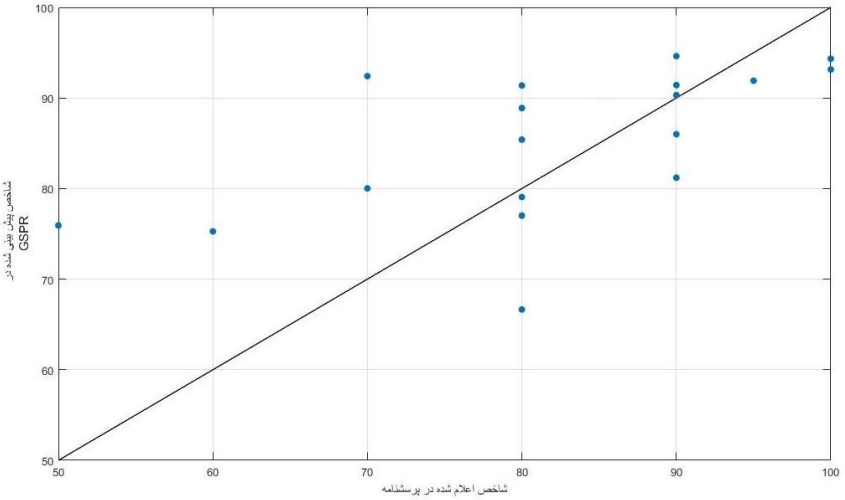

Figure 2. The project manager's competency level in the validated models compared to the questionnaires

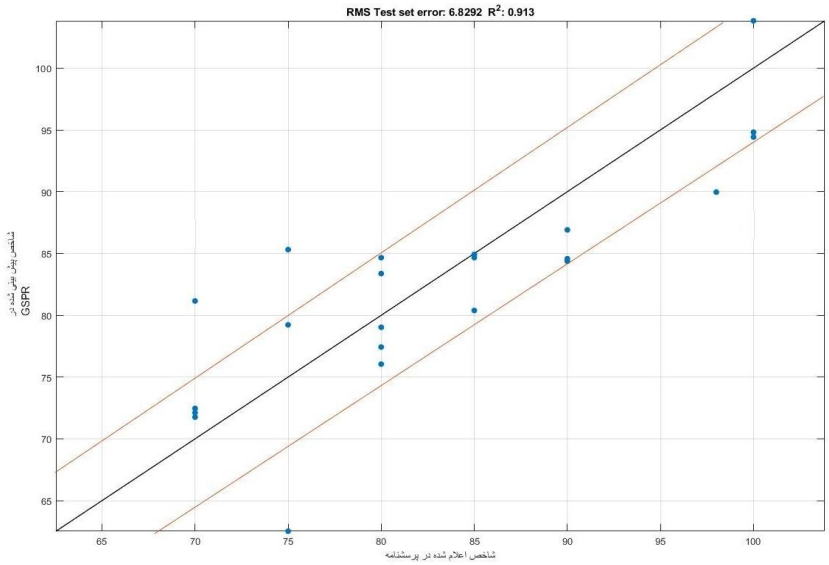

Figure 3. The project manager's competency level in the CSPR model compared to the test questionnaires

Figure 3 demonstrates the project manager's competency level in the CSPR model compared to the test questionnaires. The model's output results are compared with the actual data based on the interviews. The horizontal axis is the number of sample data in the test record, and the vertical axis is the corresponding predicted qualification scores for them. As shown in Figure 3 and through the findings of Table 7, it is proved that the results of the CSPR model are in good agreement with the results of the real questionnaire.

5.2. Performance Review of the Final CSPR Model

Figure 4 shows the same trend between CSPR model output and real data for each questionnaire's project management training, verification, and test data. More genes will not necessarily lead to a better competency model. To ensure the degree of difficulty of the optimal CSPR model, Figure 5 shows the degree of dispersion of the degree of complexity of 2000 answers created compared to $1\text{-}R^2$. Minimizing the $1\text{-}R^2$ index of the model demonstrates the accuracy of the prediction with the evaluation of the project manager. After completing the model training around the complexity of 370, the concentration of optimal models shows that the model is not stuck in the local optimal point to a large extent, and a better optimal response is not obtained around it.

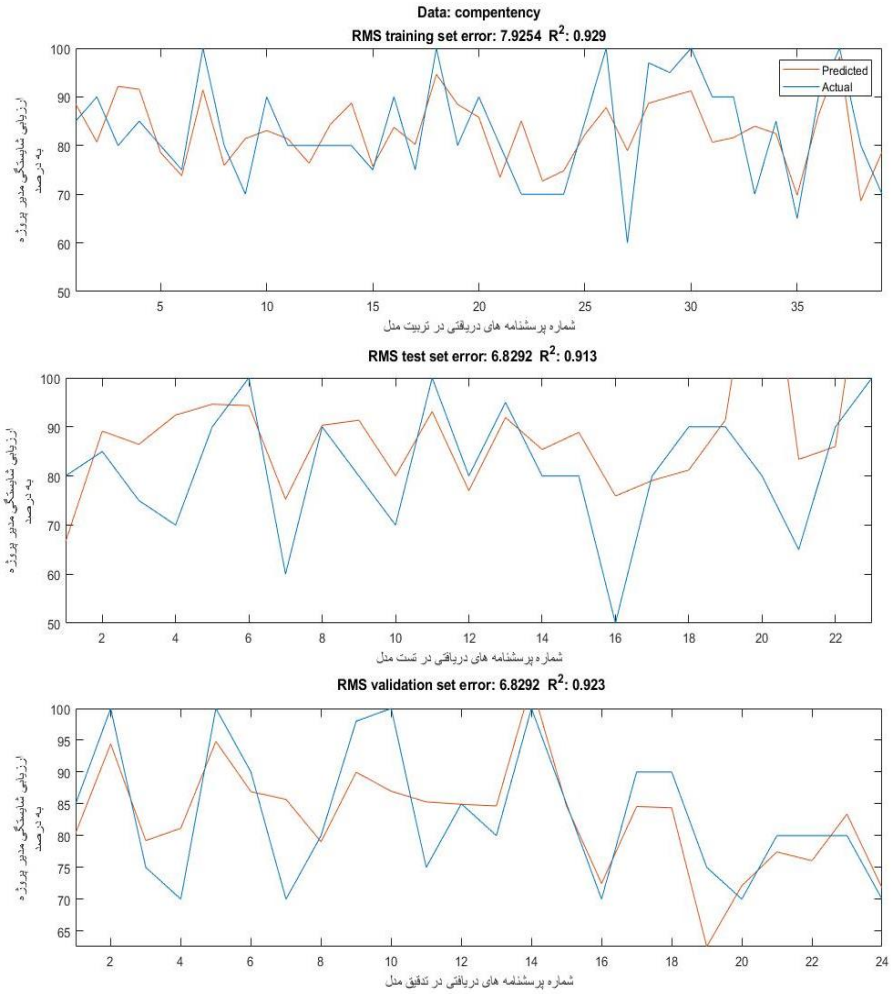

Figure 4. Comparison between CSPR model output and real data for project manager training, verification, and test questionnaires

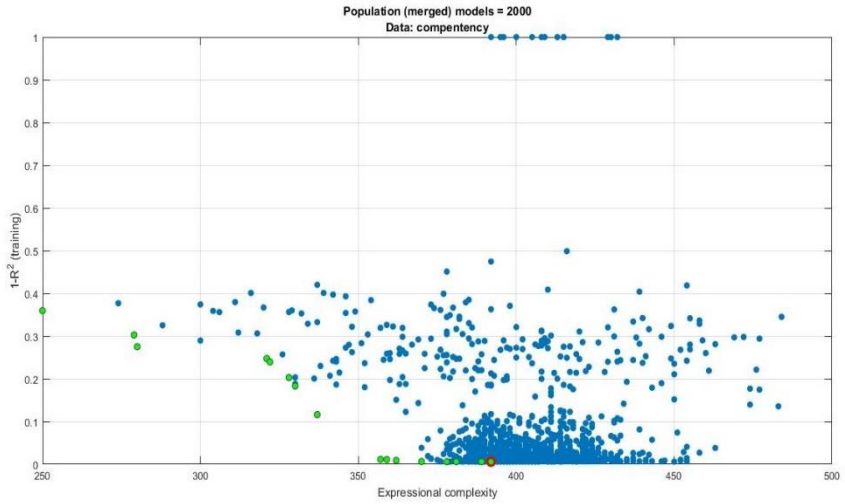

Figure 5. Simplified relationship of the level of qualifications of the project manager in the railway industry

5.3. Final Decision to Select Project Manager

The CSPR values calculate the project manager's technical qualification scores and show the total qualification score from 100%. The zero output means a person with poor qualifications, and the number 1 indicates a person with high qualifications. The model can evaluate each candidate using 53 items logically, regardless of personal or emotional comments. The CSPR independently provides the person's qualification index. All project manager candidates are ranked based on their total scores. Finally, among the top candidates, the most qualified employees could be selected for satisfactory executive performance as they have the highest qualification score regardless of personal opinions. Figure 6 shows the output of the CSPR relationship to evaluate the qualifications of the project manager.

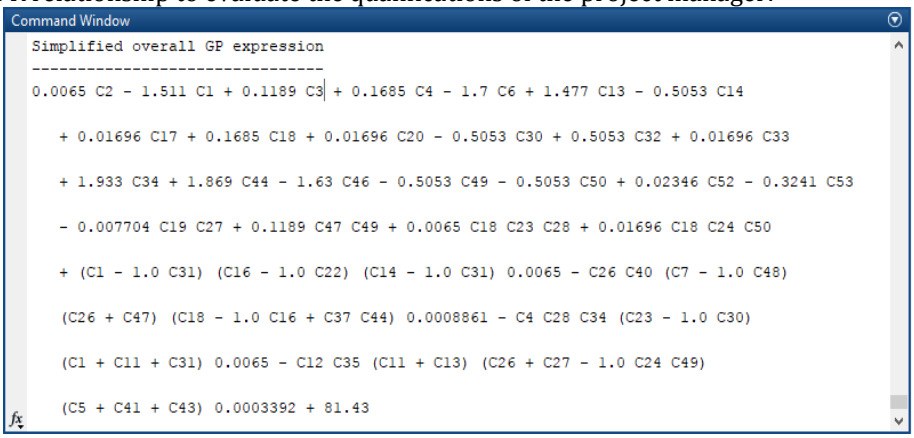

Figure 6. Simplified relationship of the level of qualifications of the project manager in the railway industry

Regardless of knowing the result of the final evaluation, the interviewer enters his comments regarding 53 critical items in the file containing this optimal

relationship. The output of the person's competence criterion is between one and 100. The qualifications in all aspects of employment are achieved if the competency is closer to 100%. The optimal relationship is based on optimal coefficients and four operations of addition, subtraction, multiplication, and division. But the time to produce the optimal answer and the possibility of modeling it after production in simple software such as Excel is difficult. This relationship provides up to 3% more accurate answers. As a result, the research was presented based on a more straightforward relationship.

6. Conclusion

In this research, an adaptive phased model for selecting and assignment of project managers, especially in railway construction, based on qualifications, has been specified and implemented. The presented CSPR can be a suitable alternative to the traditional method of selecting different personnel, such as the project manager. The proposed system was concluded using the analyzed available data that satisfactory results are provided. This reduces time and cost during the selection phase and eliminates hidden costs and contradictions during the project implementation phase. The advantages of CSPR can be expressed as follows:

1. Hierarchy structure includes all manners of qualification criteria of the project manager based on the decision of all experts.
2. The CSPR is an accurate and helpful tool for decision-makers of railway companies who lack the experience to select the best person for projects among the possible options.
3. Decision makers can break down the complex problem of employee selection into more superficial and more logical judgments of factors.

The optimal decision-making model is flexible enough to integrate additional factors into the conclusions. Due to the two-stage selection process, the CSPR is considered when there are too many applicants for a position. In the first stage, the qualification of a limited number of candidates can be separated from the general group of candidates using the CSPR system. The interview can be typically conducted with the best candidates. The scoring scale proposed in the project manager's qualification portfolio provides a better possibility to describe the competency level of the person who has been evaluated. Project managers can use this scale to assess themselves in the performance criteria of each area and field defined in the project manager's qualification promotion framework and enter the obtained results in the project manager's qualification report. This approach allows project managers to get a comprehensive picture of themselves as project managers. The ultimate goal of project managers should be at the top in all four areas. Organizations can also use the project manager's qualification report to document the relative strength of their project managers based on the qualifications defined in the framework of project manager qualification improvement. This approach allows organizations to focus on the optimal level needed by recognizing and developing the required qualifications from their project managers.

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