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An Approach to Improve Organizational Project Management Using an Interpretive Structural Model Based on Earned Value Management Maturity Model

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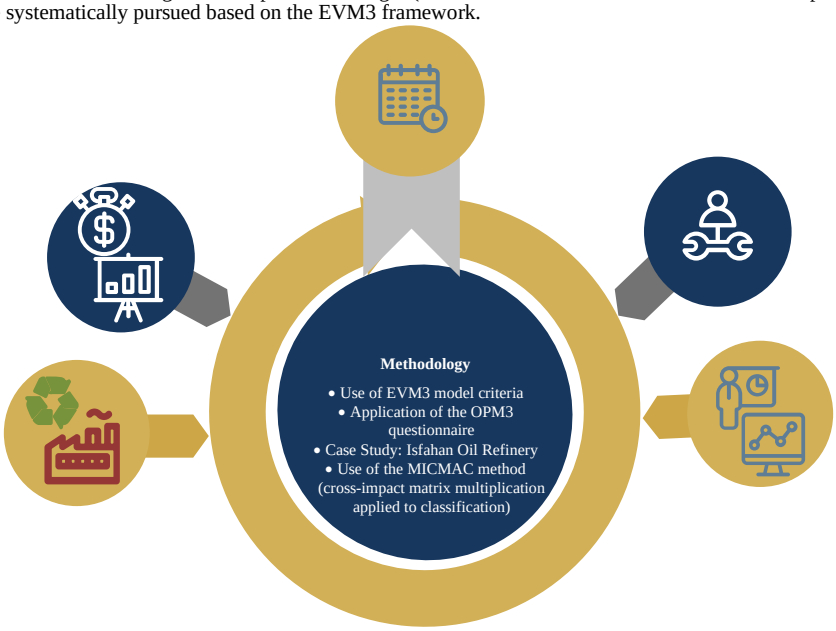
A B S T R A C T

This research focuses on analyzing and improving Organizational Project Management (OPM) at the Isfahan Oil Refinery Company by leveraging the Earned Value Management Maturity Model (EVM3). Earned Value Management (EVM) is highlighted as a practical methodology that unifies schedule, cost, and scope to accurately measure project progress, enabling timely decision-making and corrective actions.The primary objective was to enhance the OPM maturity level of the refinery using EVM3 criteria. The study first assessed the organization's initial project management maturity via the OPM3 questionnaire to identify weaknesses. These weaknesses were then linked to the EVM3 standard criteria using an Interpretive Structural Model (ISM). Finally, the results were analyzed using the Matrice d'Impact Croisé Multiplication Appliquée à un Classement (MICMAC) method to determine the most critical factors.The findings revealed that the most important criteria requiring strengthening are increased attention to scheduling and the integration process across different knowledge areas and process groups. To address these deficiencies, major policy proposals include implementing public-level project management training for all team members, specialized training for project managers, and establishing external monitoring teams to oversee performance and ensure integration between processes and scheduling. These improvement stages (standardization, measurement, control, and improvement) were systematically pursued based on the EVM3 framework.



1. Introduction

In the 2000 version of the Project Management Body of Knowledge (PMBOK), the Project Management Institute (PMI) published the Earned Value Management (EVM) guide to assist project management professionals. The EVM guide simplifies performance monitoring terms and formulas. The fourth edition of PMBOK, published in 2008, details the EVM formula and simplifies the terminology. In addition, the PMI practice standard was extended in 2011 to the EVM methodology, which covers fundamental and complex concepts. The fifth edition of the PMBOK added four planning processes, including program cost management, focusing on developing and maintaining project costs [1- 2].

In 1998, the Electronics Industry Association (EIA) published the American National Standards Institute ANSI / EIA 748-A standard for Earned Value Management System (EVMS) in collaboration with the National Defense Industry Association (NDIA) and other organizations. EVMS has become more popular in the private sector and the global community. Some describe the global acceptance of EVM:

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The United States has played a vital role in formalizing and disseminating EVM knowledge and applying EVM to various industries. Many industrialized countries, such as Australia, Canada, Sweden, the United Kingdom, and some fast-growing economies in Asia and the Middle East, have followed suit and used EVM in their industries [3].

OPM3 provides a framework for measuring project management competencies, and the higher the organization's level of maturity, the higher the organization's chances to do so [4].

OPM3 is used to assess the current state of project management, find problems, and identify ways to improve [5]. We will not find an organization that has reached full organizational maturity in the real world. No one has gone to the maximum development, and no one will. So, discussing a certain amount of maturity and trying to measure or determine organizational maturity [6] makes sense. Paying attention to the level of maturity of organizations' project management is because projects are the best way to change complex organizational situations, and the concept of project maturity is closely related to their success or failure. To date, no research has been presented that provides significant statistical evidence for the relationship between the level of OPM3 and the success of its projects. However, some ideas of project management maturity are related to organizational performance [7]. In this study, the purpose is to use the EVM3 criteria obtained as a tool for this action, i.e., to improve organizational project management's performance and maturity level.

One of the essential things in projects is to check the performance of projects. And due to the element of uncertainty in projects, it is essential to contract their status as a moment to review and manage the value obtained is one of the most common and well-known methods. Today, due to competition and the high speed of change, one of the project's goals is to complete the project according to its budget, schedule, and scope. Therefore, several factors must be constantly controlled, reviewed, and improved. This thesis identifies the most critical factors affecting OPM3 by using the EVM3 standard to level them. On the other hand, the maturity level of the studied organization is determined through OPM3. Finally, using these two models in a project-oriented organization will achieve it with the EVM standard provided by PMI.

Procurement engineering for large oil and gas projects often incurs additional costs due to long delays in the program. One of the biggest causes is the mismanagement of the project schedule. On the other hand, one of the solutions for proper project scheduling planning is to control the project's progress through EVM, which is behind the project manager's schedule, budgeting, or scope creep. Recalls that identifying these delays, which increase the project's cost, can be controlled as much as possible by identifying the influencing factors lamented on a project has significant benefits for both the contractor and the customer. Determining the project's progress and comparing it with the initial plan has always been the concern of project managers. It can be said explicitly that controlling project performance with EVM is the most efficient and common way to control project performance.

The main question:

Investigating the role of EVM in improving the OPM3 performance in Isfahan oil refinery company?

Sub-questions:

- What is the priority of the final criteria in the studied organization regarding project management maturity?

In this study, in general, the purpose is to use the EVM criteria to improve the level of OPM3, that is, by providing an ISM to provide an approach using the EVM3 criteria to have a, we pay attention to the project-based organization.

US federal agencies first introduced the concept of cost/schedule control system criteria (C/SCSC) in 1967. Currently, this concept is called EVM [8].

Around 1967, EVM was introduced by the U.S. federal government agencies as an integral part of the C/SCSC and was used in large-scale applications. Initially, EVM was often used for projects related to the U.S. federal government. It was less commonly used in the private sector, but this system has recently increased rapidly [9].

EVM is one of the techniques for overcoming program and budget issues. EVM helps track project performance by providing program variance, cost variance, and performance indicators [10].

EV analysis is a method of measuring performance. EV is a program management technique that uses work in progress to show what is happening in the future. Value management is the early warning system for planning and controlling project performance. Value management manages work packages by integrating project scope, schedule, and cost objectives and uses a baseline to control costs and evaluate the performance of a project on a given date [11].

EVM is a method for integrating scope, program, and resources. To objectively measure project performance and progress and to predict project outcome

Kwon's other definition is that EV is a project control technique used in many countries that provides a little measurement for integrating program and cost information. Evaluates to identify possible delays and excess costs

It can also be defined as: "EVM is a tool or technique that determines the progress of a project and predicts the final cost and total duration". Alternatively, "a project management tool that offers significant managerial benefits by identifying project deliveries, linking these outputs to a specific group or individual responsibilities, and tracking performance over time"

Fleming also defined the EVM as "a control method for estimating the final cost and timing of a project and performing a continuous estimate of actual work in a precise construction work schedule" [12].

This category includes five criteria that refer to the basic requirements and requirements that projects must have to get started. The most important items in this category include defining Work Breakdown Structure (WBS), Organizational Breakdown Structure (OBS), exact scope, and integration between all components

A WBS that is necessary and vital as a substructure for a building and for planning all work shows the project tasks facilitates reporting and tracking, and provides a control framework for integrated plan management. On the other hand, it facilitates communication because it is a common reference for customers, management, and the project team. It must also be ensured that the WBS fully covers the Statement of Work (SOW)

OBS directly represents the hierarchy and explains organizations for sourcing, planning, and performing tasks. OBS is used to facilitate the determination of responsibility, accountability, and authority to do all things

It provides a logical framework that connects the results of management processes through the data element. It includes integration, scheduling, budgeting, cost consolidation management processes, job tracking, actual cost collection, management analysis, and remedial action

Reviewing and observing direct and indirect costs are essential for projects' success and better management; therefore, measures should be taken to manage and control these costs, especially indirect costs

By creating an appropriate and accurate control account, the proper management level is determined based on the complexity of the work and the organization's ability. The lowest level of program performance management can also be specified

Table 1. Organization criteria [14]

Criterion 1	• WBS definition • WBS dictionary definition • Prepare the statement of work
Criterion 2	OBS definition
Criterion 3	Integration process
Criterion 4	Determining overhead costs and the person responsible for it
Criterion 5	Performance evaluation with control account resulting from OBS and WBS integration

This category has the most extensive criteria for this standard, including ten. The criteria for this group include the main integrated project roadmap for estimating contract objectives .

The schedule should be seamless and tailored to the project objectives. Moreover, all key events and activities reflect the logical sequence of events, considering the identified risks and opportunities. It is essential to ensure that all team members follow the same schedule, monitor progress, and analyze and track corrective actions .

The purpose of identifying these points and objective indicators is to provide a tool for the amount of work done so far that determines the EV and the relationship between the budget and the EV .

The step-by-step performance measurement basis shows all the work and plans allowed and is presented to the project manager as a reference for performance evaluation. This report illustrates the step-by-step and cumulative costs for the budget work. Performance measurement baseline is one of the critical components of EVM .

One of the critical elements in planning a project and creating a performance measurement basis is budgeting for all permitted tasks. This criterion regulates the budget by identifying cost elements such as manpower, raw materials, etc. Identifying cost elements identifies the resources required and thus the scope of work for the implementing organization .

Work packages may include a specific task or multiple tasks, and the budget for each work package should be clearly defined .

The control accounts or each control center must include the budget, schedule, and scope of work, and it must specify the work assigned and the budget specified for it to the relevant unit. Therefore, there should be no budgets without a specific scope of work, or vice versa; a control account manager should not have an authorized scope without an associated budget .

Project tasks need to be evaluated to determine the best way to budget and measure progress. LOE activities do not have a measurable output or product, and it is not impossible to measure them separately. The budget for this activity is individually using separate supporting documents, knowing the exact time in the work packages .

Set overhead budgets for each company's critical organizational component to be allocated to the program as indirect costs. And then, by comparing actual indirect costs with designated indirect budgets, the company can determine whether indirect costs are being recruited based on existing documented allocation schemes or whether the allocation rate needs to be adjusted [13].

A management reserve is a budget intended for unplanned events that may occur during the project and should be commensurate with the risks and opportunities involved in the project. It is predictable and is used to reduce cost risks during the project. The important point is that it should not be used as a resource to increase the scope of work, nor should it be eliminated to attract costs. An undistributed budget is a budget that applies to specific project efforts but has not yet been allocated directly to project sub-areas. Moreover, because it is a work-related budget, it forms part of the baseline for measuring performance .

The final cost for the project should be the sum of all control accounts, indirect costs, management reserves, and unallocated budgets, as well as consistent with the performance measurement basis. This criterion focuses on accounting for and controlling all types of project costs. If all types of project costs are controlled, it can be checked whether the project's total cost has exceeded the total approved budget .

The third category of criteria of this standard includes six criteria that emphasize the recording of project financial information and the implementation of methods for budgeting and accounting of financial components of the project and their integration .

Direct costs should be allocated to projects in a way that is determined following the budget, in which case we expect effective performance .

Cost allocations should be coded based on work orders so that costs can be identified at the level of control accounts and summarized costs. Make work failure structure possible at higher levels. It should be noted that a control center is not assigned to two or more elements of the WBS .
This criterion is similar to the previous standard. The only difference is in the use of different methods in summarizing the costs of control centers because WBS was used in the last criterion, but in this criterion, OBS .
This criterion re-examines the control of indirect costs and emphasizes calculating and allocating indirect costs to the work or tasks to which these costs relate .
Based on this criterion, the project should determine the cost units of items produced consecutively and continuously .
The materials accounting system should consider the following:

- ✓ Accurate and precise calculation and cost accounting allocation consistent with approved budgets.
- ✓ Measure material cost performance at scheduled times.
- ✓ Complete calculation of material costs, even inventory storage costs.

Table 2. Accounting consideration

Criterion 16	Recording direct project costs	Criterion 19	Record/allocate indirect costs
Criterion 17	Summarize direct costs by WBS elements	Criterion 20	Tracking and reporting costs and materials
Criterion 18	Summarize direct costs by OBS elements	Criterion 21	

source : See Ref [13]

Shahrizan Yusoff et al. [14] presented an article entitled model of effectiveness EVM in the Malaysian manufacturing sector in 2022. This study aims to show how EVM is used in the Malaysian manufacturing sector and to demonstrate its effectiveness in producing a survey. This approach has the potential to be extended and generalized in solving similar problems in other industrial fields. Therefore, it can be used as a prescription for different industries.
Muhammad Abdul Karim et al. [15] presented an article entitled organizational aspects and practices for enhancing Organizational Project Management Maturity (OPMM) in 2022. An organization's performance level is determined according to its performance in implementing project management knowledge and methods, which indicates the maturity level of the organization's project management. This article aims to determine the type of aspects and methods of the organization that can affect the success of PMM implementation in the organization. In this research, by reviewing 23 articles from previous literature in this field, we identified six organizational aspects that affect the implementation of PMM, which include: 1) Organizational culture, 2) Differences and priorities of stakeholders, 3) Organizational maturity structure, 4) Project complexity 5) Motivation 6) Prerequisites for the next level of maturity.
Vartenie Aramali et al. [16] presented an article entitled forward-looking state-of-the-art review on EVMS: the disconnect between academia and industry in 2022. In this article, the purpose of reviewing the status of EVM / EVMS is to critically review academic and industrial journals and focus on the maturity of EVMS and the environment around its implementation. In this regard, research on the history of EVMS since its emergence of EVM has identified 600 publications that were classified into eight main groups. After the analysis, the existing gaps were identified, and new perspectives were presented to support future research in this field.
Joaquín López Pascual et al. [17] paper entitled the Enhanced-Earned Value Management (E-EVM) model: A proposal for the aerospace industry in 2021. In this study, a model based on EVM called E-EVM was presented, which can simultaneously review and evaluate many projects, the possibility of predicting pending tasks, measurable considers time units or cost units until the end of the project, and also have the ability to identify projects with delays and convert this time into monetary units. As a result, this model is suitable for aerospace projects because it is suitable for projects with many subprojects and provides decision-making in the shortest possible time for project managers.
Hadi Shirouyehzad et al. [18] presented an article entitled maturity assessment and ranking of project management knowledge areas based on OPM3: Case study: Isfahan's Mobarakeh Steel Company in 2021. Project management maturity models are one of the most important methods of measuring project management's maturity level, making it possible to compare the organization's maturity level with a scientific and reliable standard. This article aims to measure the maturity level of organizational project management in Mobarakeh Steel Company. The method of collecting information is through interviews with experts, and finally weighing ten knowledge areas of project management according to their maturity level in four process improvement stages. Standardization, measurement, control, and improvement have been made. According to the Aras model, the ranking results include project management knowledge, timing, quality, procurement, cost, scope, communication, integration, risk, resources, and stakeholders.
Seideh Zahra Naseri et al. [19] presented an article titled OPM3 implementation challenges and solutions in Iran's petrochemical industry in 2021. The need to remain competitive and the desire to grow and improve lead organizations to use project management models shows that the most well-known of them is the OPM3, which is evaluated in three areas: project, program, and portfolio. Parts of this model were used in the Iranian petrochemical industry, and this article aims to identify the challenges of implementing this model and providing solutions for them. Among the most important identified challenges are “cultural and structural challenges and unfamiliarity in a project, program, and portfolio, recognizing and implementing organizational empowerment, implementing all OPM3 steps in the organization and not continuing to use this model in the organization” and some proposed solutions are: localization, creating sufficient training conditions, using past experiences, supporting students and researchers in order to implement PMBOK, spending time and money to master all parts of this model, simplifying concepts and their implementation.
Filipe Machado et al. [20] presented an article titled Project Management Maturity Models (PMMM) for construction companies in 2021. The purpose of this article is to identify and analyze PMMMs in order to determine the best models that are suitable for use in construction companies. By reviewing the literature, 39 PMMMs were identified. After this, the authors selected those applied in the construction sector. Based on the comparative analysis, it was found that MMGP Prado and OPM3 models are considered the best models for PMM evaluation in construction organizations, considering that MMGP Prado is the only model used in the construction sector; it has been applied that has not had any negative aspects. OPM3 was chosen because it was the most cited PMMM in the reviewed literature and was also fully developed under the supervision of one of the largest institutions in the field of PM, namely PMI.

2. Method

The present study is applied in terms of purpose because it evaluates and improves the level of OPM3 and has many applications for managers of the organization under study. In terms of data collection method, it is classified as field research, the framework of which has used special techniques such as distributing questionnaires and conducting interviews. And its sampling method is done purposefully and among people with sufficient knowledge of the organization. Finally, this research is descriptive in terms of the information analysis method because it describes the company's current state of project management processes. The flowchart of the research steps is as follows:

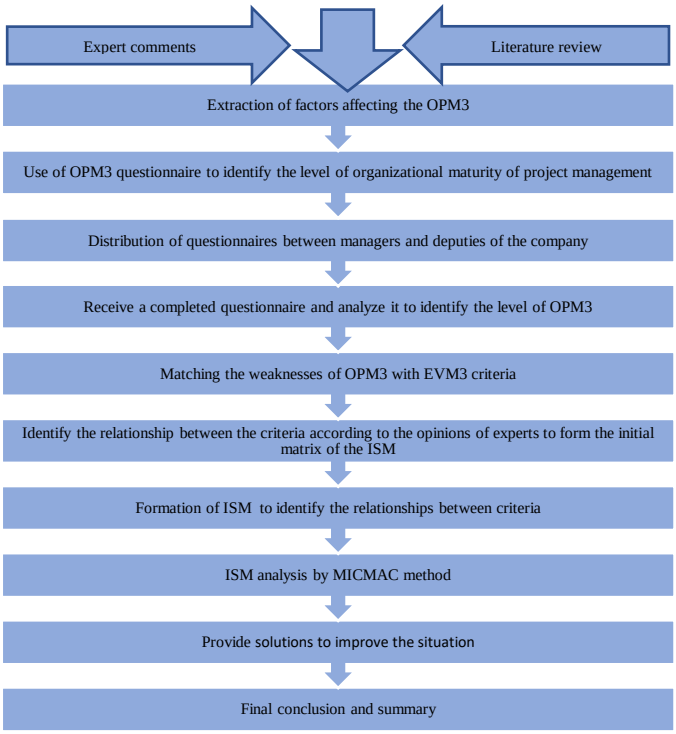

Figure 1 .Flowchart of the research [Source:Research findings]

According to the review of the subject literature in accordance with the articles presented in the second chapter, the EVM technique is mixed and applied with other methods such as Monte Carlo modeling, risk management, and also the comparison of the traditional EVM method with methods such as E-EVM or EVM-G, indicating it gives the efficiency of this method in measuring performance and improving projects.
Also, according to the review of the literature, many methods have been used to measure the maturity level of the organization's project management, such as PM2, P2M2, and MMGP Prada; in total, comparisons have been made to measure the effectiveness of these methods in different industries, the OPM3 method to measure level the maturity of the project management of the organization is one of the most suggested methods that can be implemented in most industries.
And the reason for using the interpretive structural model and the MICMAC analysis method is that in this method, the self-interaction matrix is completed according to the experts' opinions, so the opinions are based on the experts' experience, so the research results are much more useful than other methods may the results be obtained according to the data.
Finally, because these two techniques, EVM and OPM3, are both famous and widely used methods and techniques in the field of project management, we have reached them through literature studies. In this research, we used these two methods as a mix, because both methods are among the best methods of measuring project management performance and maturity in their group.
The research area of Isfahan oil refinery Company is located in Shahinshahr. The period of this research is 1400. It is an approach to improving OPM3 using an ISM based on EVM3.

The data collection tool in the self-assessment stage was an interview and a questionnaire that was prepared and translated. Questionnaire questions are used in two parts; the first part is related to personal information about the interviewee, including gender, age, and position in the organization. The second part is designed to assess the level of OPM3. PMI believes that managerial and key positions in the organization are good options for answering the questions of this questionnaire. And the answer of all informed people is of equal importance; also, there is no need to distribute the questionnaire on a large scale, And the accountability of people who have full knowledge of organizational issues is enough to achieve the correct answer.
The organization's evaluation is based on the OPM3, which includes a 151-item yes-no questionnaire. The questionnaire is extracted from this field's PMI website and related books. The questions of this questionnaire include the areas of project management, program management, and portfolio management, and in each area, the organization is examined in terms of process improvement stages, i.e., standardization, measurement, control, and improvement. In this study, due to the existing limitations and in order to complete the questionnaires by the managers of the relevant organization, only questions related to the field of project management were raised, as a result of which the questions were reduced from 151 to 55.
Regarding reviewing the validity of the questionnaire, it should be considered that this standard is a global standard in the field of project management, which has been prepared by the most reputable international organization active in this field with the participation of project management experts from more than 35 countries. Therefore, it can be concluded that the questionnaire used has sufficient validity.
After receiving the completed questionnaires, considering that the answers are yes-no, for better calculations, we consider the number zero equal to the answer no and the number one equal to the answer yes. In the next step, to get the final answer to each question, we use the arithmetic mean formula:

$$Mean\left(\frac{Number\ of\ yes\ answers}{n}\right) \quad (1)$$

Where n in the above formula is equal to the number of samples, which for this research is equal to 10, and the analysis is done in such a way that if the answer of the above formula for each question is equal to and greater than .5, the final answer to the question is equal yes or the same as one, and if the answer to the formula is lower than .5, the final answer to the question is no or zero.
The procedure in the evaluation is that the final results are entered into OPM3 software for analysis, but in this study, due to the unavailability of OPM3 software, data analysis was performed using excel software so that the answer to the questionnaires are entered in excel software, and the final answer to the questionnaire questions is determined using the above formula. In the next step, after linking the OPM3 weaknesses to the EVM3 criteria that we achieved through a questionnaire, and in the next step, determining the relationship between the EVM3 criteria through the ISM, the model analysis is performed through the MICMAC method.

3. Results and Discussion

At this stage, the data in the above table is entered into the excel software, and the resulting graphs as software outputs show the overall level of organizational maturity of the project management and each process improvement stages.

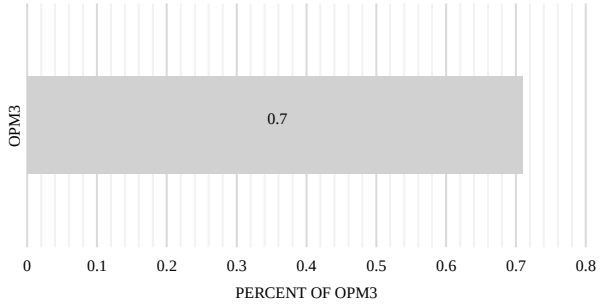

Figure 2. Maturity level of OPM3 [Source:Research findings]

According to the above figure, which shows the maturity level of OPM3, the maturity level equals 70%.
In the following, we show the charts related to the maturity level of the organization in each of the process improvement stages, i.e., standardization, measurement, control, and improvement:

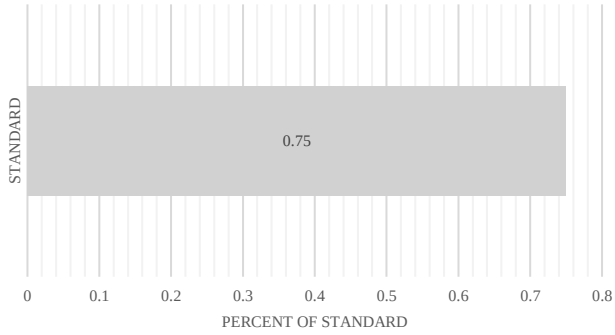

Figure 3. Maturity level of standard stage [Source:Research findings]

Standardize: It included a governing body to manage the process and related changes and document them for those responsible for making them. According to Figure 4.2, it can be seen that the maturity level of this step from the four stages of process improvement was equal to 75%.

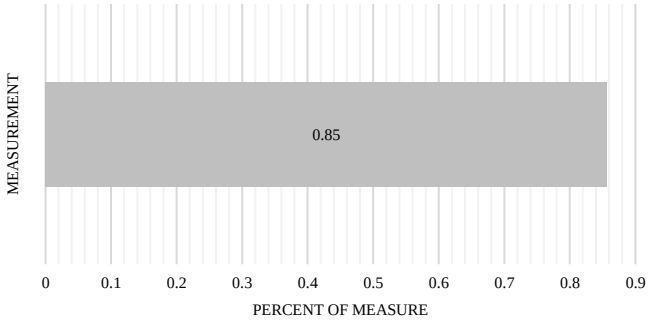

Figure 4. Maturity level of measurement stage [Source:Research findings]

Measure: The requirement for proper performance in processes is to have an accurate and appropriate measurement. In a proper measurement process, paying attention to customer needs, critical features, and inputs related to results, and measured critical parameters. According to Figure 4.3, it can be seen that the maturity level of this step from the four stages of process improvement was equal to 85%.

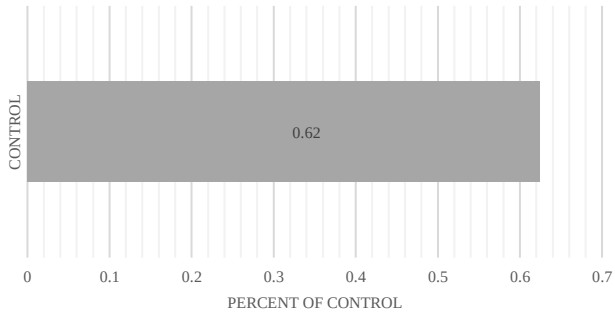

Figure 5. Maturity level of control stage [Source:Research findings]

Control: The control process compares actual performance with planned performance, analyzes variances, evaluates trends to influence process improvement, evaluates possible alternatives, and recommends appropriate corrective action as needed. In OPM3, we first set the control constraints. In the next step, we seek to find the underlying reasons for the out-of-range processes and finally identify solutions to improve them and bring them to the control range. According to Figure 4.4, it can be seen that the maturity level of this step from the four stages of process improvement was equal to 62.5%, which obtained the weakest level of maturity among the four process improvement stages.

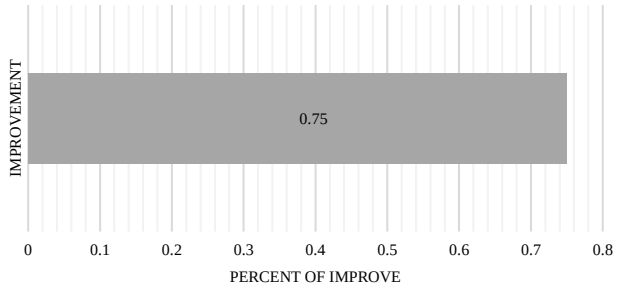

Figure 6. Maturity level of improvement stage [Source:Research findings]

Improve: At this stage, seek to identify problems to improve best practices. According to Figure 4.5, it can be seen that the maturity level of this step from the four stages of process improvement was equal to 75%.
The radar chart related to the four process improvement stages is as follows:

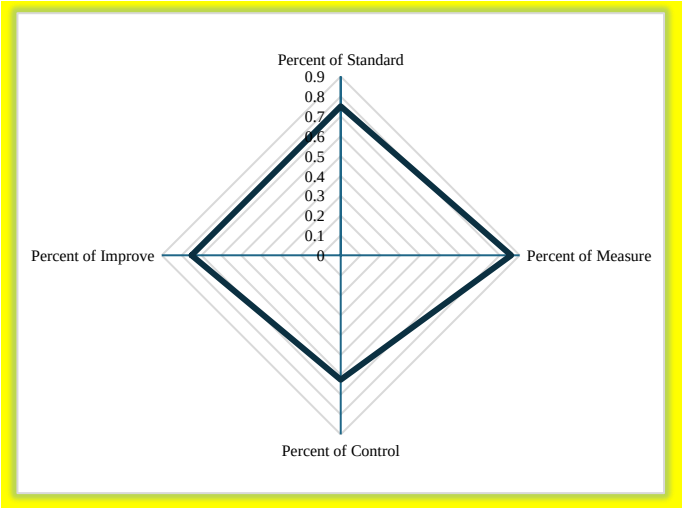

Figure7..Radar diagram of four process improvement stages [Source:Research findings]

The above charts show the performance of the organization based on OPM3 self-evaluation in the project area equal to approximately 70%, which is the average of four process improvement stages, including the standardization part with a maturity level of 75%, the measurement part with a maturity level of approximately 85%, the control part with a maturity level of approximately 62% and finally the related part to improve with a maturity level of 75%.

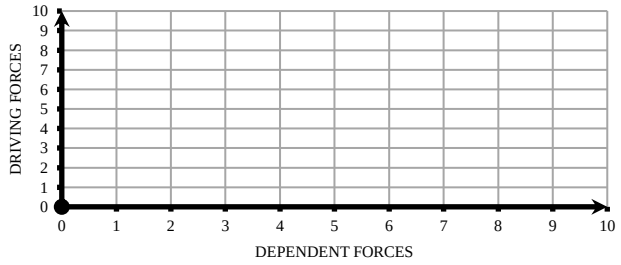

Figure 8. MICMAC analysis chart [Source:Research findings]

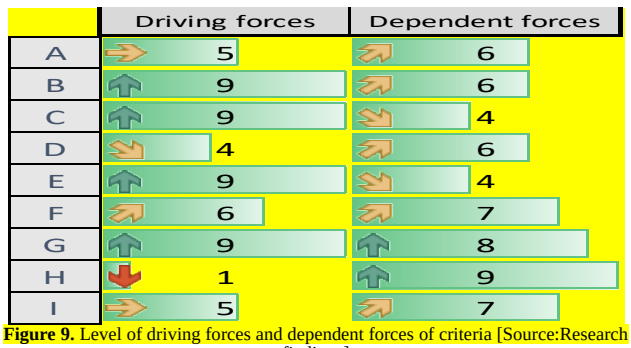

Figure 9. Level of driving forces and dependent forces of criteria [Source:Research findings]

3.Conclusions

The purpose of MICMAC analysis is to investigate and analyze the driving and dependence of the components. In this analysis, the variables are classified into four categories as follows:

- Autonomous variables: These components have a weak dependence and driving forces. The components that are included in this category operate almost separately from the whole system. These components do not have much effect on other components. In fact, the connections of these components with other components are very limited and insignificant.
- Dependent variables: These variables have a weak driving and higher dependence than other variables.
- Linked variables: Some variables have a strong driving force and dependence force. These variables are unstable components, so taking any action on these components, in addition, to directly affecting other components, can also affect the component itself in the form of feedback from other components.
- Independent variables: Some variables have a strong driving force, but their dependence power is weak, which are key variables, and by changing them, you can influence the rest of the variables.

In analyzing this method, the boundary lines of the diagram should be specified. These lines are determined using the (N/2) +1 relationship. where N is the number of variables.
(9/2) +1=5.5
By drawing two vertical and horizontal lines in the chart with a length and width of 5.5, the chart is divided into four areas, each corresponding to one of the four variable types mentioned above.
According to the diagram:
Criteria C, and E are among the criteria with high driving force but low dependence power, which are actually the most important criteria that can affect other criteria by making changes.
Criteria G, B, and F, are among the criteria that have both high power of driving and high power of dependence, so they are classified as linked variables.
Criteria D, A, I, and H have a higher dependence power than the driving force. Therefore, they are classified as dependent criteria.

Table 3. Classification of criteria in four groups of variables [Source:Research findings]

Independent variables	E, C
Linked variables	G, B, F
Dependent variables	D, A, I, H
Autonomous variables	-

In response to the main research question: As we know, OPM3 is like a hypothetical bridge that fills the gap between organizational strategic goals and success in projects. In this standard, procedures are determined and defined for the processes to reach their maturity, which helps senior managers, those who determine the strategic goals of the organization, to determine the strategic goals of the organization in accordance with these processes and in the standard mode to define.
And on the other hand, the EVM technique has been used for success in projects; as seen in this research, these two standards are not alien to each other, and their connection makes the bridge between organizational strategies and success in projects smoother Establish better relationships.
Regarding the answer to the sub-question of the research, we have: the most important criteria that are neglected in the studied organization and should be considered in order to improve, the first one is the integration process, and the second one is attention to the schedule. Integration is actually the integration of scheduling, budgeting, work progress identification, actual cost collection, management analysis, and corrective actions in a framework for better management of processes in projects. The schedule should be appropriate and agree with the project's goals, which includes a logical sequence of the important events of the projects.

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