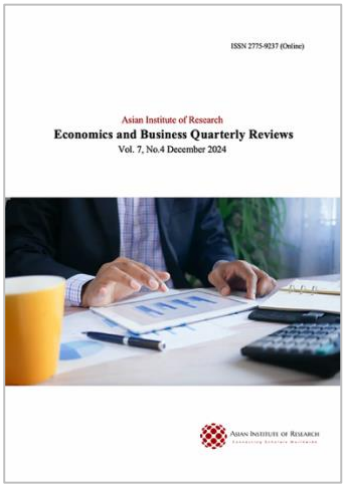

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Time Programs and their Impact on Engineering Project Management

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Abstract
Time programs are the basis for the success of any project, as they determine the timing of various activities and stages, and help in coordinating various tasks, especially in large engineering projects. These programs allow for careful planning, effective organization of human and financial resources, and continuous monitoring of project progress to detect and address any deviations. It also contributes to identifying potential risks and evaluating the project from a technical and financial perspective, which leads to improving performance, reducing costs, and enhancing quality. Commitment to the schedule enhances customer satisfaction by delivering projects on time. Through the methodology of description, analysis, and comparison, a questionnaire was conducted among a sample of project managers, executive engineers, and time program designers in contracting companies about the importance of time programs and their effects on engineering projects, and the results of the questionnaire were analyzed. The results indicated There are factors that affect the success of time programs and engineering projects. If they are taken into account, this leads to improving the quality of projects and customer satisfaction. The link between customer satisfaction and the success of projects is related to time programs. Customer satisfaction is closely linked to the success of the project linked to the schedule through a simple stage, which is the quality and success of the project. The results indicated that the quality of engineering projects linked to timetables is inversely linked to mismanagement at a rate ranging between 62% and 75% and inversely linked to changes resulting from changes in design and requirements. Customers are 77% related to external factors, such as environmental factors and 86% economic factors. If these factors improve, the quality of the project improves, meet customer requirements, and obtain their satisfaction.

Keywords: Time Programs, Tasks, Potential Risks, Schedule, Customer Satisfaction, Engineering Projects, Customer Requirements.

1. Introduction

Time programs in any project, whether engineering or non-engineering, are considered the cornerstone of the success of this project. Time programs can be defined as detailed time plans that specify the sequential time for the project activities, determine the beginning and end of each stage, and show the relationships between the various tasks and the various time stages (Nguyen et al., 2017). Through it, the progress of the project can be followed, and future strategic plans can be made to address any shortcomings in the relationships between the stages or in the implementation times for these stages. In engineering projects, especially large and complex

projects, it is necessary to rely on the policy of time programs in order to achieve coordination between all tasks and all-time stages. As we know, in large projects, there are construction items, architectural items, other mechanical items, and electrical items. The work of these items is carried out either in successive stages, and some of them are implemented in parallel stages. There must be coordination to ensure that the activities do not overlap with each other, which affects some of the other stages.

The importance of timetables in engineering projects is due to the fact that they help in planning the project in an accurate and organized manner, as well as organizing human and financial resources effectively and in an effective time Palmqvist (Palmqvist et al., 2018). Through them, the progress of projects can be monitored continuously and what has been accomplished can be compared with what is actually present in these timetables to note the presence of any A defect or any deviation, and thus taking precautionary measures against these deviations. It is also possible, through time programs, to identify potential risks that may affect the project's timetable and its implementation and delivery in a timely manner. It is also possible, through the use of time programs, to evaluate the project technically and financially, and to evaluate its strengths and weaknesses, and thus Formulating plans and strategies to improve performance, whether in this project or in future projects. Which ultimately leads to enhancing the reduction of costs, especially the costs resulting from delay fines or unjustified cessation of work, as well as enhancing quality improvement, because adherence to the schedule is one of the most important activities that guarantee the quality of work, especially when each stage is implemented on time, which leads to reducing the chances of Mistakes also include obtaining customer satisfaction and meeting their requirements. When a project is delivered on time, this is the first relationship of trust between companies and customers.

Despite the importance of time programs in engineering project management, there are many obstacles facing time programs in engineering projects (ElMaraghy et al., 2012), which are as shown in fig (1) as follows:

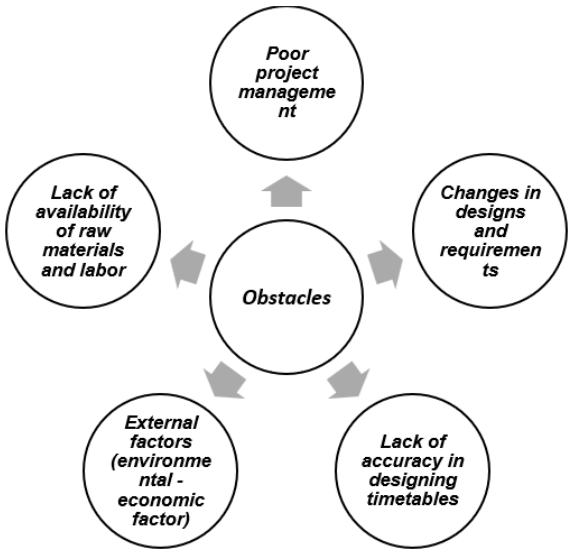

Figure 1: The obstracles facing time programs in engineering projects

Changes made in the designs or requirements, as sometimes the project requires making some modifications to the designs in line with the nature of the site and in accordance with the requirements of the owner sometimes and the consultant sometimes. As well as the change in surrounding circumstances, economic, political and other circumstances. Also, one of the most important obstacles facing time programs is the inaccuracy of initial estimates when formulating the time program and failure to take into account external factors such as the late arrival of materials and the unavailability of the same skilled workers, harsh weather conditions such as rain and temperature, and among the most important factors that affect time programs for project management is third-party management. Efficient for the project, which is considered one of the most important basic elements in influencing time programs.

The study aims to clarify the importance of time programs in project management and their impact on the success of those projects and how to overcome the obstacles facing time programs during project implementation through a methodology based on description, analysis and comparison methodologies, where description and analysis methodologies were used to collect data on time programs and how and how. How these programs work and the comparison between successful time programs on the quality and performance of the project. The importance of the study is due to the importance of the topic itself, which is the effect of timetables on the success of engineering projects in terms of improving quality, customer satisfaction, and completing tasks on time. Also, the importance of the study is due to the fact that it explains the formulation of a flexible, good and effective timetable by taking into account the circumstances and factors that affect the design of timetables. Therefore, the study can be considered a useful reference study for researchers and those interested in this field.

2. Overview of the Literature Review and Analysis

In this section, we will present and analyze the literature related to timetables and their impact on engineering project management. Reviewing the literature on timetables is extremely important, as it is possible to understand this field and identify all the points related to knowledge gaps or strategic visions that contribute to determining the relationship between timetables and the success and improvement of the quality of engineering projects. Timetables are considered the cornerstone of managing any project, especially in engineering projects. Timetables can be defined as time plans that determine the chronological sequence of project activity and determine the project stages, whether they are consecutive or parallel stages, and the start and end date of each stage.

2.1. Types of Timetables

Timelines are one of the most important tools that help in the success of any project and they are divided into several types (Hussain, 2020).

Gantt Charts: They are one of the most common timelines as they are easy to understand and display tasks in the form of horizontal bars where the length of the bar represents the time period and the beginning and end of each relationship between the tasks are represented by a start date and an end date. Fig (2) shows a picture of several Gantt charts (Schittenhelm, 2013).

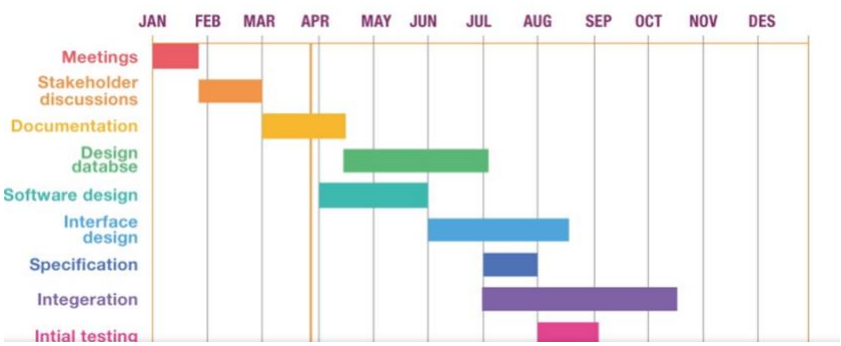

Figure 2: An example of Gantt chart

PERT Charts (Program Evaluation and Review Technique): These are charts that represent the critical relationships between tasks where the length of the path in the network or what is called the critical path that determines the duration of the project is determined and through them the critical activities that must be closely and continuously monitored can be identified. Fig (3) shows one of the PERT charts (Evdokimov et al., 2018).

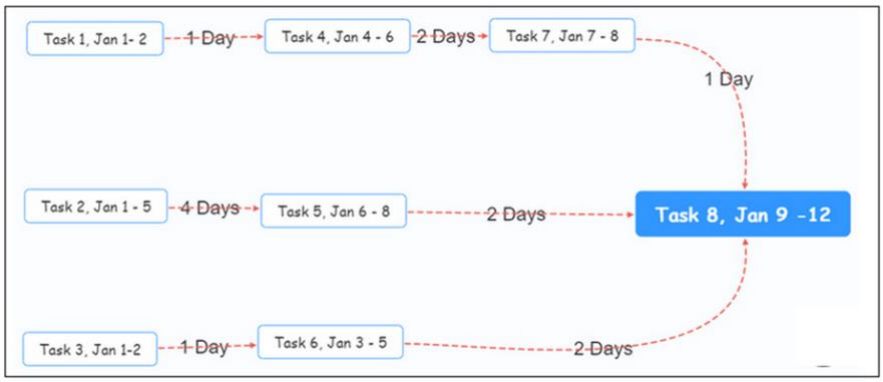

Figure 3: An example of Pert chart

Critical Path Method (CPM) charts: These Critical Path Method charts: These are charts similar to the Bard charts, but they focus more on the costs and financial activities related to the project activities. They are used to identify and evaluate activities according to costs and their relationship to time. Figure No. (4) shows an example of CPM charts (Costa, 2022).

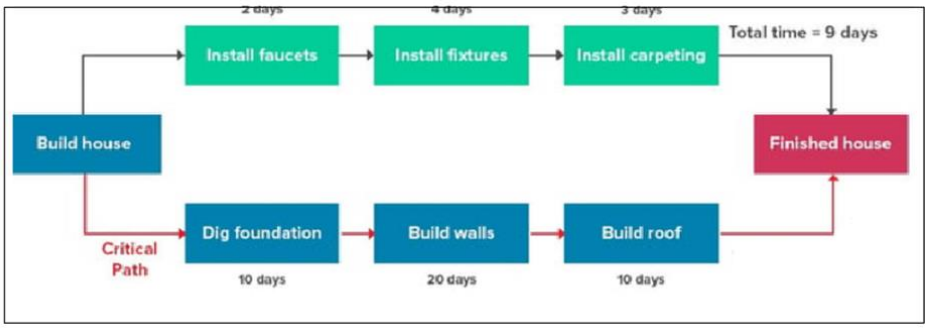

Figure 4: An example of CPM

Specialized project management software: It is a group of programs characterized by many advanced features such as managing tasks and resources, managing risks, determining the project schedule, coordinating and arranging tasks and resources, and evaluating the relationships between tasks. The most important of these programs are Primavera P6, Microsoft Project, Asana, and Trello.

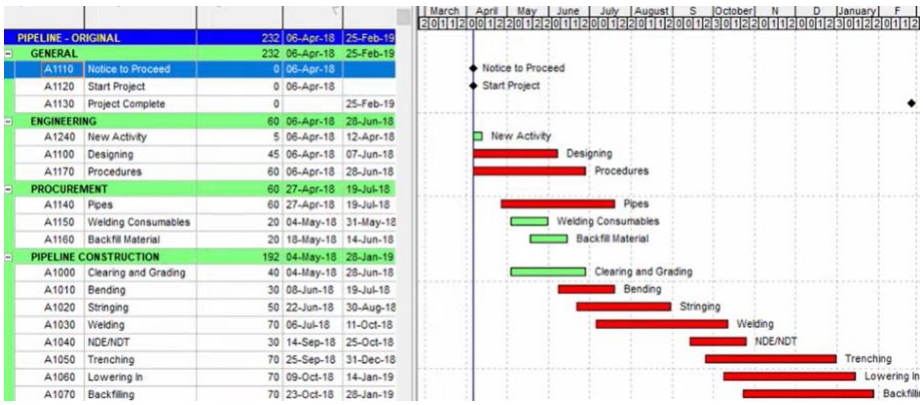

Figure 5: An example of Primavera

2.2. Program Management Tools and Techniques

Engineering program management tools and techniques are diverse, and through this diversity, a high success rate can be achieved in projects. Some of the most important of these tools and techniques can be identified as follows:

1. Charts such as Gantt Charts, pert charts, CPM charts and softwear programs
2. Risk assessment techniques: Risk assessment techniques and techniques through which risks that can affect the project and the schedule for its implementation stages can be identified and evaluated. The most important of these techniques are:

Technique: SWOT, which can identify failure points. Figure (6) shows an example of the SWOT technique.

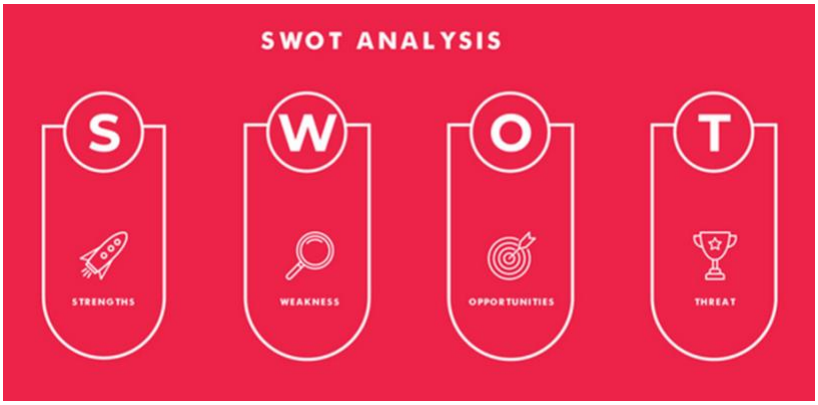

Figure 6: An example of SWOT Technique

Probability and impact matrix: It is a technique used to assess risks based on the probability of their occurrence, as risks are classified in a matrix with two axes, the first axis is the probability axis and the second axis is the impact axis. Figure (7) shows an example of the probability matrix technique for risk assessment (Saraei & Shamshiri, 2013).

	Minor	Moderate	Major	Critical
76%-100%	Low	Medium	High	High
51-75%	Low	Medium	Medium	High
26-50%	Low	Medium	Medium	Medium
0-25%	Low	Low	Low	Low

Probability

Impact

Figure 7: An example of Probability and impact matrix Technique

Fault Tree Analysis: It is a technique and tool that relies on logic to determine the possible causes of an undesirable event that can contribute to understanding the relationships between different events and how they affect the schedule activities. Figure (8) shows an example of a fault tree analysis.

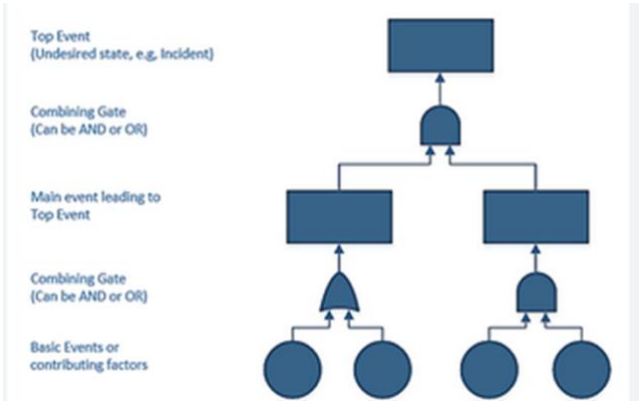

Figure 8: Fault Tree Analysis Technique

Failure Mode and Effects Analysis (FMEA): It is a systematic technique used to evaluate the potential effects of any potential failure within a task or a group of tasks. Based on this, its impact on the schedule as a whole is evaluated. Figure (9) shows an example of the FMEA technique.

Figure 9: FMEA Analysis Technique

3. Schedule improvement techniques: These are techniques that aim to improve the schedule and reduce costs, such as the critical path technique and the backtracking technique. These techniques are characterized by helping to identify activities that must be released or activities that must be delayed without affecting the schedule (Damanab et al., 2015).

4. Collaboration and communication techniques: These are techniques and tools that aim to coordinate between team members and achieve cooperation and communication with complete flexibility, such as task management programs, knowledge management platforms, or any other communication program.

5. Brainstorming: Simple but effective techniques that generate ideas about potential risks and can be used at the beginning of the project to collect the largest possible number of potential risks.

2.3 Factors Affecting Time Programs and Risk Assessment Techniques.

The most important factors that affect timetables and risk assessment techniques are the following:

1. Nature of the project: The nature of the project affects the technology required to assess risks, and the more complex the project is, the more specific the technology required is.

2. External factors of the project: These are environmental factors such as weather conditions and natural disasters, and economic conditions such as the state of the economy and the availability of liquidity and materials (Abd El-Karim et al., 2017).

3. Project management: The more efficiently the project is managed, the clearer the impact will be on the time programs and risk assessment techniques, as the time programs and risk assessment techniques become more effective.

4. Designs and changing requirements: Designs and changing requirements, whether from clients or consultants, are among the most important factors that affect time programs and methods of risk assessment.
5. Initial preparation of the schedule: The more accurate and flexible the initial preparation is, the better, and the easier and more flexible the risk assessment is.

6. Human and natural resources: The greater the team's skills in using timetable techniques and tools, the better their ability to assess risks and manage the project in time. The more natural resources are available, the more this will help them quickly complete the timetable and improve the service provided through it, as well as the ease of risk assessment.

7. Flexibility of the time program: The flexibility of the time program means the extent of the ability to adhere to it in light of changing requirements and circumstances. The more flexible the time program is, the more effective it is and the more effective the risk assessment is.

3. The Methodology

Through several methodologies that have been combined with each other, such as the description methodology and its use in describing variables, the analysis methodology in analyzing the relationships between variables, the quantitative and scientific methodology in collecting and filtering data, and the comparison methodology to compare the factors affecting time programs and the relationship between customer satisfaction and time programs and the quality of engineering projects from On the one hand, and the relationship between the variables that affect the time programs. On the other hand, through a questionnaire conducted on a group of 67 people, including project managers, executive directors, executive engineers, and then engineering program designers and some clients, a set of questions were asked and analyzed descriptively and analogically to conclude the relationship between the impact of the programs. The timeline for the success of projects, on the one hand, and customer satisfaction, the quality of services provided, and the quality of engineering projects resulting from the use of flexible engineering programs. Demographic analysis of the sample members, descriptive qualitative analysis, and standard analysis of the answers to the questionnaire were conducted, then an analysis of the study hypotheses, where the first individual was that there is no statistically significant effect of time programs on the success of projects and on customer satisfaction. The second individual issue is that there is a statistically significant effect of time programs on the success and quality of projects and thus customer satisfaction (Chitra & Halder, 2017).

3.1 The Applied Framework of the Study

It is a framework that explains a set of procedures and steps. Which was done, starting with collecting data after setting the goal, which is to study the effect of time programs on the success of engineering projects, then preparing a set of questions and dividing them into six groups, each group related to a specific direction, then analyzing the consistency, validity, and suitability of the questions in the questionnaire to the subject of the study, then analyzing the effect of time programs on the success of the projects. Improving service quality and customer satisfaction. Figure No. (9) shows the applied framework of the study.

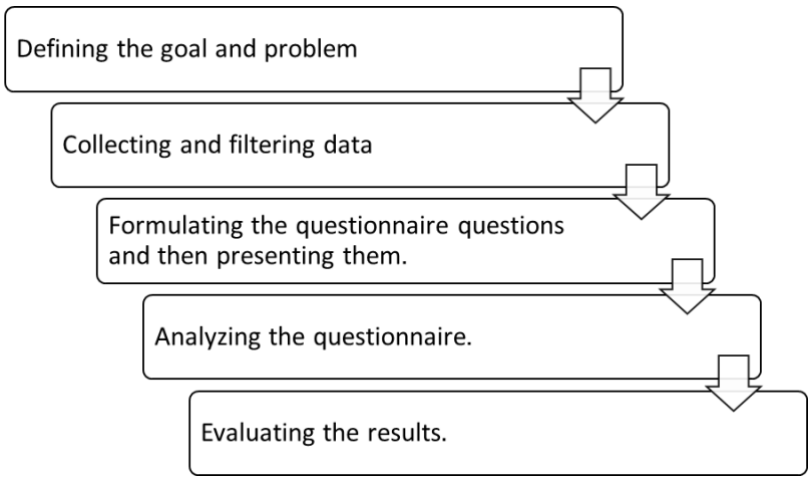

Figure 10: The applied framework of the study

3.2 Statistical analysis

Statistical analysis has been conducted to study the relationship between time programs and the factors affecting them, the success of engineering projects, and customer satisfaction by improving the quality of engineering projects by conducting a demographic analysis, which is an analytical process through which the demographic characteristics of the questionnaire sample can be analyzed, such as age, gender, educational level, educational status, job experience, and place of residence. This data plays an important and vital role in determining and consciously understanding the behavior of the participants in the questionnaire through which strategic decisions can be made in many areas, whether commercial or commercial. Or planning, research, etc. Then conduct qualitative and standard analysis by calculating Cronbach's alpha coefficient to measure the consistency and suitability of the data to the model. And using multiple linear regression analysis to study the relationship between the factors influencing the success of the time program and improving the performance of engineering projects and customer satisfaction, and calculating the direction of the regression, the coefficient of determination, as well as the correlation coefficient (Lei et al., 2017). Between the effect of time programs on the success of engineering projects and customer satisfaction. Multiple linear regression is a powerful statistical performance used to determine the relationship between a group of variables and a variable called the dependent variable, as it helps us understand how these variables affect the dependent variable. This test is subject to the following equation:

$Y = \beta 0 + \beta 1X1 + \beta 2X2 + ...+ \beta nXn + \varepsilon$

where:

- Y: dependent variable
- β0: intercept
- β1, β2, ..., βn: Regression coefficients for the independent variables X1, X2, ..., Xn
- X1, X2, ..., Xn: independent variables
- ε: random error

4. Results and Discussion

In this section, we will present and analyze the results of the questionnaire and study the extent to which timetables affect the quality of engineering projects and customer satisfaction.

Table 1: The demographic characteristics of the survey respondents

Demographics	***n***	***%***
Gender		
female	*5*	*8%*

Male	*62*	*92%*
Age		
< 20 years > 51 years	*4*	*%6*
Between 20:30	*20*	*%30*
Between 30:40years	*32*	*%48*
Between 40:50 years	*5*	*%7*
50<years	*6*	*%9*
Profession		
Project Manager	*3*	*%4*
Executive Director	*12*	*%18*
Executive Engineer	*36*	*%54*
Scheduling Designers & Developers	*3*	*%5*
Consultants	*4*	6%
Clients	*9*	13%

The table shows a comparison between the survey individuals in terms of gender, age and job. Diversity in ages and jobs was taken into account so that the results would be more accurate and more consistent. Also, it was taken into account that the survey individuals had previously dealt with time programs and had extensive experience in dealing with time programs.

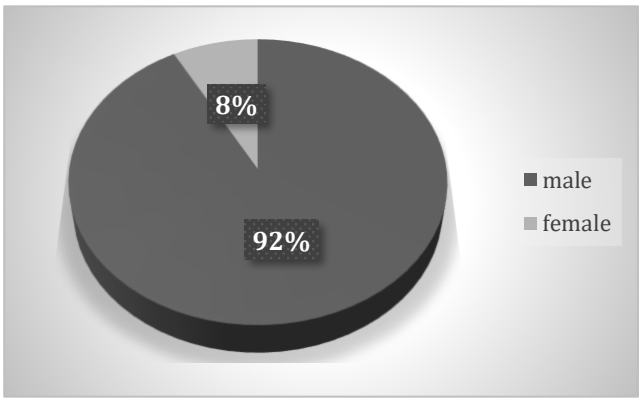

Figure 11: A comparison between the ratios of females to males in the questionnaire sample

The figure shows that the percentage of females out of the total participants was 8% and the percentage of males was 92%. This is very obvious, as most of the workers in contracting projects are males because they require strenuous effort.

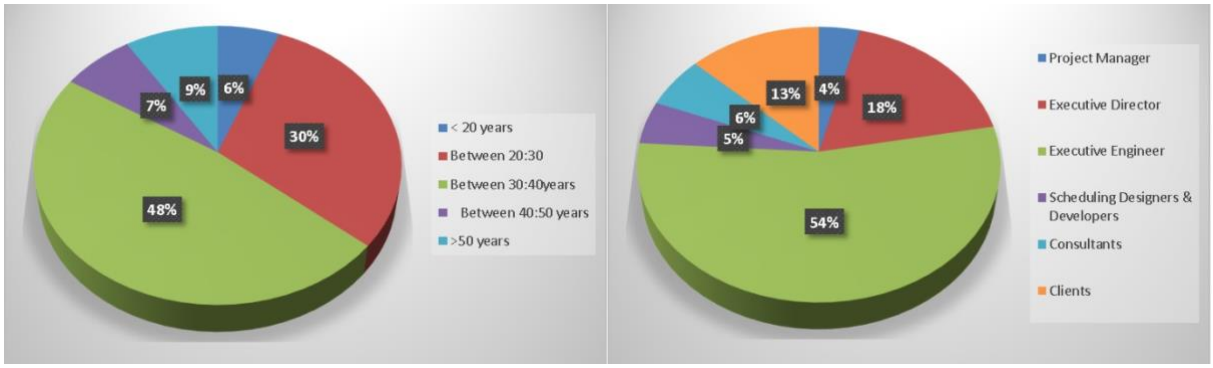

Figure 12: A comparison between questionnaire samples in terms of occupation and age sample

When selecting the samples, it was taken into account that people should have experience in the subject of time programs and have previously dealt with them, and the experiences vary so that there is flexibility in the data and we obtain accurate results for the questionnaire. The table indicates, according to the results, that the largest age group ranged from 30 to 40 years, and the group The youngest age group was less than 20 years, while in terms of profession, the largest number of sample members were executive engineers, as they are the category that deals most with the schedule because they are responsible for implementation.

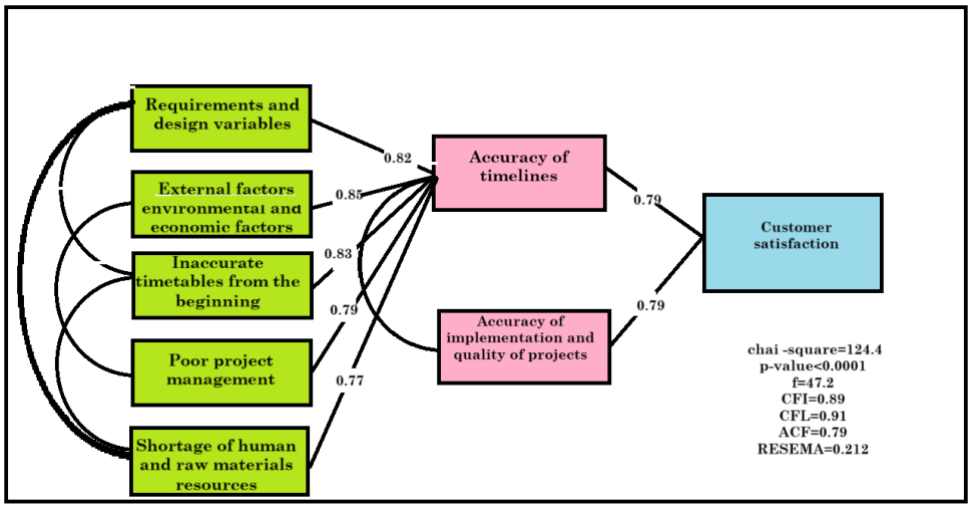

Figure 13: Actual model structural equations

Qualitative measures are tools for assessing consistency, variability, and reliability within and between sets of data extracted from questionnaires. These measures include fit, variance, agreement, and importance, and measure the extent to which variables vary and agree. Its values range between -1 and 1, where values close to 1 indicate the strength of the measures, and those close to zero indicate their weakness, while negative values indicate the presence of an inverse relationship between the variables. It is clear from the figure that I applied the measures, so the p-value was less than 0.0001, which means The data is of great importance, as the marginal value of the P-Value is 0.05, the Cronbach's alpha coefficient is 79%, and the marginal value of the Cronbach's alpha coefficient is 75%, which means that the data in the five groups have high consistency within the groups and outside the groups, and that the time programs are related to customer satisfaction (Thamhain, 2014). The quality of the services provided is strong and reaches 0.79. The goodness of fit, which measures the percentage of variance, reached 0.89, and the index of fit reached 0.89, which means that the data conforms to the model. Also, RESMEA (<0.8) = 0.122: This measure expresses the average standard deviation of the residuals, and a lower value indicates a better fit.

Table 2: The Hypothesis testing

Hypotheses		Beta	T-value	P-value	Result
H1	There is no direct impact of timetables on project quality.	0.29	1.14	0.742	Not Supported
H2	There is direct impact of timetables on project quality	4.2	3.51	<0.001	Supported

Hypothesis testing is a statistical process used to evaluate the validity of a particular claim about a set of data. It aims to make decisions based on strong evidence, such as testing theories or comparing group means to determine statistically significant differences. If the value of the statistic is in the critical region or the p-value is less than the significance level (usually 0.05 or 0.01), we reject the null hypothesis and accept the alternative hypothesis.

Table 3: The correlation coefficient between the quality of projects and the time schedule on the one hand, and between design variables and requirements, poor project management, external factors, and lack of resources

	Project quality	***External factors***	***Poor project management***	***Design variables and customer requirements***
Project quality	*1*			
External factors	*86%*	*1*		
Poor project management	*-0.707106781*	*-0.612372436*	*1*	
Design variables and customer requirements	*-0.77814*	*-0.7584*	*-0.7824*	*1*

It is clear that the correlation coefficient between the design variables, their requirements, and the quality of the projects was 77%, while the correlation coefficient between the quality of the projects and external factors was 86%, while the correlation coefficient between the quality of the projects, the schedule, and poor management was 75%. We notice from the correlation values that they are negative values, meaning that the correlation is inverse and strong, meaning that the worse the project management, the lower its quality. The fewer human and other resources, the lower the quality of the project. The worse the schedule, the lower the quality of the project. This ultimately leads to customer dissatisfaction, and vice versa.

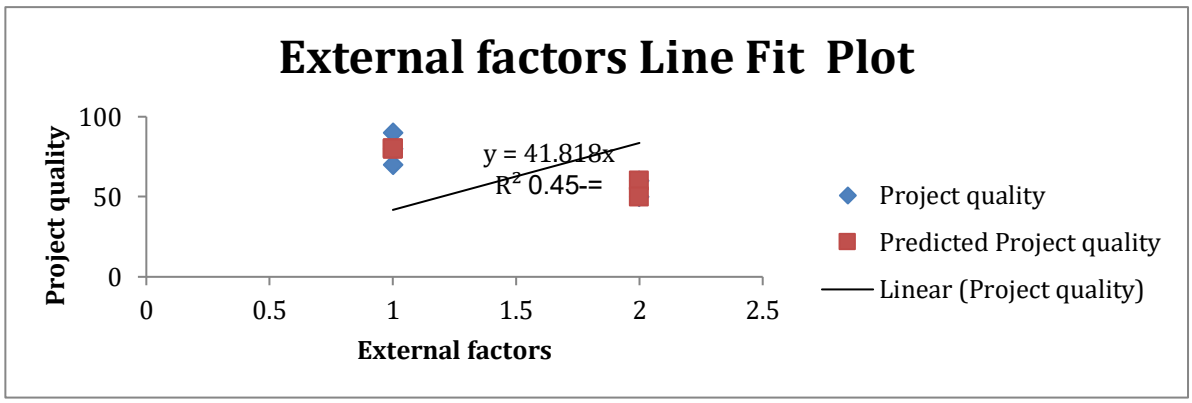

Figure 14: External factors line fit plot

The diagram shows the relationship between external factors, and their relationship to the quality of projects linked to the schedule, as it is clear from the relationship diagram that it is a negative, inverse relationship. The equation and negative R^2 value indicate an inverse relationship between external factors and project quality. In other words, as external factors increase, the quality of the project decreases. Also, the relationship is linear and takes a downward trend, and the value of the coefficient of determination is limited to between one and negative one, which means that the data fits and agrees with the model (Inayat et al., 2015).

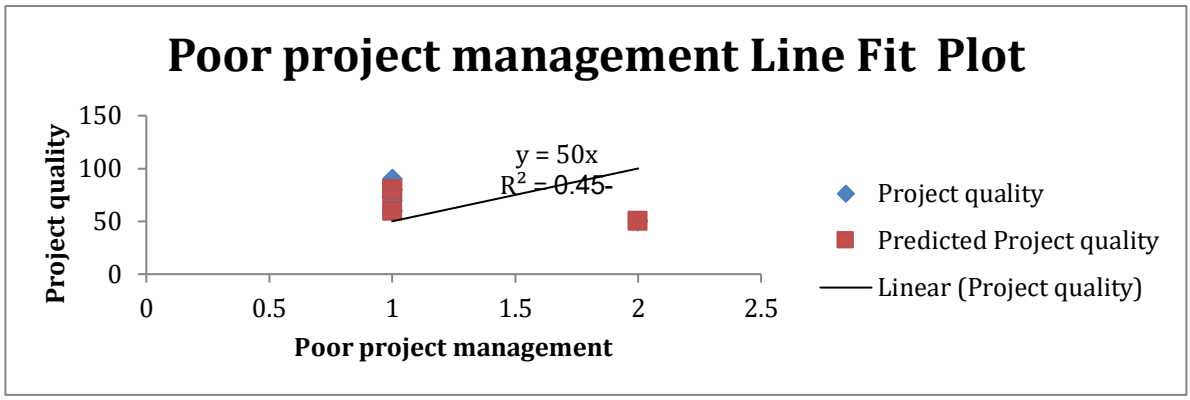

Figure 15: Poor project management line fit plot

The diagram shows the relationship between poor project management, and their relationship to the quality of projects linked to the schedule, as it is clear from the relationship diagram that it is a negative, inverse relationship. The equation and negative R^2 value indicate an inverse relationship between external factors and project quality. In other words, as external factors increase, the quality of the project decreases. Also, the relationship is linear and takes a downward trend, and the value of the coefficient of determination is limited to between one and negative one, which means that the data fits and agrees with the model (Sithambaram, et al., 2021).

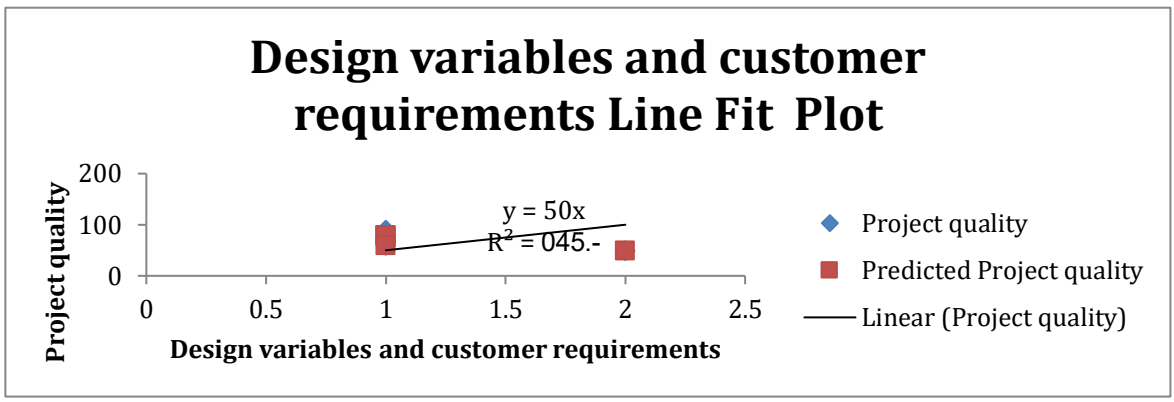

Figure 16: Customer requirements and design changes and line fit plot

The diagram shows the relationship between design variables, customer requirements, and their relationship to the quality of projects linked to the schedule, as it is clear from the relationship diagram that it is a negative, inverse relationship. The equation and negative R^2 value indicate an inverse relationship between external factors and project quality. In other words, as external factors increase, the quality of the project decreases. Also, the relationship is linear and takes a downward trend, and the value of the coefficient of determination is limited to between one and negative one, which means that the data fits and agrees with the model (Moshood et al., 2020).

5. Conclusions

Among the most important conclusions that were drawn from the study are the following:

- In order for the results of the study to be accurate, scientific methods must be followed in conducting the study and there must be diversity in the data, as the larger and more diverse the size of the data, the more accurate and more flexible the results will be. (Czaja et al., 2014).
- In questionnaires, the individuals participating in the questionnaire must have diversity characteristics that allow flexibility in dealing and accuracy in the data, and the questions must be formulated in separate groups, so that there is consistency within the groups and between the groups and each other, and the individuals participating in the questionnaire must have sufficient experience to answer the questions,

whether from In terms of dealing with the subject of the questionnaire and knowledge of it. (De Leeuw et al., 2012).

- Most workers in the engineering sector and engineering projects are male, and the percentage of female participation in these projects does not exceed 21%, which is a small percentage given the physical strength and high effort required by these projects.
- One of the most important factors affecting the quality of time programs and the quality of projects are the variables of design requirements and customer requirements. Poor project management. External factors, whether economic. Lack of resources (Alghamdi et al., 2020). of the schedule from the beginning. It is clear that the correlation coefficient between the design variables and their requirements and the quality of projects was 77%, while the coefficient reached 77%. The correlation between project quality and external factors was 86%, while the correlation coefficient between project quality, schedule, and poor management was 75%. We notice from the correlation values that they are negative values, meaning that the correlation is inverse and strong, meaning that the worse the project management, the lower its quality. The fewer human and other resources, the lower the quality of the project. The worse the schedule, the lower the quality of the project. This ultimately leads to customer dissatisfaction, and vice versa. (Altoryman, 2014).

The relationship between design variables and requirements and clients, poor project management, lack of resources, and poor schedule planning from the beginning are all negative relationships that lead to poor project quality and thus customer dissatisfaction. Therefore, avoiding these observations leads to improved project quality and improved timetables, thus gaining customer satisfaction and achieving sustainability in the field. Engineering projects thus achieve companies, especially contracting companies, continuity in the markets and competitiveness (Nicholas & Steyn, 2020).

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