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ISTANBUL GEDİK UNIVERSITY
INSTITUTE OF GRADUATE STUDIES

EVALUATION AND IMPROVING EFFICIENCY OF THE OPERATING AND MAINTENANCE PROCESS MANAGEMENT FOR BARRAGES IN MID AND SOUTH IRAQI PROVINCES (CASE STUDY OF AL-KUFA BARRAGE)

MASTER THESIS

Nadhim Hamid Mohsin ALSHAREEFI

Engineering Management Department

Master of Engineering Management in English

SEPTEMBER
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Thesis Advisor: Prof. Dr. Redvan GHASEMLOUNIA

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DECLARATION

I Nadhim Hamid Mohsin Alshareefi, hereby certify that this thesis entitled " Evaluation and Improving Efficiency of the Operating and Maintenance Process Management for Barrages in Mid and South Iraqi Provinces (Case Study of the Al-Kufa Barrage)" is my original thesis for the award of master's degree in engineering management at the Faculty of Engineering Management. I further certify that this thesis or any part thereof has not been submitted and presented for any other degree or research thesis at any other university or institution. (19/09/2024)

Nadhim Hamid Mohsin ALSHAREEFI

PREFACE

I would like to thank everyone who has supported me through what is usually a very long journey. I would like to thank my supervisor, Prof. Dr. Redvan Ghasemlounia, because he directed me to the right path and played a major role in crowning this effort, as his encouraging comments played a major role in significantly increasing the quality of the project. I believe this institution, where I have been on a mission all these years, has earned its place as my home. Thanks go to my parents for their great encouragement and for raising me to continue, to my brothers and relatives for their endless support, and to my country, which is still struggling to rise despite its suffering.

Nadhim Hamid Mohsin ALSHAREEFI

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EVALUATION AND IMPROVING EFFICIENCY OF THE OPERATING AND MAINTENANCE PROCESS MANAGEMENT FOR BARRAGES IN MID AND SOUTH IRAQI PROVINCES (CASE STUDY OF AL-KUFA BARRAGE)

ABSTRACT

In this document, an evaluation was made of the management of the operation and maintenance process in the Kufa Barrage, which was chosen in this research to be a model of the barrage in central and southern Iraq.

The details of this process will be clarified by communicating with the administration of the barrages and academics with experience in this specialty, according to the guide for the Kufa barrages. A questionnaire was conducted to determine the quality of the details of the management of this process in the Kufa Barrage. The questionnaire was presented to those with experience and workers in the Kufa Barrage and its related departments and places affiliated with the Ministry of Water Resources to obtain an adequate result that gives a clear picture of the management of this process.

Given the major role of managing the operation and maintenance process in hydraulic structures, the evaluation of this process reflects a good picture of the interest in continuing and sustaining these structures.

Data from the questionnaire and its participants were collected, statistical programs were used to determine the accuracy and reliability of the tool to obtain the required results, and the data was analyzed using descriptive statistics within the SSPS program and presented in graphs and clarification of the results that give sufficient evaluation for managing the operation and maintenance process.

This evaluation will give a clear picture to academics and people associated with this field about the management of this process in central and southern Iraq.

Keywords: *Operation and maintenance; Management; Processes; Kufa Barrage; Barrage in central and southern Iraq*

ORTA VE GÜNEY IRAK İLLERİNDEKİ BARAJLAR İÇİN İŞLETME VE BAKIM SÜRECİ YÖNETİMİNİN DEĞERLENDİRİLMESİ VE ETKİNLİĞİNİN İYİLEŞTİRİLMESİ (EL-KUFA BARAJI ÖRNEĞİ)

ÖZET

Bu belgede, bu araştırmada Orta ve Güney Irak'taki barajın modeli olarak seçilen Kufe Barajı'ndaki işletme ve bakım sürecinin yönetimine ilişkin bir değerlendirme yapılmıştır.

Kufe barajları rehberine göre barajların idarecileri ve bu konuda tecrübeli akademisyenlerle iletişime geçilerek bu sürecin detayları netleştirilecek. Kufe Barajı'nda bu sürecin yönetimine ilişkin detayların kalitesini belirlemek amacıyla bir anket yapıldı. Bu sürecin yönetimini net bir şekilde ortaya koyan yeterli bir sonuç elde etmek amacıyla anket, Kufe Barajı ve ilgili daire ve Su Kaynakları Bakanlığı'na bağlı yerlerde deneyim sahibi olanlara ve çalışanlara sunulmuştur.

Hidrolik yapılarda işletme ve bakım sürecini yönetmenin önemli rolü göz önüne alındığında, bu sürecin değerlendirilmesi, bu yapıların sürdürülmesi ve sürdürülmesine olan ilginin iyi bir resmini yansıtmaktadır.

Anketten ve katılımcılardan veriler toplanmış, gerekli sonuçları elde etmek için aracın doğruluğunu ve güvenirliğini belirlemek için istatistiksel programlardan yararlanılmış ve veriler SSPS programı kapsamında betimsel istatistikler kullanılarak analiz edilmiş ve grafiklerle ve sonuçların açıklanmasıyla sunulmuştur. İşletme ve bakım sürecini yönetmek için yeterli değerlendirmeyi sağlayan.

Bu değerlendirme, Orta ve Güney Irak'ta bu sürecin yönetimi konusunda akademisyenlere ve bu alanla ilgili kişilere net bir resim verecektir.

Anahtar Kelimeler: *İşletme ve bakım; Yönetmek; Süreçler; Kufe Barajı; Orta ve güney Irak'ta baraj*

1. INTRODUCTION

1.1 Introduction

Agriculture and the building of hydraulic structures are long-term occupations for the population, and the success of these industries and occupations is believed to be based on the priceless knowledge and wisdom of scientists and thinkers in this field. Water is therefore essential to all technological processes worldwide. Sewerage and hydraulic projects rely on these structures, and their upkeep and preservation are of the utmost importance due to the importance of these structures in utilizing water resources for agricultural purposes, irrigation, flood control, and water conservation. Faulty hydraulic structures can have devastating effects on people's lives, property, and the environment. Economics made very clear.

Drainage canals, rivers, irrigation canals, bank protection works, dams, canals, waterways, regulators, big barrages, water canals, and pumping stations are all examples of water-related infrastructure that is built to support human needs and enhance the quality of life.

Buildings that are immersed in water, either entirely or partly, are called hydraulic structures. The basic idea of hydraulic engineering is to manipulate the flow of water in some way, whether it by redirecting it, storing it, or even halting it. Hydraulic structures may be categorized according to their intended function on stream flow: those that hold water (dams and barrages), those that transfer water (artificial canals), and those with a specific use (hydroelectric structures or inland waterways).

The primary goal of any water or hydraulic project is to alter the flow characteristics of an existing body of water (whether it a river, lake, sea, or even groundwater) by the manipulation of flow concentration. Electric power production, flood control, water supply, silt alleviation, navigation, irrigation, drainage, fish farming, environmental protection, and recreation are some of the proposed uses for this asset to the national economy and ecology. It is usual practice to build many hydraulic structures, also known as hydraulic works, with different general or specific objectives and then combine them into one larger hydraulic project to accomplish all of the aforementioned goals. A hydropower project, which aims to generate electrical power among other possible advantages, is one example of a water resources project. Primary, auxiliary, and temporary structures are the three primary categories into which hydraulic projects' general-purpose and special-purpose structures fall.

Therefore, it is necessary to preserve and sustain these structures, follow all necessary means for their continuous maintenance, develop appropriate work plans for this thing, and adhere to these plans, as the plans serve as a guide for these structures and work in them. The process of operation and maintenance of hydraulic structures is considered an essential part of preserving them. Developing the management of this process gives good behavior. To make these structures.

The Operation and Maintenance Manual for a hydraulic structure is a detailed written description of the procedures necessary to ensure it operates safely and is maintained in good condition through regular repairs/maintenance. Timely maintenance is important for the continued safe operation of the structure and productive use of the tank. The term “operation and maintenance” as used in these guidelines includes operation, maintenance, and general repairs of hydraulic structure components including replacement, as necessary. The primary audience for the handbook should be the operations staff and supervisors tasked with the building's physical upkeep and functioning. At the very least, it should include all they need to know to do the responsibilities that have been given to them. All individuals directly or indirectly engaged in the operation or maintenance of the structure must have access to the handbook, which must include instructions for hydraulic structure operations workers as well as all other relevant information. It is standard practice to have the operator's handbook on hand prior to filling up the tank for the first time.

Continuous work in describing and developing the management of the operation and maintenance process of hydraulic structures increases the results required from these structures, as managing this process correctly is considered one of the basics of hydraulic structures that are important for their continued operation.

The need to establish hydraulic facilities emerged when Iraq suffered in the fifties of the last century from repeated floods and the extent of the damage they caused. Hence, the need to establish hydraulic structures came.

The barrages in central and southern Iraq play a major role in exploiting water for storage, irrigation, agriculture, and protection from the danger of floods. Iraq's preservation and exploitation of this water wealth reflects on the economic stability of the country and the preservation of the population due to its role in exploiting water, which is the basic element of life. The Kufa Barrage is one of these important projects in which this document was concerned with studying the management of the operation and maintenance process.

1.2 Objectives and Purpose of the Research

This paper focuses on the objectives for which this research was conducted, which include:

1- A comprehensive evaluation of the management of the operation and maintenance process in the barrages of central and southern Iraq, relying on the Kufa Barrage as a case study and evaluating the process in it, as it gives a clear reflection of this process in central and southern Iraq.

2- Focus on the strengths and weaknesses of this process and provide the necessary recommendations to continue working properly.

3- Identify the parts that need development and provide the necessary recommendations for them.

1.3 Methodology of the Study

The details of this study were:

1- **Data Collection:** Data was collected from various sources such as electronic platforms that explained the topic or similar, but the focus was on the data obtained from the Kufa Barrages and their operation and maintenance manual, in addition to what was obtained from specialists who have sufficient experience to organize the questionnaire tool and collect the necessary answers for the work.

2- **Test of Reliability and Validity of the Tool:** The test was conducted for apparent and content validity by presenting the work tool to experts in the field of management to confirm its consistency with what is intended to be measured, in addition to the target community whose comments were collected to ensure content consistency. Then, Cronbach's alpha coefficient was applied for its reliability.
3- **Data Analysis:** Analysis of data collected from the questionnaire tool presented to experts working in the Kufa Barrages and related departments using the SPSS program.
4- **Show the results:** After analyzing the data using SPSS, it was displayed in the form of graphs to illustrate the results obtained.
5- **Discussion of results:** The results obtained were discussed and detailed in tables to clarify the result of the data, which in turn is reflected in the final result of the desired objective of this study.

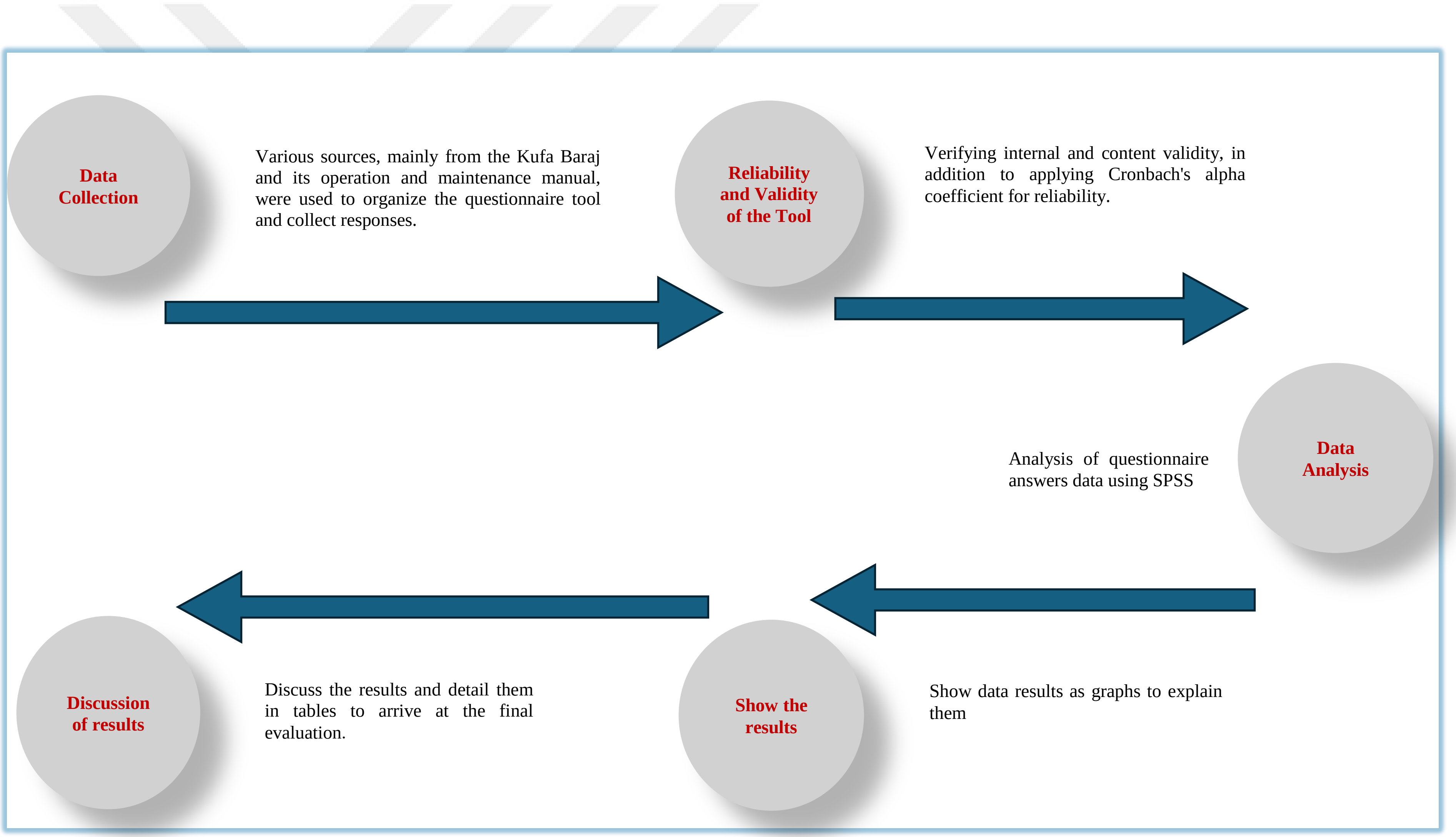

Figure 1.1: Flow chart of the methodology of this study

2. LITERATURE REVIEW

2.1 Literature review

A Manual for Operation and Maintenance (O&M) is a detailed written document of procedures and protocols for the accurate and timely operation and maintenance of dams to avoid further deterioration in health and prolong the service life of these assets. It is based on these guidelines. The preparation of the draft of these guidelines includes the expert group of the Environmental Information System of France (engineering and administrative consultations in the Central Water Commission in the coordination and implementation of the ongoing rehabilitation), which will consider the guidelines to produce a document that is in line with current thinking and will be widely adopted and used by the public. Pre-practicing dam engineers will be used by working professionals and audit committees. For the members, this task was not easy. It takes significant time and effort to reach an agreement on the details and is a comprehensive document covering acceptable practices, as it is the first document of its kind published by the Central Water Authority. These guidelines provide the basis for drafting new operation and maintenance manuals or updating existing operation and maintenance manuals. However, the team that produces the Dam Operation and Maintenance Manual should consist of experts with significant experience who can use sound engineering judgment in applying these guidelines. This guideline consists of 6 chapters: General Information, Project Operations, Project Inspection, Project Maintenance, Instrumentation and Monitoring, and Manual Updates. It contains all the important details generally required for developing operation and maintenance manuals for any type of dam. International best practices are used in preparing these guidelines, considering their applicability and acceptability.

Assuming it is both functional and technically sound, a dam may last for quite some time. The state of a dam may be preserved, in most cases, with regular maintenance of the dam and its related components and the ability to manage the aging process. In order to keep a project running well, there has to be a responsible agency and enough funding to see it through. Failure to do so may cause the infrastructure project's safety to decline rapidly, and the building itself to become hazardous relative to the infrastructure in a very short period of time. Properly maintaining a cap working mechanism is essential for controlling aging, which may diminish integrity and lower service life. To get the most out of dams and reservoirs, operation and maintenance are crucial. For optimal service life extension, this is a key component. In order to keep these assets safe and reduce threats to homes, property, the environment, etc., India needs standardized operation and maintenance standards, rules, and processes due to the country's many major dams. Prior to filling any tank for the first time, it is standard practice worldwide to develop an Operation and Maintenance Manual. There is little evidence of this for most dams in India. The document's goal is to assist every Indian dam specialists in creating their own guidebook for operating and maintaining dams. The proper operation and maintenance of all civil, hydrological, and mechanical components of each dam needs a customized operation and maintenance manual due to the uniqueness of each dam. A significant step toward integrated dam safety management, the present standards for writing an operational and management handbook should satisfy the necessity for writing dam-specific documentation.

The current operating and maintenance protocols for most of these dams must be improved to ensure adequate health and safety. For a dam safety management system, several important components must be put into it. Based on the experience of the Central Water Commission, develop the necessary dam safety laws to address the dam safety sector comprehensively and comprehensively. It will be mandatory for all stakeholders to carry out the necessary activities for the benefit of these assets. Other than maintenance, some issues need to be considered over time and addressed scientifically. Operation and maintenance manuals are needed to ensure safe operation and thus to obtain the desired benefits. This document is treated as important leadership throughout the project life cycle. The current Operation and Maintenance Manual Development Guidelines systematically and comprehensively describe all the elements necessary for operation, inspection, maintenance, instrumentation, regular monitoring, and sometimes, if necessary, monitoring of the health of the dam. These guidelines are formulated based on general global practice, and the individual experience of experts. The Central Water Authority strives to develop best practices for dam safety management based on sound governance and global experience. The document is based on continuous changes in technological advancement, such as comprehensive screening of rehabilitation materials, monitoring and control systems, dam safety, and risk assessment, and all dam owners can use this document to develop and review dam operation and maintenance manuals.

These areas were also clearly defined. Responsibilities related to the operation and maintenance of the dam. Responsibility for the following functions shall be determined by assigning them:

Figure 2.1: **Responsibilities related to the operation and maintenance of the dam**

The Central Water Committee would like to thank the members of the Advisory Group, the Audit Committee, and all stakeholders involved in developing and implementing these guidelines. This document will be of great interest to experts in dam engineering in India. It is recommended that this document be further revised based on future developments, as well as the removal of important practices in the current document (Bhawan, S., & Puram, R. K. 2011).

The Sungai Sarawak Barrage, which was established in 1997 and operated in 1998, poses great challenges to its operators to achieve high efficiency in facing the risks associated with its operation and achieving the required goals without harming society. Periodic monitoring of its operation was a general part of monitoring tidal fluctuations, in addition to the amount of water collected, to manage the operation of the barrage well to reduce the risk of floods. Among the safe precautions, people were educated on the good use of the river, and the addition and benefits provided by the barrage to control the dangers of the river played a good role in the users' dealings with the river. With a good plan for operation and continuous maintenance to sustain it, it had a major role in significantly reducing the risk of flooding on more than one occasion. The first test of the barrage was in 1999, when there was significant rainfall accumulated in areas with high tides, and the barrage had a major role in controlling the amounts of rain. well. The researchers indicated that the Sungai Sarawak Barrage achieved its set goals at a good level. It must be pointed out that nature cannot be controlled with specific structures. Moreover, these bridges played a role in reducing the duration and strength of floods while ensuring that the required amounts of water reached the city. In addition to a good change in the use of the river (Guan, G. C., Marzuki, O. F., Teo, E. Y. L., Hung, Y. P., & Mariah, N.2022).

Increased displacement, variations in skin and skull, and deterioration of materials are only a few of the issues that plague many of the old Nile River barrages. Consequently, the Nile River and other key water control infrastructure projects need to be prioritized for strengthening irrigation networks. Based on an analysis of the structural conditions, damaged regions, and expected lifespan after restoration, it was decided to replace a number of the Nile's diverted canals after assessing their structural integrity, with the exception of the Zifta Canal, which was restored. Also, a conclusion was reached after calculating how much it would cost to repair or replace the barrage. It is uncommon to test reinforced structures subjected to significant shear deformation using methods that are not suitable for testing flexible structures like bridges.

In light of the importance of hydraulic structures, a program was launched by the Ministry of Water Resources and Irrigation to restore or construct the primary historic barrages along the Nile River and its systems. Most modern regulatory agencies determine if something needs fixing or replacing by looking at the structural and hydraulic conditions. Rehabilitating the Zifta Canal in the Damietta branch on the Nile and the adjacent hydraulic facilities of the Mansouriya, Omar Bey, and Al-Abbassi regulators is part of the program, which was recently informed to the Ministry of Water Resources and Irrigation by technical evaluation reports from different regulatory authorities. Though originally constructed between 1901 and 1903, the Zifta waterworks had a full overhaul between 1952 and 1954 to accommodate higher levels downstream and upstream. Furthermore, the barrage's performance and strength must be enhanced to accommodate increased load, water pressure, and traffic conditions; hence, the barrage's piers, boats, and bridges must be enlarged in both length and breadth. There were many phases of barrage monitoring and maintenance from 1994 to 2014, as well as a structural study from 1996 to 2013. The quality and features of the barrages were assessed by collecting and analyzing the findings. The gantry was subjected to a stress test in order to track its horizontal and vertical motions, as documented in the composition article. Also, between 1994 and 1996, a pressure gauge was put in. Lastly, between 2003 and 2004, the gates and cranes underwent extensive repair. A preliminary study was conducted for the culverts in 2003–2005. The study's overarching goal is to assess the missile's present structural health and to determine the potential threats to the situation's survival. This is essential for studying the potential of increasing the water level in front of the barrage and for identifying the immediate tasks required for repair and replacement. In this case, the expert suggested rehabilitation, which means keeping an eye on the driveway for cracks and doing any required repair based on the allowed traffic load. Economic, environmental, and technological feasibility assessments were carried out between 2011 and 2014. In order to carry out this investigation, ten holes were bored into the right side next to the replacement lock; these holes exposed the fissures from which the water had been extracted. The caulking floor has been thoroughly examined, the pavement is free of significant flaws, and all of these components perform admirably. In order to restore the arches, the research suggested emptying and exposing twenty more apertures on the left side. Fixing the necessary electromechanical parts of the gate, grouting the pavement, and restoring the barrier structure are all part of the rehabilitation procedure. In the first of two stages, the restoration of the last barrage included draining, capping, and rafting twenty holes on the left side. Several hydraulic structures were reinforced and thirty apertures on the right were rehabilitated as part of the second phase. From a monetary perspective, it is crucial to upgrade and fortify the Zifta barrages, similar to Egypt's older hydroelectric dams, as fresh construction of these facilities is prohibitively costly, as shown in a plethora of studies. Methods for improving, restoring, and fixing hydraulic infrastructure have been the subject of several research.

One of the ways that restored hydraulic systems were evaluated was via dynamic testing. Dynamic identification and condition assessment, evaluation of strength, and repair of historic building structures are topics that have been extensively studied. Both experimental and numerical studies have been conducted on the dynamic behavior of various structures. As an added bonus, dynamic testing is often used by researchers to find out the mode shapes and natural frequencies, which are dynamic qualities that significantly impact the dynamic response of certain structures. Large hydraulic constructions seldom use these methods. To model the bombardment in three dimensions using finite element software, ANSYS FE was used. Mode shape, natural frequency, and damping ratio are experimentally and statistically investigated as barrage dynamical properties. Therefore, dynamic testing is an effective method for evaluating the regulator's structural integrity. Furthermore, experimental model analysis shows the real state of the structure and is a useful but time-consuming technique for long-term monitoring of this sort of structure. It is easy to see and reflect changes in hardness and damage incidence using the natural frequency value. The only factors influencing the natural frequency are the structure's mass and stiffness. In order to determine how effective the recently finished Zifta Canal Rehabilitation Project was, this research was carried out. Both before to and during recovery, dynamic tests were administered. Everything from the test setup and method to the data collecting and analysis phases, the first and second phases of the test, the resulting interference and mode profile, the key results, and the conclusions are detailed here.

Evaluate the structural condition of the asphalt bridges before and after rehabilitation using dynamic testing. Then all data and results of the study were presented with comparisons between them. As a result, the rehabilitation work carried out positively affects the structural condition and integrity, increasing the service life (Elhakem, Y., & Emarah, D. 2023).

The article is devoted to safety issues of the hydraulic system and assessment of its reliability, which is in the Karadarya River in Uzbekistan, where recommendations that provide safe operation of this hydraulic complex are mentioned.

It was one of the reasons for the poor safety of the hydraulic complex, which prompted the administration to take the necessary measures for evaluation, safety, and development to improve its safe operation to obtain good results for its continued operation. The reasons for the poor safety of the hydraulic complex are:

1- There was a belief that the water in the basin had risen above the specified and safe range, causing a defect in the proper operation of the complex

2- Sediments accumulate in the drainage channel due to high water flow at certain periods, such as flood periods, which is due to rapid drainage. The presence of these sediments in the canal during normal periods when the water level is somewhat low causes concrete damage in certain parts of the hydraulic structure, such as corrosion and rust.

3- A lack of control and monitoring equipment necessary for important measurements in the movement of water and sediments and data that have a role in the movement of the various hydraulic structure expansion joints, which in turn negatively affects the performance of the hydraulic complex in general.

4- There were sediments in the upper basin along the coast on one of its banks, reaching approximately 100 meters, with a thickness of approximately 2 meters, and increasing to 3 meters near the shore of the complex.

5- There was erosion in the lower basin of one of its banks, reaching a depth of 2 meters, which could be caused by sediments and high water flow.

To ensure the safe operation of the hydroelectric power complex at the International Conference at King Saud University, the safe operation of the complex must be carried out while adhering to the requirements of the “Operating Instructions”. Sediments must be disposed of down the river and in the sedimentary channels at the correct time and the river’s path must be protected from damage by creating a barrage. Conversion to maintain the integrity of the system for the gates and hydraulic and technical devices to achieve safe operation of the Koyganor Hydroelectric Power Complex and to preserve the entire complex through good adherence to operating instructions, in addition to continuous repair and restoration of the damaged areas, according to the need and necessity for the safety of the river, where there will certainly be a major role for continuous expertise in monitoring the operations and periodic maintenance.

Safety and reliability were evaluated by correct data and design requirements according to the regulatory documents for hydraulic structure safety indicators (Dilmrod, X., Raxmatillo, S., Ferubek, A., & Yunusbek, S. 2021).

This guide to the Periyar Valley Irrigation Project is owned and managed by the Water Resources Department, Government of Kerala. The barrage, built across the Periyar River at Puthathankettu, is the main undertaking of the project. The Operation and Maintenance Manual for the Buthanketu Valley Irrigation Project includes procedures for carrying out the operation, inspection, and maintenance of tanks and gates. This helps ensure that the barrage is operated safely, properly operated, and maintained. For safe operation of the barrage and continuous productive use of the barrage and its tanks, timely inspection and maintenance are required. The term “operation and maintenance” used in this manual includes, if necessary, the operation, inspection, maintenance, and repair of the corridor and annex components. This manual has been prepared based on data available from existing and mechanical departments by the Guidelines for the Preparation of the Barrage Operation and Maintenance Manual. The details of operation and maintenance were explained completely, and the operation and maintenance budget was talked about and the details it included, including (the cost of employees and their details - medical compensation - vacations, retirement and maintenance of transport vehicles - the locations of employees, roads and paths - office arrangement and invoices - maintenance of electrical systems - mechanical and civil works - and all... Details related to this process).

This operation and maintenance manual was adopted as a basis for the instructions approved in the barrage control room in terms of:

The manual for the operation of Puthathankettu Barrage includes routine operation of canals and reservoirs and emergency conditions. The normal operating procedure is described in this paper in all its details, including the operating parameters of the tanks, waterways, and irrigation outlets of the canal system. Waterway operation includes organizing its reservoir according to specific project requirements, emergency operational procedures, and all details essential for safe operation. In addition to the details necessary for the continuous periodic maintenance of the barrage on an organized schedule with constant monitoring and a full explanation of the times for continuous monitoring and maintenance, all these details have an effective role in reducing the deterioration of the bridges and increasing their lifespan. Timely maintenance ensures the safety and good operation of the barrage (Chaube, U. C., Pandey, A., & Singh, V. P. 2023).

With the increase in hydraulic data records and the development of new methodologies for flood discharge estimates along with societal requirements for safety issues, there are many requirements for the rehabilitation of water drainage sewers for hydraulic projects to improve their capacity in many countries. Many hydraulic projects in France have little water drainage capabilities compared to floods (160 projects for the Electricity de France company). Therefore, improving the capacity of many water drainage streams to increase their drainage has become important. whereas Modifying drainage channels has an important impact on the structure of the hydraulic structure due to removing quantities of concrete or adding loads to the existing structure.

As mentioned, the cost of these projects is high. Rehabilitation of drainage sewers requires a comprehensive study in terms of design and maintenance, such as the design of the Piano Key Weir maze dams, which was considered one of the company's Electricity de France company rehabilitation projects. What is characteristic of labyrinth dams Piano Key Weir is that the increase in the height of the crest with an appropriate width plays a role in increasing the reservoir capacity. Piano Key Weir is a free-flowing stream with a good level of safety and reliability, in addition to the possibility of placing it on top of most gravity dams. And dams Piano Key Weis it has a role:

- In maintaining normal levels of operation.
- Little impact on the hydraulic structure.
- There is no effect on gates and mechanical components.
- Free flow with little maintenance.
- Low-cost solution.

Other systematic tests are necessary to reach a detailed analysis of its effect on hydraulic capacity.

Over the years, many of these projects have been built around the world. It is effective and had a role in hydraulic bridge projects during the rehabilitation period. An alternative solution was developed and allocated with a special method with a certain height and the ability to control the barrage better. The article presented an understandable approach to Piano Key We, its details, and its development (Leite Ribeiro, M., et al., 2009).

In recent years, floods that have occurred due to severe typhoons and heavy rains have occurred frequently in Japan. There was a need to develop and advance the proper operation of hydraulic facilities associated with flood control by controlling the water level downstream to reduce the resulting damage in urban areas. The Japanese Water Agency had a role in developing a new simulation device that allows the acquisition of the necessary skills. For proper operation of hydraulic installations. It gives good training efficiency by simulating the water stream and its flow during floods, reversing the stream in different ways, the momentum of the rain, and the precise drainage of the stream into the reservoir after large amounts of rain, where the simulation is very close to reality, as well as simulating previous floods and knowing their behavior through what has been observed. Recently, the Tombstone Floods have caused severe typhoons, linear plumes, and frequent severe flash floods in Japan. Keeping these events in mind, proper development and pressure based on river water level are required to reduce the damage caused by barrage inundation, especially in urban areas, etc. It serves as a new simulation to obtain the competencies needed to develop bridges correctly. The goal of developing the simulator was to increase the versatility of modeling materials, reproduce the state of flood control in a manner close to reality, and adjust the debts of the river in addition to the debts of the excretory reservoir, considering the debt situation of the entire basin depending on the differences in the effects of rainfall. In addition, the simulator calculates changes in rainfall, flow through the reservoir, and dam water levels, and reproduces the operating sensation of the barrage control device. In addition, the function allows the simulation of all previous flights reviewed after the start of Japanese Water Agency operations.

The new Japanese Water Agency Dam Operations Training Simulator has been developed to enable staff to train on release planning and operations while confirming downstream locations. It also provides a variety of strategic training functions to improve the quality of training in flood control operations. Most of them are new operations that mimic the operation of existing dams. Additionally, because it can be installed on standard desktop computers, it provides a simpler environment for Japanese Water Agency staff to provide dam operations training opportunities. As a result, Japanese Water Agency employees are now able to master advanced unloading operations in a short time. In addition, given the frequent occurrence of supertyphoons, linear rain bands, and locally heavy rains across Japan in recent years, NEW S-DOT is suitable for simulating advanced discharge processes to make optimal use of dam capacity even in extreme situations. It has to be the most advanced emulator in the world with such diverse features. The new S-DOT system has allowed the Japanese Water Agency to significantly improve the flood prevention process skills of its disaster prevention personnel (Tamura, K., & Kano, S. 2019).

Lac La Ronge Dam was built in 1966. During an annual inspection in the spring of 2017, the staff discovered three noticeable depressions at the top of the dam. Subsequent geotechnical investigations confirmed evidence of emergency response pipes. Temporary measures have been taken to slow the leakage while permanent remedial measures can be designed and implemented. Contract with Clifton Associates Ltd. Completing remedial design work including:

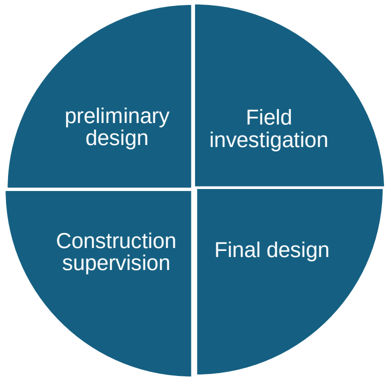

Figure 2.2: Completing the remedial design of Lac La Ronge Dam

Five treatment options were considered:

1- Grout curtain upstream of existing sheet pile wall installed to the fractured bedrock interface,

2- Vibrocompaction of the dam core.

3- Geomembrane installation on the downstream face of the core.

4- Soil cement bentonite slurry wall along the dam core between two sheet pile walls.

5- Deep soil mixing with soil cement/bentonite replacement along the dam core centerline.

After evaluating these options, the recommended approach is implementing leak containment using proven techniques for known site conditions. There are two conceptual design options:

1- Downstream geomembrane cutoff.

2- Cutting of the sheet pile and gypsum curtains.

A detailed site investigation program has been completed including geophysical surveys, drilling, instrumentation, packaging testing, and tracer dye testing to characterize the site. The study aimed to obtain soil samples to characterize the subsurface soil, identify seepage areas, determine groundwater conditions, and improve geotechnical design parameters. The work devoted to improving the corrective concept includes the initial idea, the topographical survey, the final concept, etc., and Construction supervision. The following five solutions were envisioned: plaster dredging, internal compaction, installation of geomembranes on arches, suspended walls, and soil mixtures. After evaluating these options, the recommended approach involves conducting penetrations with the help of proven techniques for ongoing site conditions. Concepts were developed for downstream geomembrane cutoff and sheet pile and grout curtain cutoff.

A detailed topographic study plan was completed including geophysical levels, recharge, instrumentation setup, cover testing, and trace color for site assignment. The research objectives are to obtain solar flares to characterize the southern face of the Sun, determine the permeability zones, determine groundwater conditions, and attach geotechnical conceptual parameters. The raid was proposed in early 2019. This article examined the Lake La Ronge barrage, from its construction to the chosen assassination concept.

Among the challenges of safety management for hydraulic structures is the dam safety plan, as the Water Security Agency follows dam safety guidelines. The program requires monitoring and inspection to ensure facilities are operated and maintained safely. The frequency of monitoring for each structure is determined by several factors, such as:

a- Previous structure performance and technical maintenance time,

b- Conclusion and classification,

c- Instructions on hydraulic structure safety

d- Location.

Lac La Ronge Dam is a major one. They are intended to be inspected annually by personnel with equipment monitored once a year (Kozun, R., et al., 2019)

In the mentioned study, the upgrade of the old Bolin regulator built in 1928 in Egypt, located in the main Behairy Canal, was discussed. The hydraulic structure was in good condition. Due to changes in irrigation systems and agricultural areas, a height of 0.5 meters was necessary, as the evaluation process was planned, and data was collected about the status of the regulatory body. The evaluation process was divided into four main components, which included (data collection - site examination - field tests - numerical modeling). With the lack of available data for the structure, a good team had to measure the drawings for the structure and prepare the drawings. The focus was on finding deteriorating points and a general assessment of the regulator's status.

It has been verified and tested that there are no cracks in the upper part of the organizer. The field properties of the land and building were known by conducting field tests. Knowing the compressive and tensile strength of concrete wells at different levels. A two-dimensional model was prepared to complete all evaluation tests.

The results of the numerical analysis showed that the locking support was exposed to excessive pressure without safety, with an increase in the head height difference and seismic loads, where there were tension stresses of 12 km/cm^2. This problem existed in more than one regulator. It was observed that the cracks did not extend along the length of the raft, as the vertical acting loads were less than the lifting force, and it was expected that cracks would occur on the bottom surface of the raft. Lifting forces did not control the maximum pressure, but what controlled it were seismic loads. In addition to all the details related to the evaluation of the structure to determine its evaluation.

The shell model accurately represents hydraulic bodies and structures and is therefore a useful representational model. Nontraditional methods of repair and rehabilitation may become possible as our knowledge of structure, load, and behavior grows. Pilings are an excellent method of supporting the pier; nevertheless, they need frequent maintenance and do not obstruct the passage of water. Conventional methods of repair using concrete jackets pose risks to the hydraulic component, whereas steel jackets need regular maintenance. Relieving tension is easy with the raft de-stress technique. But in this situation, it's important to verify the lifting force to make sure the small dirt particles don't migrate. In order to stop water pipes and the flow of tiny soil particles, it is recommended to plug artificial fractures using flexible materials like epoxy. Furthermore, experimentation is needed to confirm the artificial crushing approach (Mohamed, E. K., & Khalil, E. 2018).

In the last few decades, methods for analyzing the risks and uncertainties of hydraulic structures have been refined. As an example, we also investigate how well the hydraulic design works in an open channel. Utilizing the sophisticated first-order moment formula in conjunction with the Monte Carlo simulation technique, we assess the implemented channels' dependability. Channel design and operational factors are seen as potential unknowns in both approaches.

Coefficient of friction, channel width, transverse slope, and flow depth are all aspects of channel design that may be affected by surface runoff uncertainty, such as rainfall and drainage force. In both static and dynamic settings, a comprehensive sensitivity analysis of the dependability index was carried out for different system load levels. One of the most important aspects impacting the safety and reliability factor, according to the sensitivity study, is the spill depth and bottom width. A stormwater drainage network in North Bangalore, India, is the subject of another investigation.

Design flow, channel size, and liner material roughness are three parameters that are taken into account when designing a stormwater drainage network that can efficiently convey wastewater, with the uncertainty induced by natural and inherent randomness being treated as a random variable. The results of the reliability study show that the channel liner material's roughness, slope, or breadth has to be changed, and that several channel sites need to be redesigned. Two studies have shown that storm drainage, open canals, and water system infrastructure failure may endanger the public and harm both property and the environment. When dams and gate arches are the objects of this study, we conduct a reliability analysis, and we establish operational processes and management methods. Adiningrum and Hadihardaja (2017) state that checking the gate operating methods is required to limit the danger of floods and spills.

Regular maintenance is essential for ensuring the safety and continued functionality of arches, which are significant structures that incur large construction costs. Many factors, including changes in the environment or human activity, as well as an increase in the actual load relative to the original design load, might impact an arch's performance. The objective of visual inspection, monitoring, and numerical model output, together with all accessible design and construction data, is to continually assess the structure and its related characteristics for damage. When evaluating a building's stability, inspection is essential. The primary reasons of building collapse must be constantly known, understood, and kept in mind.

Consequently, keeping the building in a safe state requires an efficient inspection procedure. The intervals between inspections determine the frequency of the inspections, which may be categorized as yearly, semiannual, regular, special, or emergency. The goal of the test dictates the methodology used to collect data. Negative conditions are more likely to be detected when testing intervals are shorter.

Loss of performance may lead to functional deterioration, increased operating and maintenance expenses, or catastrophic failure, hence it's crucial to maintain hydraulic structures. Making accurate judgments is essential for maintenance because of the complexity of the process. Before beginning any kind of maintenance, it is necessary to do a comprehensive assessment of the building. This includes taking precise measurements, looking for patterns, reading the blueprints, researching the building's history of repairs, and making note of any visual observations. Considerations such as the surrounding environment, the applied loads, and any changes brought about by corrosion or structural failure should be carefully considered. Foundation soil, water movement around the building, leaks beneath or through the structure, and live load given to some of its sections are a few of the many considerations that make maintenance of hydraulic structures an extremely difficult task. A subfield of AI known as "expert systems" has been making waves as of late. Studying how to construct human-machine systems with expert-level problem-solving abilities is a subfield of expert systems. The building, designing, planning, operating, and maintaining of hydraulic infrastructure are only a few of the many water engineering tasks that might benefit from expert systems.

Large hydraulic constructions, like barrages, may be costly to reconstruct after a sudden breakdown owing to neglect, so instead, a lot of work goes into fixing construction channels and making them more stable. Since there aren't many experts in this sector anymore, we compiled and made public all the knowledge we could find. Water supply system engineers that specialize in preventative maintenance and emergency repairs The expert may effortlessly modify the facts and rules to suit modifications and include new rules to tackle them, all without taking the difficulties into account. Very possibly. Users are able to find potential issue reasons and get treatment suggestions from the created expert system. Egyptian field data acquired by the Nile Canal Ministry of Water Resources and Irrigation was used to verify the proposed system. In order to maximize the structure's lifespan and save decisionmaking time during maintenance, the suggested expert system should be used. Transportation knowledge, time and money savings for experts, improved problem understanding and solution quality, ease of use for novice users, and a host of other benefits are all part of the expert application system technology for bridge repair in construction.

Here we detail the steps used to build an expert system that can inspect, diagnose, and fix issues with building water supply systems. In order to safeguard structures, the created expert system will seek out issues, determine their origins, and provide solutions. It was with CLIPS 6.0 that the expert system was constructed. Visual Basic 6.0 was used to build the user interface. The created expert system has many user-friendly interfaces that make it simple to input data and get results. According to Abd-Elhamid, H. F., et al. (2011), the suggested program has been proven in several real-life instances.

The aforementioned research enhanced the numerical depiction of the Severn Tidal Energy Cluster's turbines and dam gates using the Environmental Hydrodynamics Code's water environmental model and applied it to the Cardiff-Weston Barrage project. This study shows how important it is to accurately describe hydraulic structures by comparing the long-range hydrodynamic impacts of the Severn Barrage before and after reinforcement using the European Continental Shelf Extended Field Model. The upgrades may reduce peak water levels in the Bristol Channel by around 1 meter in some places and affect predictions in other places further from Scotland's west coast. Actually, it's true, but only to a considerably smaller degree. We checked how the model responded when we changed the parameters that determine the flow through the sluice gate and turbine. Continuous discharge, as opposed to instantaneous discharge, improves the Severn Barrage's performance, which is insensitive to variations in modulus values. At now, the tidal range proposal's influence is more reliably anticipated, and the parameter's sensitivity analysis shown that, despite the parameter's uncertainty, the modeling findings are more trustworthy (Bray, S., Ahmadian, R., & Falconer, R. A. 2016).

The hydraulic structure's exceptional functionality and susceptibility to issues have put it in an unprecedented state of repair. As a result, stringent regulations on building and building upkeep or repair are required. To achieve these goals, cutting-edge technological advancements are essential to guarantee effective building processes and to fulfill the owner's expectations for the building's expected operating life. In light of this, we provide two novel approaches to building and repairing hydraulic concrete structures. Concrete technology that enables for the construction of dams in flowing water or repairs to be made below water level is the basis of the road. Both techniques were created at Germany's Karlsruhe Institute of Technology's Institute for Concrete Structures and Building Materials and put into action during the building of Indonesia's Preben Hydropower Station and Germany's Albrück-Dögern River hydropower station, respectively.

An original idea for building and repairing hydraulic concrete structures was born out of a cooperative initiative between the Federal Ministry of Research and Education and other organizations. A novel approach of building concrete members in moving water and fixing damaged concrete members below water level has been developed based on extensive research efforts. Underwater concrete building is now a reality, thanks to a significant advancement in the field that has allowed researchers to tailor their work to the stringent standards for long-term operability and durability. H. With no need to flood rivers in motion or individually reduce water levels, this would result in substantial economic advantages. According to Müller, Bohner, Vogel, and Kvitsel (2013), both novel approaches have been validated in large-scale lab tests and shown to be applicable when applied to preexisting hydraulic systems in Indonesia and Germany.

This paper presents the author's method for evaluating the stability of water levels and discharges over time. It also proposes a new way to categorize water facilities environmentally, using water flow velocities as a reference and "instability factors" to calculate the capacity to convey discharges and levels, which is both acceptable for the design and effective throughout the project's lifetime. The categorization is based on the premise that hydraulic working conditions remove or significantly reduce local channel processes and risks, such as biological, erosional, sedimentary, ice control, etc. Preventing cracking, deterioration, and degradation of hydraulic structures is the primary goal of the applicable categorization. Here you will find the fundamentals of investment management, general guidelines for designing sewer capacities for water drainage, and the means by which to identify outlet works. The purpose of establishing both general and specific technical criteria is to lessen the environmental and negative effects of building hydraulic headwaters.

Naprawa (2018) states that the breadth of the required adjustments is outlined in rules and specifications that will be included in the present standards and regulations in Poland.

Numerous hydraulic structures make up Egypt's extensive irrigation network. Its historical and economic significance is immense. Due to growing traffic loads, unfavorable climatic conditions, and a lack of maintenance, several hydraulic structures have experienced material degradation and structural damage. The National Project for the Protection of Old Irrigation infrastructure mandates continuous structural evaluation efforts to address safety and maintainability concerns about these significant infrastructure. Located in the Nile Delta, the 80-year-old Ras Al Shola Regulator stands in Tayarat Al-Bahia. Field inspections, material identification, deterioration characterization, and load condition calculation were all part of the existing conditions study. To find out whether reinforcement is necessary, assess the structural efficiency and safety margin, and study the structural behavior, numerical studies are used. The applied and predicted load conditions are used to conduct numerical modeling and nonlinear finite element structural analysis utilizing commercial software. Based on the findings concerning structural stress, deformation, and fractures, it may be concluded that the structure is now stable and intact. Surprisingly, there are spots on the wing walls where tremendous pressure is felt (Hamdy, G. A., et al., 2021).

2.2 Examples of Water Resources Projects in Iraq Barrages

2.2.1 General

The barrages that may be seen around Iraq are among of the country's oldest hydraulic structures. Several barrages have already been constructed along Iraq's major rivers, and others are in the works. Such constructions date back to the earliest days of Mesopotamian civilisation. Ottoman officials constructed the Hindiya Barrage on the Euphrates River in response to a water scarcity in the Hilla branch during the contemporary era. The walled Hindiya, Kut, Fallujah, Ramadi, and Samarra barrages were all built as a result of proposals made by William Wilcox in 1911. Prior to World War I, only the Hindiya Barrage was constructed. Construction of the Kut Barrage began later, in the 1930s. The barrages on the lower Euphrates River, as well as the Ramadi and Samarra Barrages, were constructed after the establishment of the Development Council in the 1950s. The Dibis Dam and the Diyala Barrage were two further control structures that were constructed throughout the 1960s. A dam in the Al-Kifl-Al-Shanafiya section of the Euphrates River, together with the new Hindiya Barrage and the Fallujah Barrage, were constructed in the 1980s. In2004, work began on the Amara Dam (Abdullah, M., Al-Ansari, N., and Lawi, J. 2019).

2.2.2 Diyala Barrage

Situated on the Diyala River, 7 kilometers away from the Hamrin Dam, lies the Diyala Barrage. Orchards along the Diyala River and the needs of the local municipalities are met by this structure, which is part of the lower Diyala region's irrigation projects. On one side, you have the Khalis Irrigation Project, and on the other, you have the Joint Stream Irrigation Project. In the beginning, during flood seasons, a makeshift dam would be constructed from stones and trees, but it would eventually collapse. A dam, constructed in 1928, that was only meant to be temporary, fell in 1935. The reconstruction of an additional dam took place from 1936 to 1940, but it failed in 1946. Sir M. MacDonald's business was asked to investigate the Diyala area, including the Diyala Dam, due to the growing fascination with the Diyala Basin and the construction of the Darbandikhan Dam. After submitting a study in 1963 for a new walled dam with vertical regulators to be built for the Khalis Canal and the Joint Tributaries Canal, the business was succeeded in 1969 by a Finnish company that had developed the Diyala Barrage. A concrete structure measuring 400 meters in length, the barrage has 23 apertures that are controlled by vertical gates. At a height of 67.5 meters, it conveys 1200 cubic meters every second and has dimensions of 2 meters by 12 meters. The fundamental design consists of two sets of square gates, with three sets on the right side and five sets on the left. Every erosion gate has dimensions of 2.5m × 8m, and their maximum discharge may reach 700 m3/sec. In the case of very strong floods, the water should be directed to the Salah al-Din canal, which is linked to the Shuwaikha depression, by means of an emergency spillway that was constructed on the left side, above the barrier. The water level of two primary head regulators is controlled by Diyala Barrage. The openings of these regulators measure 2.5m × 8m. The first regulator, on the right, has three gates and a discharge of 75m3/sec. The second, on the left, is the common head regulator, with four gates and a maximum discharge of 126m3/sec.

Excavations at adjacent quarries along the canal have altered the river's original cross-section, which is one of the main current issues impacting the Diyala Dam. As the hydraulic leap was relocated away from the sedimentation basin, the hydrological impact was negative due to the change in the river's cross-section. Near the dam's base, dredging started to show up. To confine the hydraulic leap inside the basin, a concrete sill was created in 2008 as a technological precaution. Even now, quarrying remains a major problem that shows no signs of abating (Al-Simawi, H. 2010).

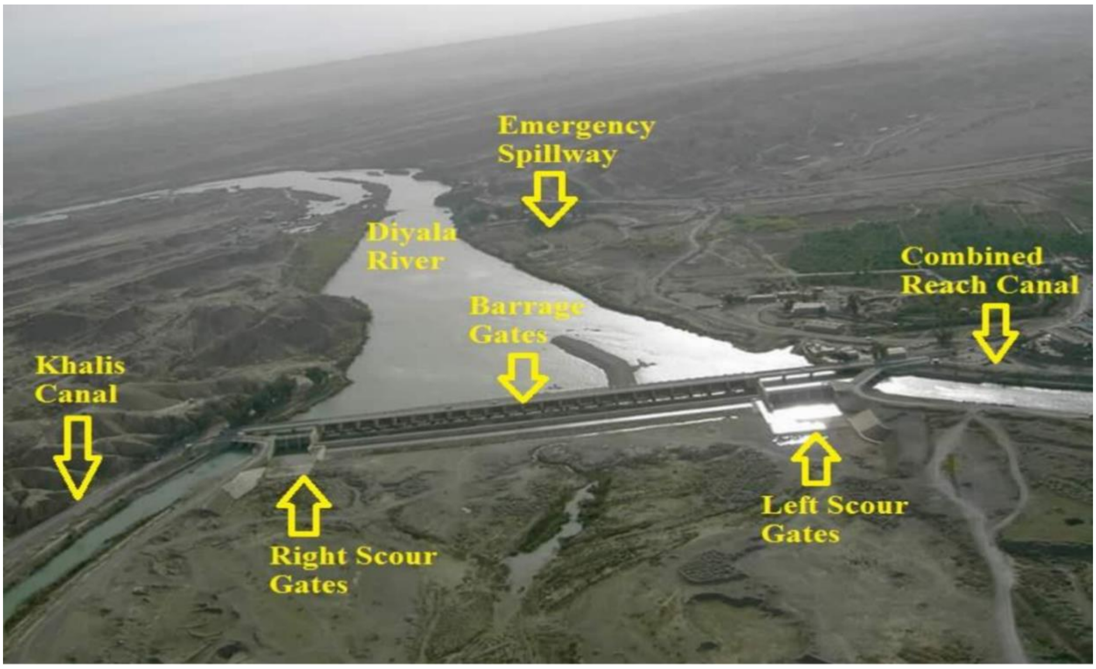

Figure 2.3: **Aerial view of Diyala Barrage**

Source: Abdullah, M., Al-Ansari, N., & Laue, J. (2019)

2.2.3 Samarra project

Among the several large-scale water resource initiatives undertaken to save Baghdad against floods was the Samarra Project. As a safe haven from Baghdad floods, William Wilcox suggested it. The Council of Development chose to set the cornerstone for the export project after the 1954 flood, the last major flood to inundate portions of Baghdad. The German firm Zubrin was given the task of building, while the British firm Ransom & Roper was given the task of hydro mechanical works. April 16, 1956 was the official opening of the project. The Tharthar project relied heavily on the Samara project as its control framework. That is, the Samarra Barrage project and the Tharthar regulator! (Sousa, A. 1966) .

Figure 2.4: **Satellite view of Samarra Barrage and Tharthar Regulator**

Source: Abdullah, M., Al-Ansari, N., & Laue, J. (2019)

2.2.4 Kut Barrage

An important Iraqi river's oldest remaining canal is the Kut Barrage. In his 1911 report, Sir William Wilcox suggested it as a means to stabilize the Al-Gharraf Canal's water levels. Sir Codd Wilson & Co. Consultants, hired to study irrigation projects in the 1930s, did the surveying and designing. Balfour Beatty oversaw the civil works and Ransom & Rapport the hydromechanical works when construction started in 1936. By 1939, the canal had been opened. At a height of 16.75 meters above sea level, the Kut Canal construction work began. The Middle Tigris Project, and the Dalmaj Project in particular, were later studied, and consultant M. MacDonald said that high water levels were required to guarantee water supply for the project. This allowed for the reservoir to be filled up to its current operating water level of 18.5 meters above sea level. After these repairs were finished in 1967, Al Kut Dam could feed water to the Dujaila Irrigation Project, the tributaries of the Dalmaj Irrigation Project, and the Al Garraf Canal by gravity. A vertical gate measuring 6 meters by 6.5 meters regulates 56 openings in the 550-meter-long Al-Kout Barrage, which has a drainage capacity of 6,000 m3/s. Located on the right side of the bridge, next to the navigational whisperer, is a 16.5m x 80m fish ladder. It was repaired by Iraqi soldiers after being damaged in an air attack in 1991. Located 330 meters to the right of the Kut Canal, the project includes the primary regulator at Dujaila. Two 5-by-6-meter apertures make up the organizer, which was opened with the project and subsequently restored in 1978. Both the maximum and usual discharge rates are 42 m3/s and 35 m3/s, respectively. Just 2 kilometers to the right, beyond the kut-Kentat, is where the Garraf Canal's primary regulator is situated. It has a navigation lock that is 8 meters by 80 meters in size and seven apertures that are 3.8 meters by 6 meters in size. On the other side of the canal from the regulator is where you may find it. The standard discharge from the regulator is 350 m3/s, while its maximum capacity is 500 m3/s (Sousa, A. 1966) .

Figure 2.5: **General view of Kut Barrage**

Source: Abdullah, M., Al-Ansari, N., & Laue, J. (2019)

2.2.5 Amarah Barrages

The Amarah Great Project is one of Iraq's most ambitious ongoing irrigation projects. Water from the Tigris River, from which several historic canals sprung, is vital to the project command area in Maysan governorate. Since Willcock's 1911 suggestions—which included building barrages to provide the necessary sailing depths—the region has been considered for development. Consultants subsequently evaluated the Amarah area for potential utilization; their recommended barrages would have served as irrigation systems. The Amarah Barrage, the Qal'at Saleh Barrage, and the Kassara Barrage are the three extant barrages that span the Tigris River.

2.2.5.1 Amarah Barrage

With the help of Indian experts WAPCOS for the comprehensive design and a final survey in 1982, the barrage was investigated as part of a large construction project by Sijob and Khairullah Wardi. The barrage, which has six bays regulated by six gates and a discharge of 373 m3/s, was built from 2000 to 2004. A 20 x 217 meter fish ladder and navigation lock make up the barrage body. The present operating level is 6 million cubic feet, which is lower than the anticipated level of 9 million cubic feet, due to additional precautions that were initiated but never finished to safeguard the city of Amara and the groundwater drainage network (Al-Simawi, H. 2010) .

Figure 2.6: **General view of Amarah Barrage**

Source: Abdullah, M., Al-Ansari, N., & Laue, J. (2019)

2.2.5.2 Qal'at Saleh Barrage

On the Tigris River, close to the village of Qalat-Saleh and 45 km downstream from the Amarah Barrage, is the Qalat-Saleh Barrage, which was built in 1978 and has three 6m x 8m openings that are controlled by radial gates. A fish ladder and a navigation lock measuring 16.5m x 100m are located inside the dam. It is in disrepair despite being situated on a significant river. (Abdullah, M., Al-Ansari, N., & Laue, J. 2019)

2.2.5.3 Kassara Barrage

It sits on the Tigris River, 70 kilometers below the Amara Barrage. They finished building it in 1978. It has three radial gate-controlled apertures measuring 6 x 8 meters in size. A fish ladder and a lock measuring 16.5m x 100m in length are part of the barrage. It will be necessary to restore the abandoned dam before it can be used again (Abdullah, M., Al-Ansari, N., & Laue, J. 2019).

2.2.6 Hindiyah Barrage

When the Saqlawiya Canal was closed in the late 1800s, the water flow of the Euphrates River increased, leading to a water deficit in the Hilla branch. The Euphrates River rushed downstream into the Hilla canals as a result of its increasing flow. Consequently, the Hilla tributary's flow reduced while the Euphrates' flow grew, leading to silt accumulation at the tributary's base and a subsequent rise in the riverbed. In the latter half of the nineteenth century, the Ottoman government took action and hired the French engineer Schenderfer to find a remedy. The construction of the Euphrates River dam was a short-lived endeavor. Following Wilcox's involvement, he proposed a new dam with 36 apertures, each 5 meters wide. In 1913, the dam was cut open and accessible to the public. Despite many floods, the barrage has remained functioning for decades. A new stream was required since the existing one had fallen into disrepair. In 1978, the French firm Sugre was hired by the Ministry of Irrigation to do a research and design. It wasn't until 1989 that the dam, started in 1984 by a Chinese engineering firm, was finally finished. A major regulator for the Hilla and Kifl Canals, navigation locks, a hydroelectric power facility, and the main canal make up the New Hindiyah Canal project. The Al-Husseiniyah and Bani Hassan Canals, together with government buildings and housing complexes for workers. Just 1.7 kilometers separate the two reservoirs. The following components make it up:

1- A hydroelectric station with four generating units and a discharge of 420 m3/s is located on the right side of the main conduit. The conduit is made of concrete and has six openings measuring 6.75 m x 16 m. It can hold a maximum water capacity of 2500 m3/s and a water level of 32.55 m above sea level. The gates control the openings. Located next to the station is a 20 m x 150 m fish ladder and navigation pole.

2-The Hilla Canal's primary arbiter: Left of the main dam is where the Hilla Canal's primary regulator is located. Radial gates regulate its six apertures, each of which measures 5.4 x 6 meters. The typical discharge is 200 m3/s, however a high of 326 m3/s does pass. A 600-meter-long navigation canal, with a 6-by-90-meter navigation lock, connects the Hilla Canal to the Euphrates River on the island's left side.

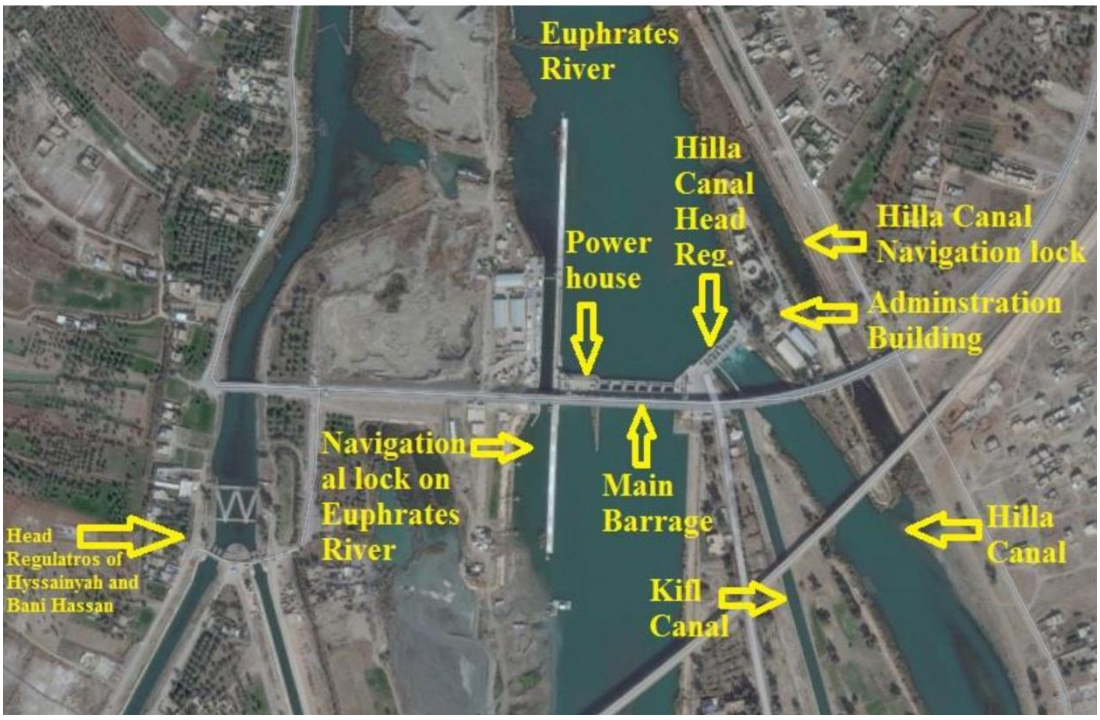

Figure 2.7: **The details of Hindiyah Barrage**

Source: Abdullah, M., Al-Ansari, N., & Laue, J. (2019)

3-The Kifl Canal head regulator, situated between the main barrage and the Hilla Canal main regulator, has two apertures measuring 3.4m × 4.5m. It has a maximum discharge capacity of 36.12 m3/s and a usual discharge of 20 m3/s.

4-Crossing the main barrage, on the right side, are the closing dykes of the abandoned river reach. After that, there is a combined canal that leads to the head regulators of the Hussainiya and Bani Hassan Canals. This is the fourth point on the route. The two 3.4m×6m ports make up the Bani Hassan head regulator, which has a maximum discharge of 45 m3/s.

5. The Hussainiya head regulator is located to the right of the head regulator of Bani Hassan. The dimensions of the three apertures are 3.4m × 6m. The regulator has a normal discharge of 32 m3/s and a maximum discharge of 55 m3/s.

6- Meshes for fish protection: 1cm×1cm meshes were put in to stop fish from making their way to the irrigation channels. The first mesh is 2.5m × 24m and is located near the Kifl Canal head regulator. The second mesh, which is upstream of the Hussainia and Bani Hassan head regulators, is 36m long and 5m high and was built in the form of a letter (W). It is part of a system that pumps water back into the Euphrates River.

According to Al-Simawi (2014), there are seven infrastructures that will be constructed. These include a building for project administration, a complex of worker housing, and a railway bridge for the Musayab-Karbala railway.

2.2.7 Shinafiyah-Kifil Barrages

As one of Iraq's largest and most populous irrigation projects, Kifl-Shinafiyah is a massive undertaking. There are two major streams of the Euphrates River that run through the project. The Shamia Branch and the Kufa Branch in particular. Various barricades were constructed at various points throughout time. That is, (1) regulators for the Shamiya branch and (2) barriers for the Kufa branch.

2.2.7.1 Shamiya branch regulators

Regulators were constructed across the Shamiy Branch to elevate the water level for the irrigation canals. The Euphrates River splits into two branches downstream of Kifl city, the Shamiya Branch to the left and the Kufa Branch to the right. Regulators in this branch do not have navigation locks since the Kufa Branch is the major route for navigation. The Shamiya Branch is overseen by three regulators: Abbasiyah, Shamiya, and Khawarnaq.

1. Upstream of Abbasiyah City, on the Shamiya Branch, you'll find the Abbasiyah Regulator, the first regulator. While the Sogreah French Company and others in the region were responsible for designing this regulator, a Chinese construction engineering firm put it into action in the 1980s. The Abbasiya regulator, which went live in 1988, has radial gates that regulate six openings of 6.3m×12m, and it can pass a maximum discharge of 1100 m3/s. There is a fish ladder on the regulator as well.

2. The Shamiya Regulator, located 39 km upstream of Shamiya Branch and 6 openings measuring 6m.3×12m, was opened in 1986. Its maximum discharge is 1100 m3/s and it is regulated by radial gates. There is a fish ladder on the regulator.

3. The Khawarnaq Regulator, which is located 69 km upstream of the Shamiya Branch and upstream of Ghama's city, was opened in 1986. It has five 8m×8m openings that are regulated by radial gates and has a maximum discharge of 1100 m3/s. There is a fish ladder on the regulator. (Abdullah, M., Al-Ansari, N., & Laue, J. 2019).

2.2.7.2 Kufa Branch Barrages

The Barrages and Regulators built on this branch are Kuafa Barrage, Meshkhab Barrage, Abu Ashraa Regulator, and Al-Ya'aw Regulator,

1. Kuafa Barrage: Kufa Barrage, the first barrier on the Kufa Branch, was inaugurated in 1988 by the same company who had developed and constructed the hydraulic structures in the region in the 1980s. The diameters of the seven apertures in the Kufa Barrage are 6.3m×12m, and they are regulated by radial gates that allow a maximum discharge of 1400 m3/s. A 20m×150m fish ladder and navigational lock are part of the regulator. Included in the barrage is a hydroelectric power plant that generates 6 megawatts from four separate units.

Figure 2.8: **General view of Kufa Barrage**

Source: Abdullah, M., Al-Ansari, N., & Laue, J. (2019)

1. Meshkhab Barrage: Constructed in 1959, this construction is located in Meshkhab city. A maximum discharge of 750 m3/s is passed through the barrage, which has

seven openings, a width of 12.55 m, and is regulated by vertical gates. The 8m×80m dimensions of the navigational lock and fish ladder are part of it.

2. Abu Ashraa Regulator: situated close to the Qadisiyah sub-district, is one of the long-standing regulators. A drop structure was constructed in 1939 and completed in addition to the building that was finished in 1936. The maximum discharge of the regulator is 50 m3/s, and it consists of four 2.5m×3m apertures that are regulated by vertical gates. An 8-meter-by-105.75-meter navigation lock is situated to the left of the regulator.
3. Al-Ya'aw Regulator: Located 5 km to the left of Abu Ashraa regulator, this ancient regulator marks the mouth of the Al-Ya'aw River, which splits off from the main river 5 km upstream. With seven apertures measuring 2.5m×3m and a maximum discharge of 200 m3/s, this regulator was finished in 1940 by the regulating firm Balfour Beatty (Abdullah, M., Al-Ansari, N., & Laue, J. 2019).

3. METHODOLOGY

3.1 Introduction

The practical aspect aims to evaluate the management of the operation and maintenance process in the Kufa barrage, which was considered a model for the barrages in central and southern Iraq, where the results of the evaluation of this barrage are reflected in the barrages in central and southern Iraq. The focus will be on the results and recommendations to be comprehensive for the regions of central and southern Iraq to achieve the maximum possible benefit from managing the operation and maintenance process in future challenges.

Through the analytical study, the focus is on the comprehensive evaluation of the process and observing the experiences of the key individuals in managing this process and their implementation of the operation and maintenance program for business continuity. The target audience includes all managerial, administrative, and technical employees with sufficient experience who bear this responsibility in managing the operation and maintenance process of the Central and Southern Iraqi Barrage and its related departments.

The sample will be focused on a specific group concentrated in the Kufa Barrage and the circles attached to it in the governorate in which the barrage is located, from the broader community that includes central and southern Iraq, as it includes managers, administrators, and technicians who have a role in the operation and maintenance process of the barrage. The individuals in the sample are selected based on experience and influence in the operation and maintenance process.

This sample represents the barrages on which the study was focused and will give a clear picture of the management of the operation and maintenance process in the barrages at the administration level, its implementation of the barrages in central and southern Iraq, and the continuity of their work.

The sample amounted to 56 individuals, and the questionnaire was distributed to them, as the sample size is sufficient to evaluate the management of the process and give the necessary results to achieve a comprehensive evaluation, which will in turn be reflected in the target community. The data provided was analyzed using tools and techniques that allow us to draw useful conclusions and recommendations based on evidence. These elements play a role in representing our efforts to achieve the goal of the study.

3.2 Case Study (Kufa Barrage)

3.2.1 Description and location of the Kufa Barrage

The Kufa Barrage is in Babylon, Iraq, and it is one of the parts of the irrigation project for the cities of Kafl and Shinafiya, which includes organizing irrigation and drainage of lands irrigated by the Kufa River and the Abbasiya River.

Which has an area of 550 thousand dunams. The design drainage of the barrage is 1,400 m^3/s, with an advance level of 25.70 m above sea level. The barrage contains 7 openings, each measuring 12.00×6.30 m, and they have radial iron gates. There is a hydroelectric power station on the site. After the construction of the Kufa Barrage, it was possible to control the water discharges that pass through the Euphrates River, ensuring the success of the annual agricultural plans, as water is rationed at 40% of the quantities supplied. It was launched before the construction of the barrage, and agricultural plans could be successful with a smaller amount of water, in addition to removing new agricultural lands that were flooded with water and washed away from the annual agricultural plans. The entire project was completed in 1988.

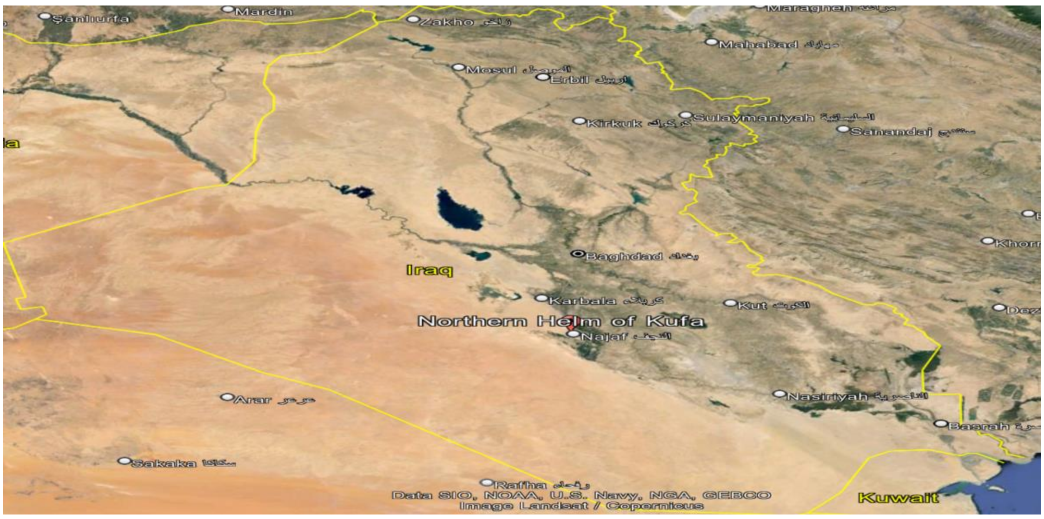

Figure 3.1: **Kufa Barrage location**

3.3 Research Methodology

The focus of this research was on evaluating the management of the operation and maintenance process in the Kufa Barrage, which in turn reflects on the management of the operation and maintenance process in central and southern Iraq and finding the strengths and weaknesses in the management of this process. To achieve the desired goal, the statistical and descriptive approach was relied upon.

The study dealt with evaluating the management of the operation and maintenance process to clarify the extent of the quality of this process in the barrages and presenting it to the owners of this field, where the aim is to analyze the data to draw conclusions and provide appropriate recommendations.

Using these methods and analyses to provide good and reliable results has a role in improving the management of the operation and maintenance process in the barrages in central and southern Iraq.

3.3.1 Data collection methodology

In this study, data was collected from various sources such as data obtained using electronic platforms that addressed the topic and similar topics, in addition to focusing on data obtained from specialists who have sufficient experience in this topic and from the Kufa Barrage and its details and its operation and maintenance manual, in addition to the research questionnaire tool that was designed to obtain answers to the research questions. The questionnaire was distributed to the study targets, and the study tool consists of 6 parts. These parts were designed to cover the study and its requirements well, and they were distributed as follows:

1. General characteristics of the study participants, academic qualification, years of experience, and work specialty.
2. Operation and maintenance manual for Kufa Barrage.
3. Quality of operation and maintenance procedures for the Kufa Barrage.
   - Records
   - Procedures for operating barrage.
   - Procedures for maintaining barrage.
4. Operating and maintenance budget for the barrage.
5. Training and exercises.

6. Safety and security.

These tools and methods used to obtain strong and good results have a role in strengthening and improving the management of the operation and maintenance process in the barrages of central and southern Iraq.

3.3.2 Test of reliability and validity of the tool

In this study, the validity of the tool was tested using two methods: face validity and content validity. Ostensibly, a committee of experts in the field of management reviewed the instrument to ensure its consistency with the concepts to be measured. In terms of content validity, the tool was presented to a sample of the population targeted for the study, and their comments and opinions regarding the compatibility of the tool with the studied concepts were collected.

Cronbach's alpha coefficient model was applied to evaluate the reliability of the tools used, as these steps help in evaluating the quality of data and the stability of the tools used in the research.

3.3.2.1 Internal and construct validity

Both internal consistency (the relationship of the statement to its axis) and construct validity (the relationship of the axis to the questionnaire as a whole) indicate the accuracy of the questionnaire items in measuring the goal for which they were designed, as shown below:

Pearson's correlation coefficient, often denoted by (r), is widely used in statistics to determine how closely two variables are related.

$$r = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum (x_i - \bar{x})^2 \sum (y_i - \bar{y})^2}}$$

Where,

r = Pearson Correlation Coefficient

x_i = x variable samples y_i = y variable sample

$\bar{x}$ = mean of values in x variable $\bar{y}$ =mean of values in y variable

Measures the strength and direction of the linear relationship between two continuous variables. It ranges from -1 to 1, where:

1: indicates a perfect positive linear relationship.

-1: indicates a perfect negative linear relationship.

0: indicates no linear relationship.

Table 3.1: The scale of the correlation coefficient Pearson

scale of the correlation coefficient	value
$0 < r \leq 0.19$	Very low correlation
$0.2 \leq r \leq 0.39$	Low correlation
$0.4 \leq r \leq 0.59$	Moderate correlation
$0.6 \leq r \leq 0.79$	High correlation
$0.8 \leq r \leq 1.0$	Very high correlation

Source: Schober, P., Boer, C., & Schwarte, L. A. (2018)

3.3.2.1.1 Internal validity

The tables below show the values of the correlation coefficients for the sections of the study statements, to clarify the validity of the study axes statements.

1- Operation and maintenance manual

Here is an explanation of the correlation coefficient values for the statements of the Operations and Maintenance Manual, to indicate the validity of the statements of the study axes.

Table 3.2: **Pearson correlation coefficient values for the Operations and Maintenance Manual section statements.**

Axis	Pearson correlation
The extent to which the operation and maintenance manual covers every detail of the Kufa Barrage	.923**
Providing a guide and distributing it to employees to know the necessary tasks well	.763**
Commitment to and implementation of the procedures contained in the Operation and Maintenance Manual	.793**
Employees' knowledge of the operation and maintenance manual and their interest in adhering to it	.733**
Review and update the guide consistently with changes	.859**

* Correlation is statistically significant at the 0.05 level.
** Correlation is statistically significant at the 0.01 level.
Source: "Prepared by the Researcher Based on Outputs from SPSS Software".

Indicates the values of the correlation coefficients for the Operation and Maintenance Manual, all of which were statistically significant at the significance level (0.05), which confirms the validity of the statements of this axis

2- The quality of the operating and maintenance procedures for the barrage

The correlation coefficient values are shown for the Operations and Maintenance Quality section, which includes records and operations and maintenance processes.

A- Records

Explaining the correlation coefficient values for the recording statements.

Table 3.3: **Indicates the Pearson correlation coefficient values for the recording statements.**

Axis	Pearson correlation
The extent of interest in recording daily activities in the site's records	.734**
Record daily water levels and barrage flows	.808**
Records of operation and periodic maintenance of the barrage	.828**
Reservoir records hourly during monsoon periods and daily during non-monsoon periods	.677**
Records of water releases for irrigation and supplies for the areas covered by the barrage	.778**
Records of rainfall amounts on a daily and periodic basis	.726**
Records of unusual situations that may occur and emergencies	.809**
Daily meteorological data records	.769**

* Correlation is statistically significant at the 0.05 level.
** Correlation is statistically significant at the 0.01 level.
Source: "Prepared by the Researcher Based on Outputs from SPSS Software".

Table (3.3) above shows the statistical significance of the values of the correlation coefficients for the recordings' statements, which were at the significance level (0.05), which confirms that the statements of this axis are correct.

B- Operation procedures

Operational expressions and explanation of their correlation coefficient values.

Table 3.4: **Indicates the Pearson correlation coefficient values for the operation process statements.**

Axis	Pearson correlation
Monitor tank levels and records	.808**
Taking care of the public safety of the barrage regularly	.690**
Operating procedures during monsoon and non-monsoon periods for	.855**

barrages	
Emergency operating procedures	.765**
Complete visual inspection of bridges and water levels in the tank 6- Review meteorological data records on an ongoing basis	.757**
Review meteorological data records on an ongoing basis	.853**
Floodwater drainage procedures	.749**
Different types of inspection in barrage safety inspection	.714**
The extent to which different data devices are relied upon in evaluating barrage behavior	.729**
appreciation for the comprehensive inspection of all civil structures, regulatory bodies, and all barrage facilities	.739**
The quality of available data used to estimate floods and their paths	.723**
Studies on testing and stabilizing barrage	.690**
Reports on roads, bridges, and communications	.756**
Regular inspection before and after monsoon	.770**
Emergency inspection in terms of unspecified conditions and any unusual events in the project	.809**
Reports submitted to project authorities in special cases that could cause damage to the dam	.755**

* Correlation is statistically significant at the 0.05 level.
** Correlation is statistically significant at the 0.01 level.
Source: "Prepared by the Researcher Based on Outputs from SPSS Software".

All statements were statistically significant at the significance level of (0.05), which confirms the validity of the statements of the operating process axis.

C- Maintenance procedures

Explaining the correlation coefficient values for maintenance process data.

Table 3.5: **Indicates Pearson's correlation coefficient values for maintenance process statements**

Axis	Pearson correlation
The project authorities give priority attention to maintenance activities	.827**
Maintenance of cases that contain damage in general	.746**
Routine ongoing maintenance regularly	.673**
Maintenance of gate openings and keeping them free of debris or plant growth	.676**
Regular maintenance of the road leading to Barrage and communication devices	.693**
The extent to which the guidance of the expert group for barrage is followed when maintaining it	.778**
Speedy maintenance of equipment when there is any need for maintenance according to the equipment manufacturer’s manuals	.752**
Efficient daily maintenance of gates and cranes based on daily	.790**

inspection when there is damage	
Efficient monthly maintenance of gates and cranes and when parts need to be replaced	.854**
Efficient annual maintenance of gates and cranes and replacement of damaged parts	.718**
Maintenance efficiency every three years	.686**
Maintenance efficiency every six years	.719**
Review basic spare parts periodically and update them	.680**
Providing immediate maintenance materials in cases of emergencies and unexpected accidents	.588**
The project authorities' interest in preparing for immediate maintenance at any time and continuous monitoring during periods of high tank level	.823**
Records of comprehensive maintenance work for recorded information	.757**
For painting and repairing damaged surfaces	.719**
Precautions to be taken for painting damaged surfaces	.808**
The extent of attention to layers and type of paint used	.776**
When periodically maintaining electrical elements, care must be taken to follow the manufacturer's advice	.722**
Complete monthly and annual inspection and maintenance of all electrical parts (power lines, control panels, voltage, switch, communication points, motors, and lighting), identifying the damaged parts and taking remedial measures.	.904**
Continuous maintenance of the electrical system used in operation	.751**
Regular maintenance of generators used for additional power in emergencies	.916**

* Correlation is statistically significant at the 0.05 level.
** Correlation is statistically significant at the 0.01 level.
Source: "Prepared by the Researcher Based on Outputs from SPSS Software".

Statistical significance at the significance level (0.05) for the values of the correlation coefficients confirms the validity of the maintenance axis statements.

The values of the correlation coefficients for the statements of the Operation and Maintenance Quality Department were all statistically significant at the (0.05) level, which confirms the validity of the statements of this axis.

3- Operation and maintenance budget

Table 3.6 shows the correlation coefficient values for the terms of the Operation and Maintenance Budget section**.**

Table 3.6: **Indicates the Pearson correlation coefficient values for the Operation and Maintenance Budget section statements**

Axis	Pearson correlation

Budget for costs associated with implementing the operation and maintenance program	.824**
The budget available for different labor offices	.777**
Budget for employees working in different duties	.917**
Budget for operating and maintaining vehicles and equipment	.932**
Budget for providing the necessary systems and devices to obtain data	.913**

* Correlation is statistically significant at the 0.05 level.
** Correlation is statistically significant at the 0.01 level.
Source: "Prepared by the Researcher Based on Outputs from SPSS Software".

The level of statistical significance is (0.05) for the values of the correlation coefficients for the statements of the Operations and Maintenance Budget Section, and this indicates the validity of the statements for this axis.

4- Training and Exercises

The correlation coefficient values for the training and exercise section data are shown below.

Table 3.7: **Refers to the Pearson correlation coefficient values for the training and exercises section statements**

Axis	Pearson correlation
The necessary training in implementing the operation and maintenance manual program	.871**
Trainings that make employees familiar with the work plan, their responsibilities, and available equipment	.878**
Training to detect problems, damages, and remedial measures	.886**
Complete health and safety instructions exercises for employees in terms of instructions, signs, and alarm devices	.886**

* Correlation is statistically significant at the 0.05 level.
** Correlation is statistically significant at the 0.01 level.
Source: "Prepared by the Researcher Based on Outputs from SPSS Software".

In the training and exercises section, the correlation coefficient values were at the statistical significance level (0.05), so the statements in this section are correct.

5- Safety and Security

Table 3.8 below shows the safety and security section statements and their correlation coefficient values.

Table 3.8: **Pearson correlation coefficient values for the safety and security section statements**

Axis	Pearson correlation
Complete health and safety instructions in terms of instructions, signs,	.930**

and alarms	
Safety of roads connecting every detail of the barrage	.760**
Paying attention to the safety of residents of the areas around the barrage	.862**
Safety instructions in times of floods	.921**

* Correlation is statistically significant at the 0.05 level.
** Correlation is statistically significant at the 0.01 level.
Source: "Prepared by the Researcher Based on Outputs from SPSS Software".

The statements in this section are correct because the level of statistical significance for the values of the correlation coefficient is (0.05).

The above tables indicated the values of the correlation coefficients for the study sections' statements, all of which were statistically significant at the (0.05) level, which confirms the validity of the study statements.

3.3.2.1.2 Construct validity

It is clear from the table below that the values of all correlation coefficients were statistically significant at a significant level of (0.05), which confirms the validity of the study axes.

Table 3.9: **indicates the values of the pearson correlation coefficient for the study's axes**

Axis	Whole questionnaire
Operation and maintenance manual	.751**
The quality of the operating and maintenance procedures for the barrage	.938**
Operation and maintenance budget	.528**
Training and Exercises	.795**
Safety and Security	.823**

* Correlation is statistically significant at the 0.05 level.
** Correlation is statistically significant at the 0.01 level.
Source: "Prepared by the Researcher Based on Outputs from SPSS Software".

3.3.2.2 Reliability

The values of the reliability coefficient (Cronbach's alpha) indicate the stability of the questionnaire for each axis.

Below is the formula for Cronbach's alpha.

$$\alpha = \frac{N * \overline{c}}{\overline{v} + (N-1) * \overline{c}}$$

Where:

N = number of items

$\overline{c}$ = mean covariance between items.

$\overline{v}$ = mean item variance.

Cronbach’s alpha ranges from 0 to 1.

Table 3.10 shows that the value of the reliability coefficient was greater than 0.7 for all axes of the questionnaire and ranged between 0.903-0.99, and 0.991 for the questionnaire. This confirms the stability and validity of the tool for the study.

Table 3.10: **Shows the values of Cronbach's alpha coefficient**

Axis	No. statements	Cronbach’s alpha coefficient
Operation and maintenance manual	5	.903
The quality of the operating and maintenance procedures for the barrage	47	.99
Operation and maintenance budget	5	.942
Training and Exercises	4	.932
Safety and Security	4	.921
Whole questionnaire	**65**	**.991**

Source: "Prepared by the Researcher Based on Outputs from SPSS Software".

3.3.3 Presentation and analysis of questionnaire data for research

The research questionnaire questions were presented in the form of graphs showing the answers of the participants in the questionnaire about the Kufa Barrage to the research questions and the percentages of these answers after analyzing them using the SPSS program.

3.3.3.1 Analysis of Phrases in General Information

Displaying general information for participants in questionnaires in terms of academic qualification, specialization, and years of experience. The participants in the questionnaire were selected from those with specialization and experience who work directly in the Kufa Barrage and the institutions related to it, to obtain accurate and good opinions that give very realistic results. Therefore, there were 56 participants to focus on the category of experience and competence, so that the answers would be focused and reliable, with greater precision and more accurate evaluation.

A. Academic Qualification

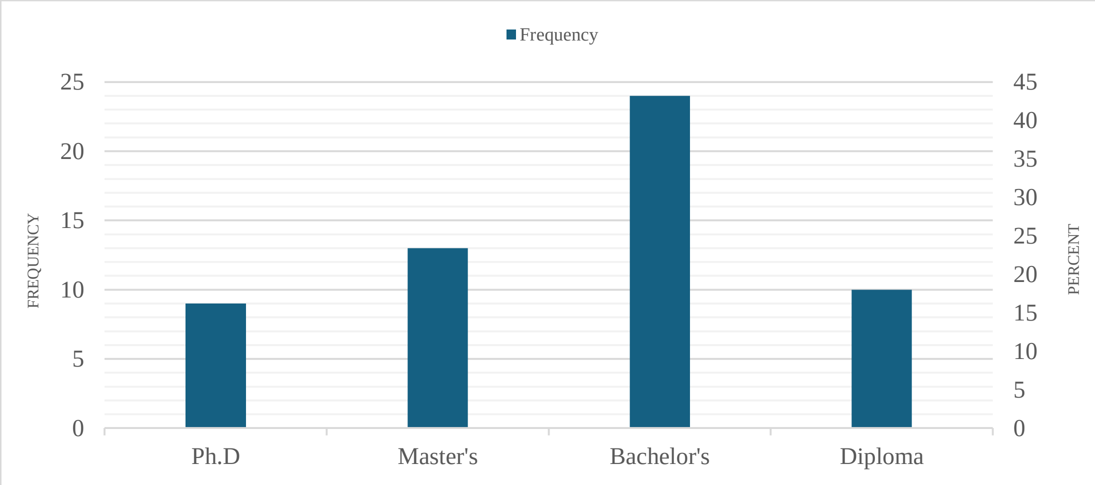

Figure 3.2: Frequency and Percentages for Participants by Academic Qualification

The numbers and percentages of participants in the questionnaire according to academic qualification are Ph.D.: 9 participants (16.1%), Master's: 13 participants (23.2%), Bachelor's: 24 participants (42.9%) and Diploma: 10 participants (17.9%)

B. Specialization

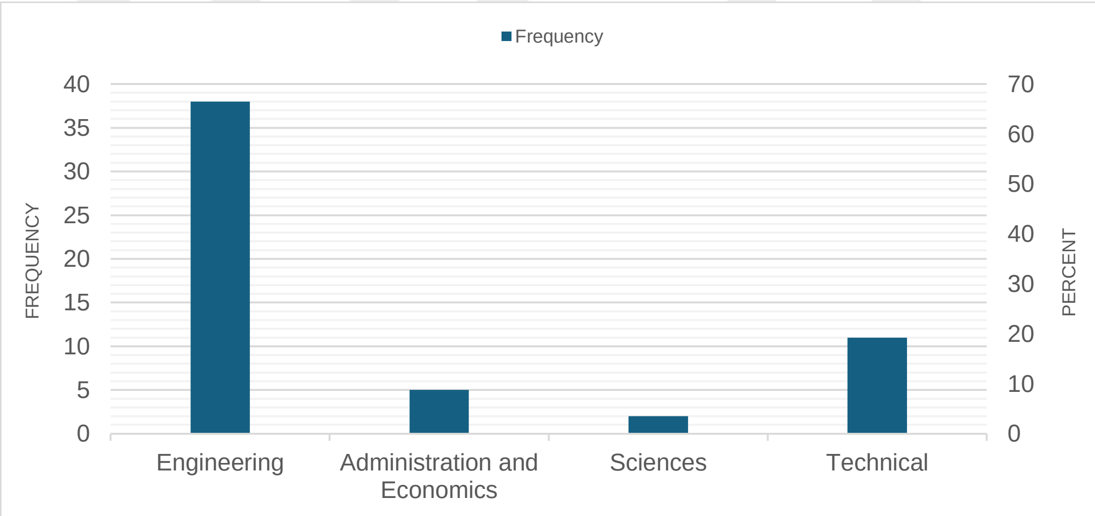

Figure 3.3: presents the frequency and percentages of the participants based on their specialization

The numbers and percentages of participants in the questionnaire according to specialization are Engineering: 38 participants (67.9%), Administration and Economics: 5 participants (8.9%), Sciences: 2 participants (3.6%) and Technical: 11 participants (19.6%). Most of the participants were engineers who have a close connection to this work, as this gives a good overview of this work due to their sufficient knowledge of this topic.

C. Years of Experience

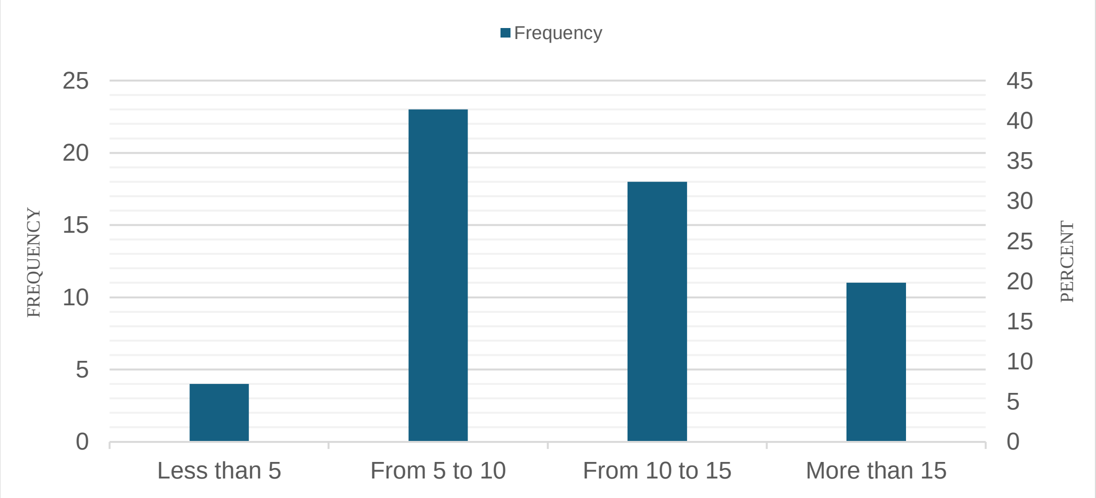

Figure 3.4: **displays the frequency and percentages of the participants based on their years of experience**

The numbers and percentages of participants in the questionnaire according to years of experience in these specialties are: Less than 5: 4 participants (7.1%), From 5 to 10: 23 participants (41.1%), From 10 to 15: 18 participants (32.1%), More than 15: 11 participants (19.6%).

In this part, the researcher explained the data related to the general information of the participants in the questionnaire in terms of frequency and percentage.

3.3.3.2 Analysis of research data

Analysis of the collected data using the SPSS program

1- Analysis of Phrases in Operation and Maintenance Manual

In this section, reference was made to the importance of the operation and maintenance manual for barrages and its effective role in this process

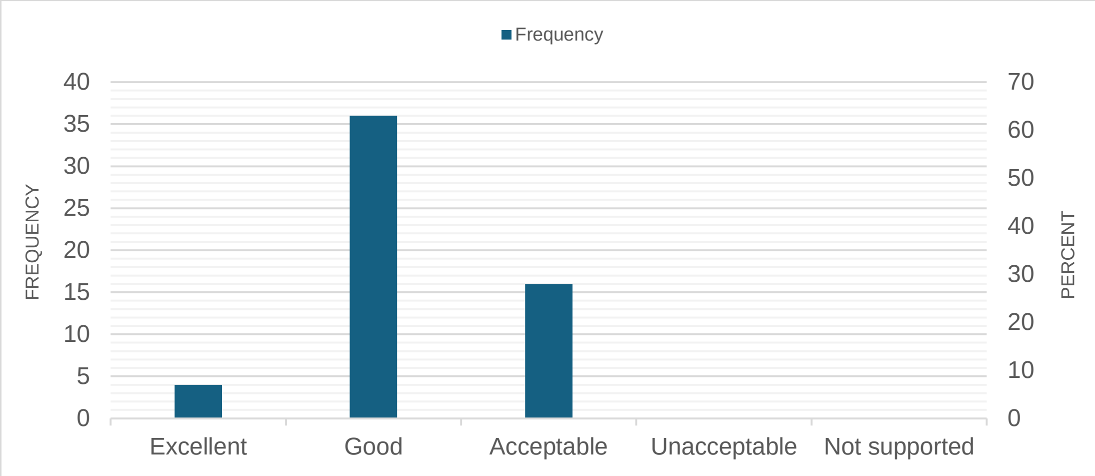

Figure 3.5: **The extent to which the operation and maintenance manual covers every detail of the Kufa Barrage**

The numbers and percentages of questionnaire participants' responses to this paragraph are Excellent (4, 7.1%), Good (36, 64.3%), and Acceptable (16, 28.6%).

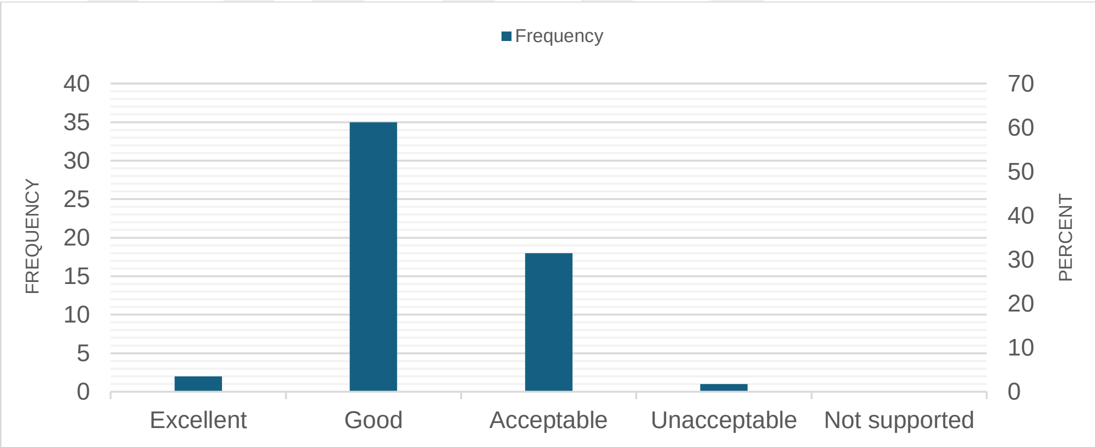

Figure 3.6: **Providing a guide and distributing it to employees to know the necessary tasks well**

The answers were excellent (2, 3.6%), good (35, 62.5%), acceptable (18, 32.1%), and unacceptable (1, 1.8%).

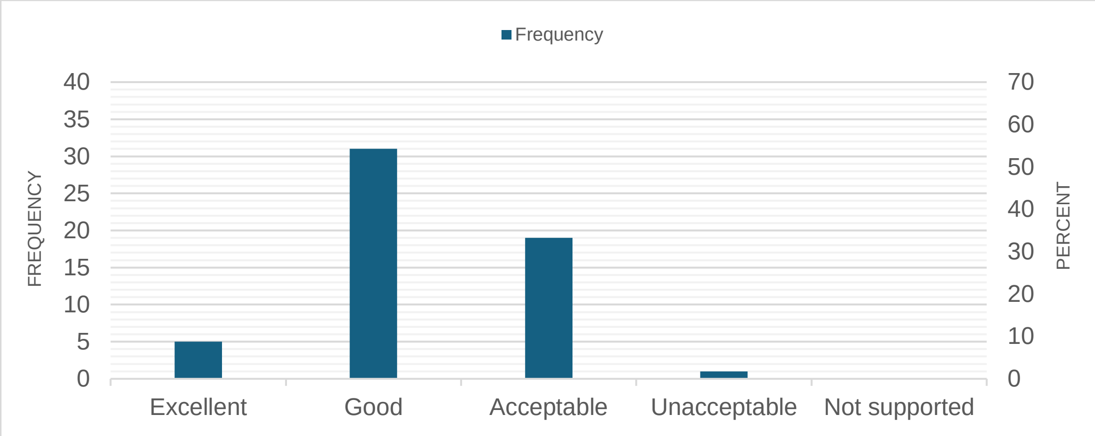

Figure 3.7: **Commitment to and implementation of the procedures contained in the Operation and Maintenance Manual**

In this form, the number of answers and percentages of participants in the questionnaire in this paragraph appear as follows: excellent (5, 8.9%), good (31, 55.4%), acceptable (19, 33.9%), and unacceptable (1, 1.8%).

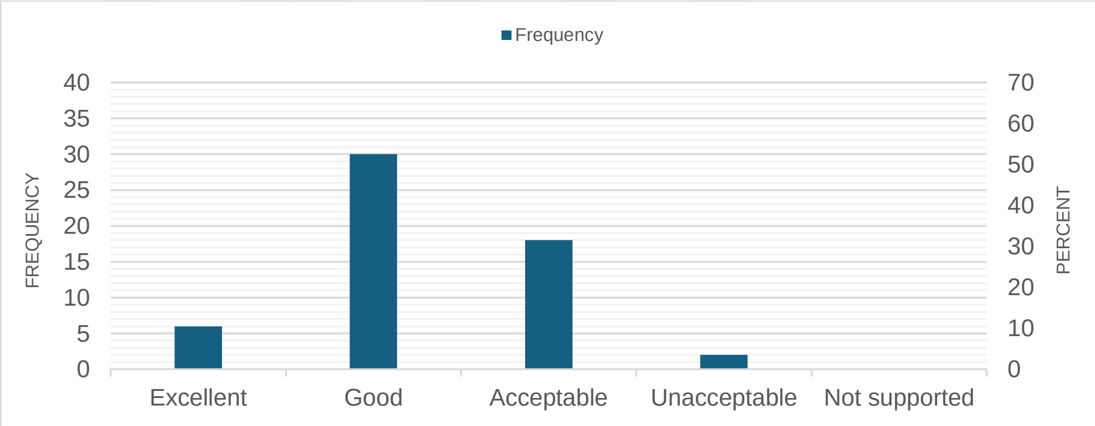

Figure 3.8: **Employees' knowledge of the operation and maintenance manual and their interest in adhering to it**

In this paragraph, it is clear that (6) people answered excellent at a rate of (10.7%), and the number of people who answered good was (30) at a rate of (53.6%), while those who answered acceptable were (18 at a rate of 32.1%), and those who chose unacceptable were (2 at a rate of 3.6%).

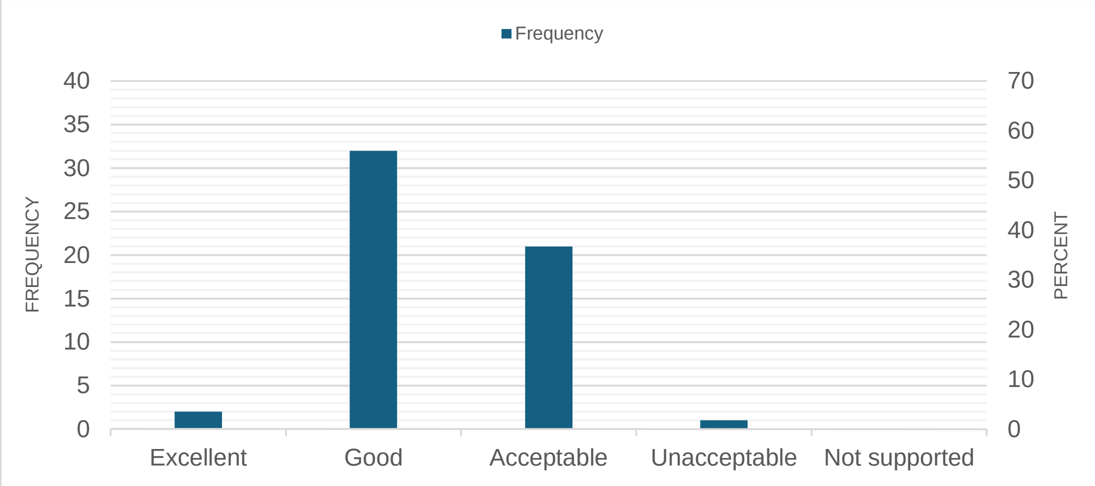

Figure 3.9: **Review and update the guide consistently with changes**

In this paragraph, the percentages and numbers are as follows: Excellent (2, 3.6%), Good (32, 57.1%), Acceptable (21, 37.5%), and Unacceptable (1, 1.8%).

2- Analysis of Phrases in the quality of the operating and maintenance procedures for the barrage

The answers of the participants in the research questionnaire about the details of the operation and maintenance process, such as (records, operation process, and maintenance process) in the Kufa Barrage.

A- Analysis of Phrases in Records

Records related to the work of the barrages in all their details, in terms of records of the activities that are being carried out or tank levels, the effect of winds and their periods, recording maintenance records, water flows, and all the details that give a clear picture of the accuracy of the work and obtaining the appropriate answers to obtain an appropriate and good evaluation of this part.

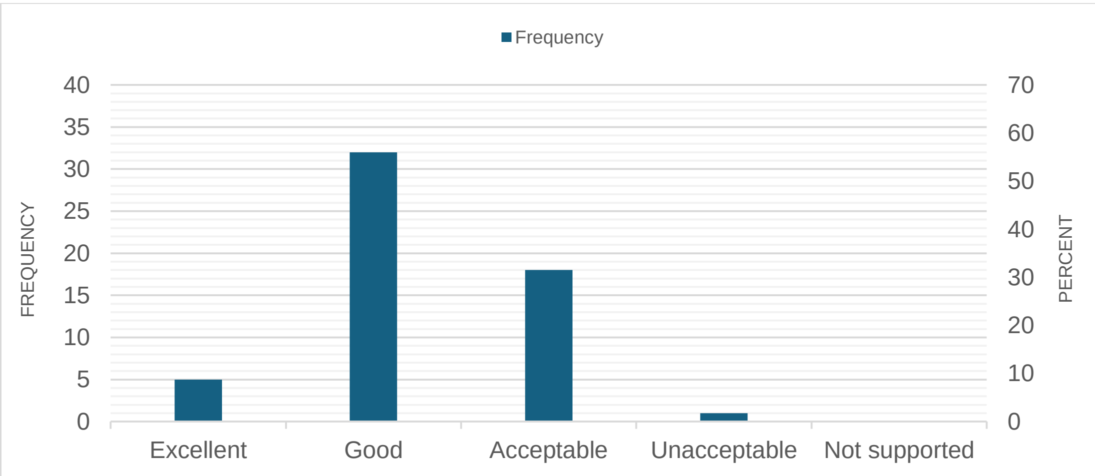

Figure 3.10: **The extent of interest in recording daily activities in the site's records**

The answers and their percentages varied between the options presented to this question, as they were: excellent (5, 8.9%), good (32, 57.1%), acceptable (18, 32.1%), and unacceptable (1, 1.8%).

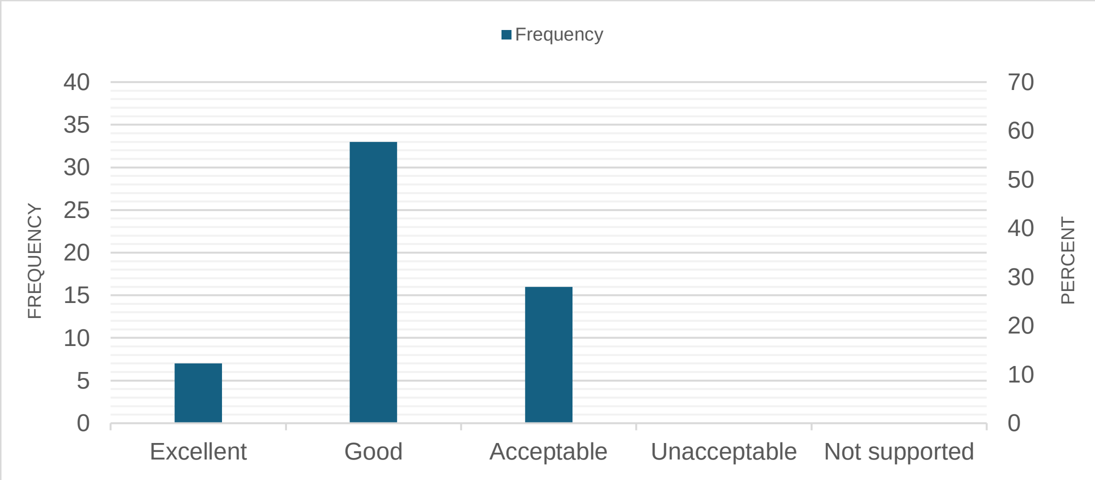

Figure 3.11: **Records daily water levels and barrage flows**

In this figure, the number of answers and percentages for each choice for this paragraph appear as follows: Excellent (7, 12.5%), Good (33, 58.9%), Acceptable (16, 28.6%).

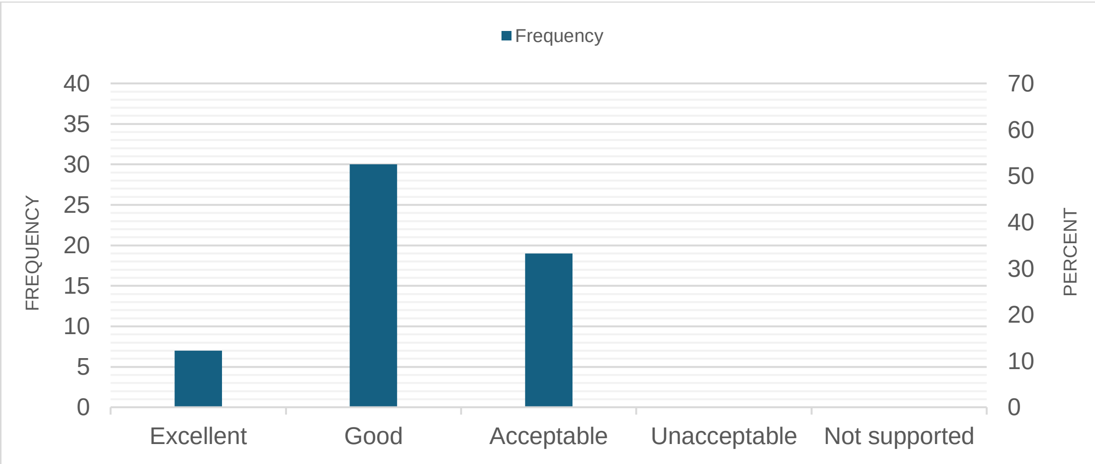

Figure 3.12: **Records of operation and periodic maintenance of the barrage**

In this figure, the number of responses and percentages of participants in the questionnaire for each choice appear as follows: Excellent (7, 12.5%), Good (30, 53.6%), Acceptable (19, 33.9%).

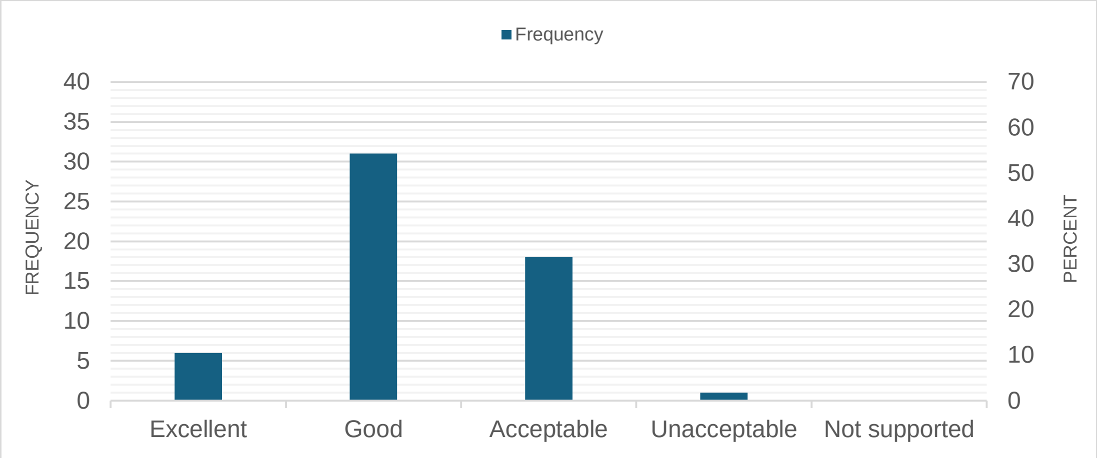

Figure 3.13: **Reservoir records hourly during monsoon periods and daily during non-monsoon periods**

6 people chose the excellent option (10.7%), and most chose the good option (31, 55.4%), who chose acceptable (18, 32.1%) and unacceptable (1, 1.8%).

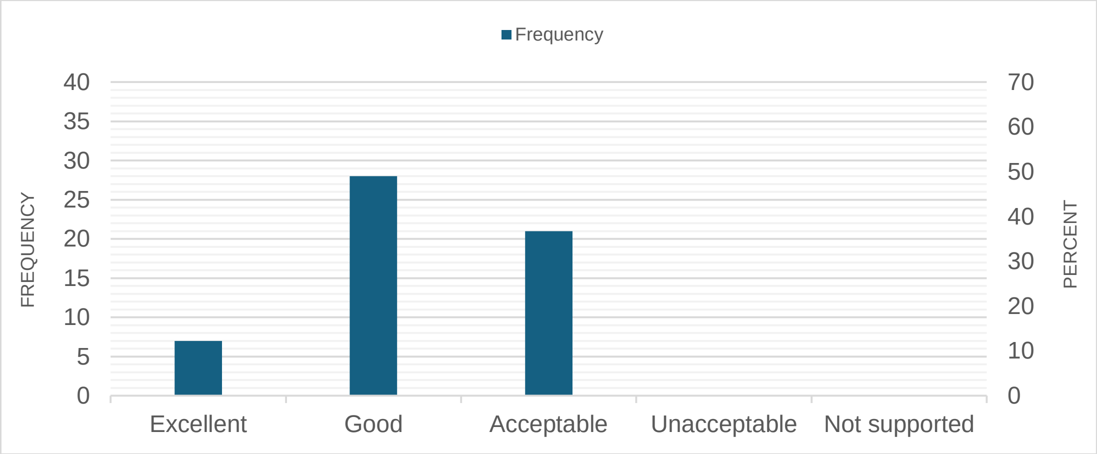

Figure 3.14: **Records of water releases for irrigation and supplies for the areas covered by the barrage**

In this figure, the numbers of responses and percentages of participants in the questionnaire in this paragraph appear as follows: Excellent (7, 12.5%), Good (28, 50%), and Acceptable (21, 37.5%).

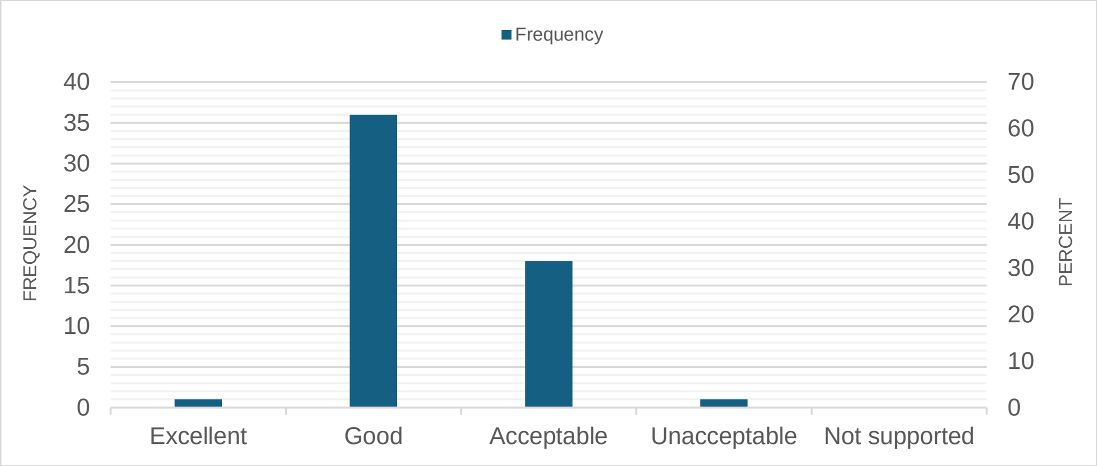

Figure 3.15: **Records of rainfall amounts on a daily and periodic basis**

Most chose good (36, 64.3%), while those who chose excellent (1, 1.8%) and some chose acceptable (18, 32.1%), while those who chose unacceptable were 1 at a rate of (1.8%).

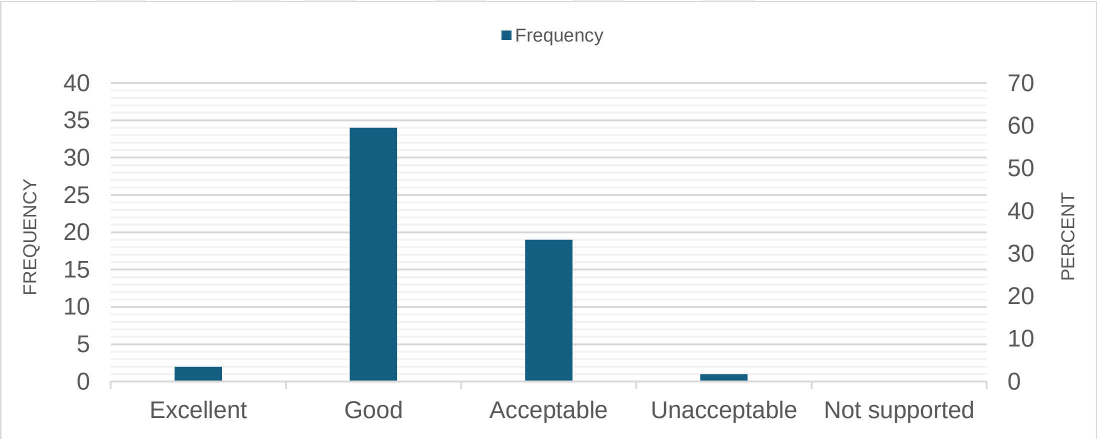

Figure 3.16: **Records of unusual situations that may occur and emergencies**

The numbers and percentages of answers to the options for the participants in the questionnaire appeared: excellent (2, 3.6%), good (34, 60.7%), acceptable (19, 33.9%), and unacceptable (1, 1.8%).

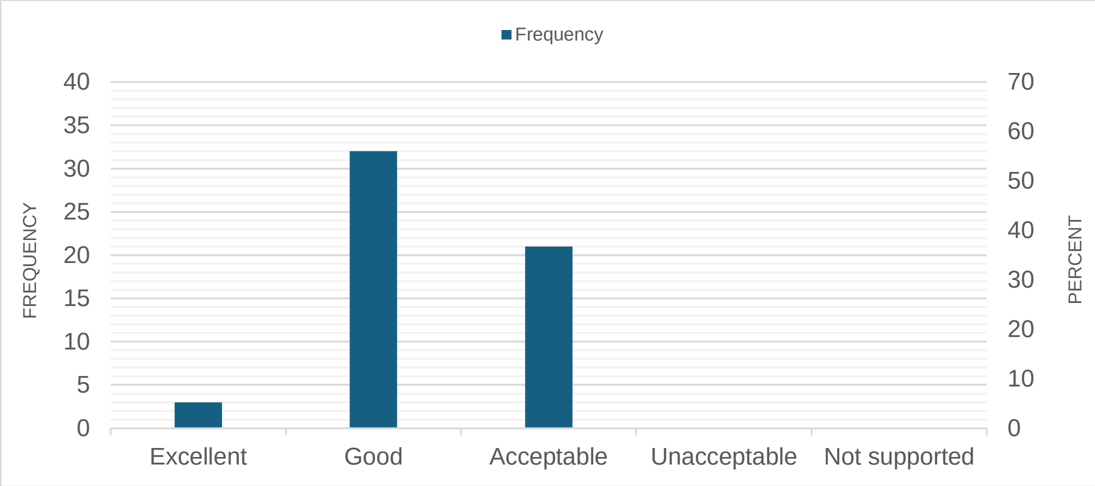

Figure 3.17: **Daily meteorological data records**

This figure shows the numbers and percentages of the participants' answers to the questionnaire as follows: Excellent (3, 5.4%), Good (32, 57.1%), Acceptable (21, 37.5%).

B- Analysis of Phrases in Operation Procedures

The great role of this process gives it great importance in the stability of the barrage's work and the quality it provides.

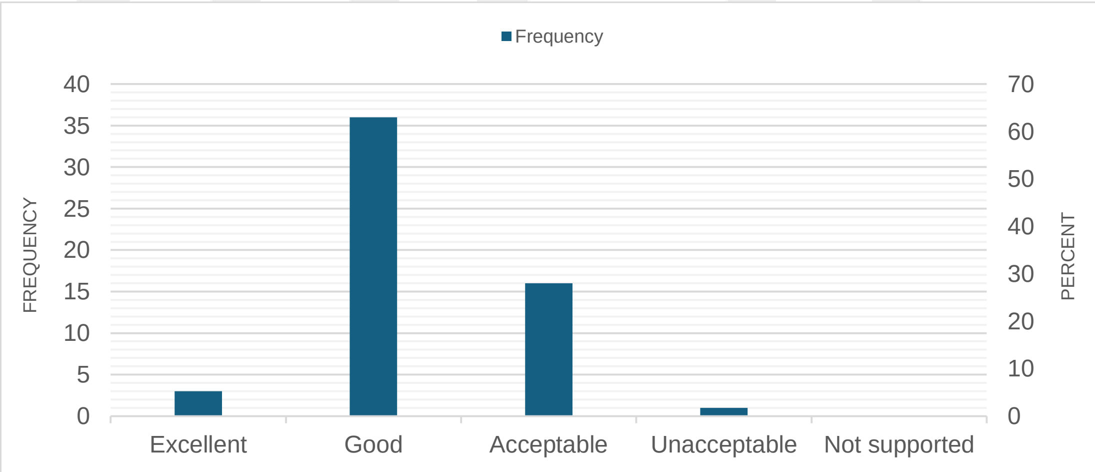

Figure 3.18: **Monitor tank levels and records**

The answers to the options for the survey participants were excellent (3, 5.4%), good (36, 64.3%), acceptable (16, 28.6%), and unacceptable (1, 1.8%).

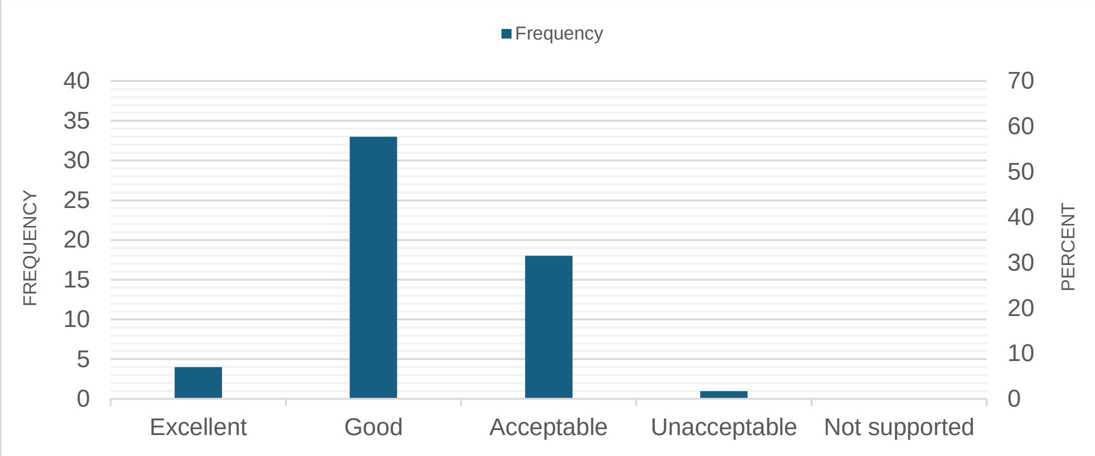

Figure 3.19: **Taking care of the public safety of the barrage regularly**

4 people (7.1%) chose the excellent option, while the majority chose good (33, 58.9%). Those who chose acceptable were (18, 32.1%), and one person chose unacceptable (1.8%).

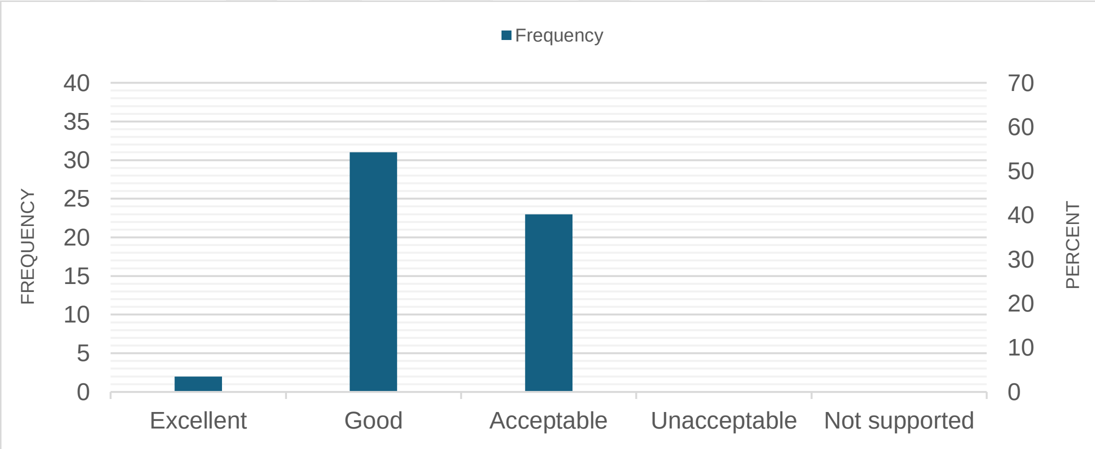

Figure 3.20: **Operating procedures during monsoon and non-monsoon periods for barrages**

The answers to the choices in this paragraph are as follows: Excellent (2, 3.6%), Good (31, 55.4%), Acceptable (23, 41.1%).

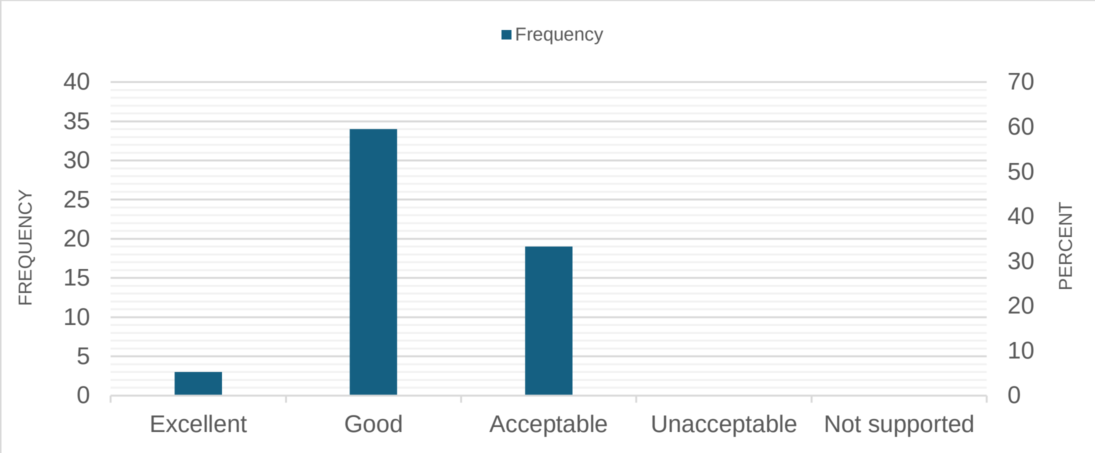

Figure 3.21: **Emergency operating procedures**

In this figure, the numbers of responses and percentages of participants in the questionnaire in this paragraph appear as follows: Excellent (3, 4.5%), Good (34, 60.7%), and Acceptable (19, 33.9%).

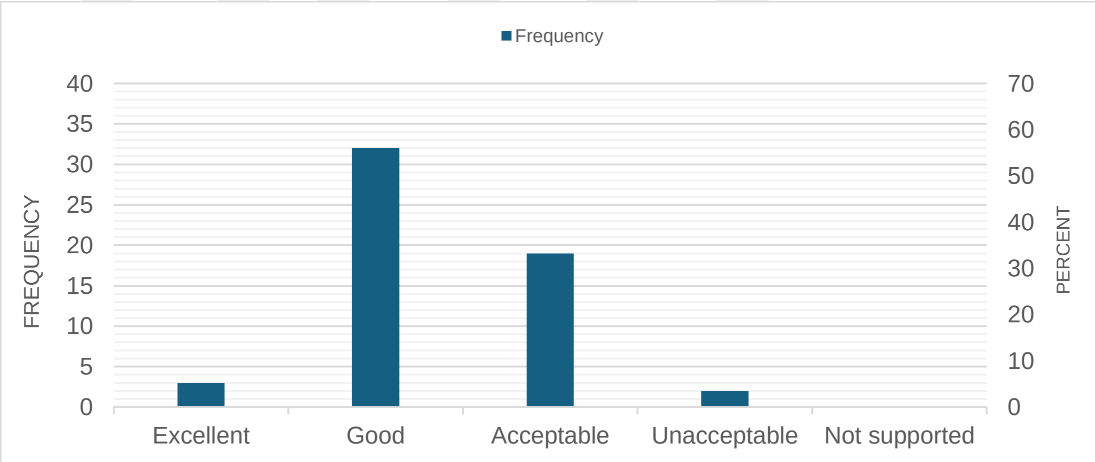

Figure 3.22: **Complete visual inspection of bridges and water levels in the tank**

The numbers of answers and percentages in this paragraph are as follows: excellent (3, 5.4%), good (32, 57.1%), acceptable (19, 33.9%), and unacceptable (2, 3.6%).

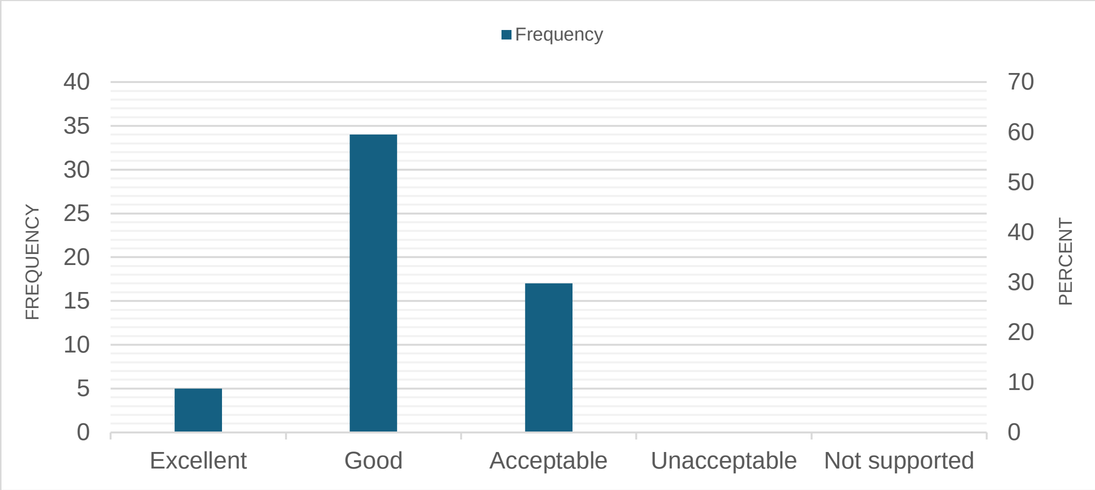

Figure 3.23: **Review meteorological data records on an ongoing basis**

The number of people who chose excellently was 5 and their percentage was 8.9%, while those who chose good were the majority, as their number and percentage were (34, 60.7%), while the others chose acceptable with a number and percentage of (17, 30.4%).

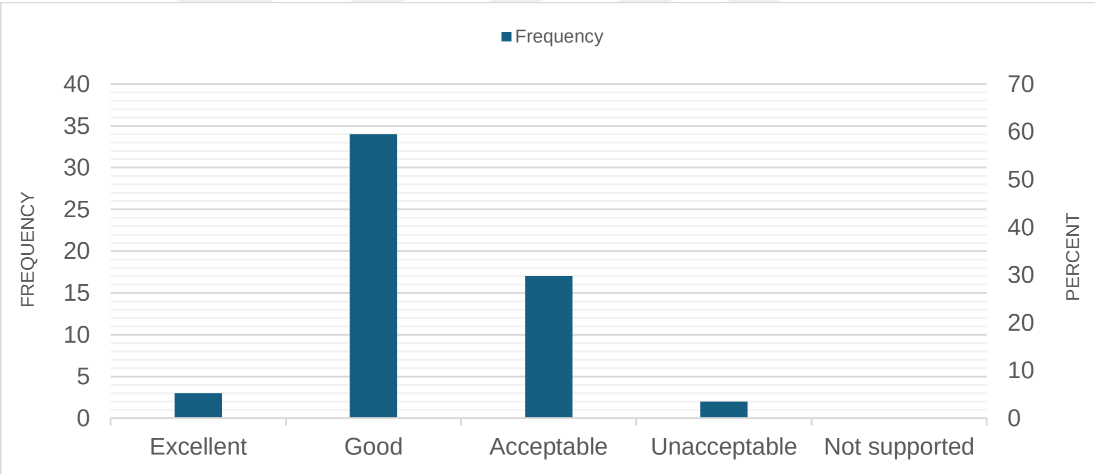

Figure 3.24: **Floodwater drainage procedures**

The multiple-choice responses appeared in numbers and percentages as follows: excellent (3, 5.4%), good (34, 60.7%), acceptable (17, 30.4%), and unacceptable (2, 3.6%).

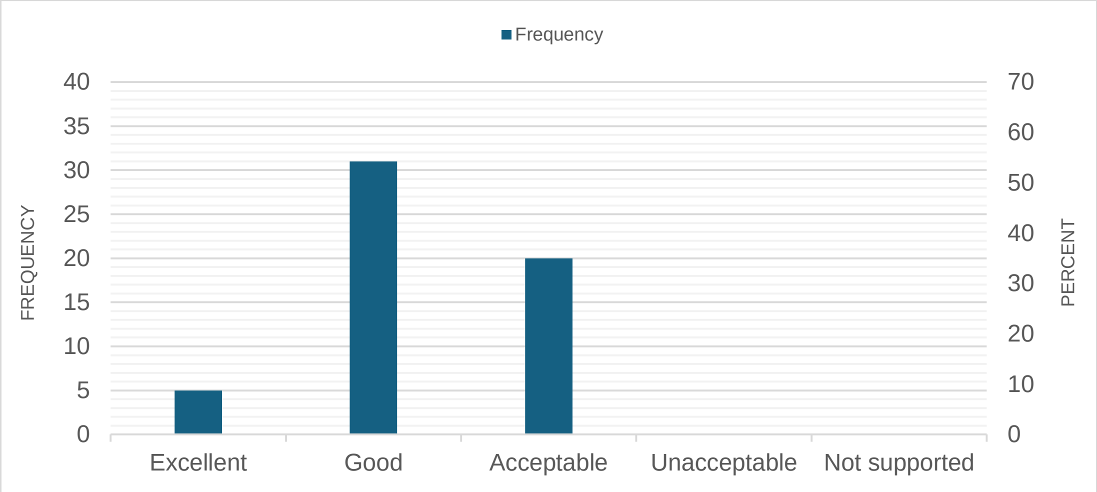

Figure 3.25: **Different types of inspection in barrage safety inspection**

Good (31, 55.4%) is the most common answer in this paragraph, followed by acceptable (20, 35.7%) and then excellent (5, 8.9%).

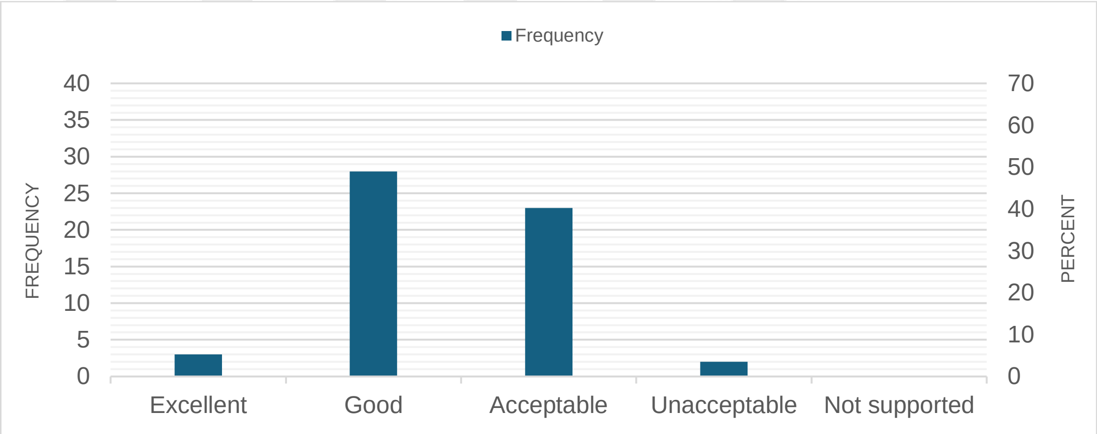

Figure 3.26: **The extent to which different data devices are relied upon in evaluating barrage behavior**

In this figure, the numbers of responses and percentages of participants in the questionnaire in this paragraph appear as follows: Excellent (3, 5.4%), Good (28, 50%), Acceptable (23, 41.1%), and Unacceptable (2, 3.6%).

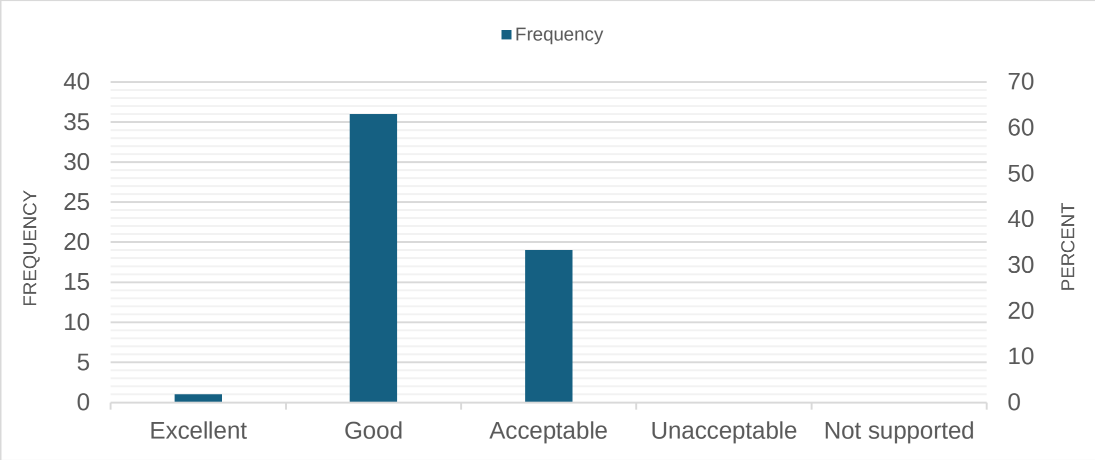

Figure 3.27: **Appreciation for the comprehensive inspection of all civil structures, regulatory bodies, and all barrage facilities**

The numbers of responses and percentages of the participants in the questionnaire are shown as follows in this paragraph: Excellent (1, 1.8%), Good (36, 64.3%), Acceptable (19, 33.9%).

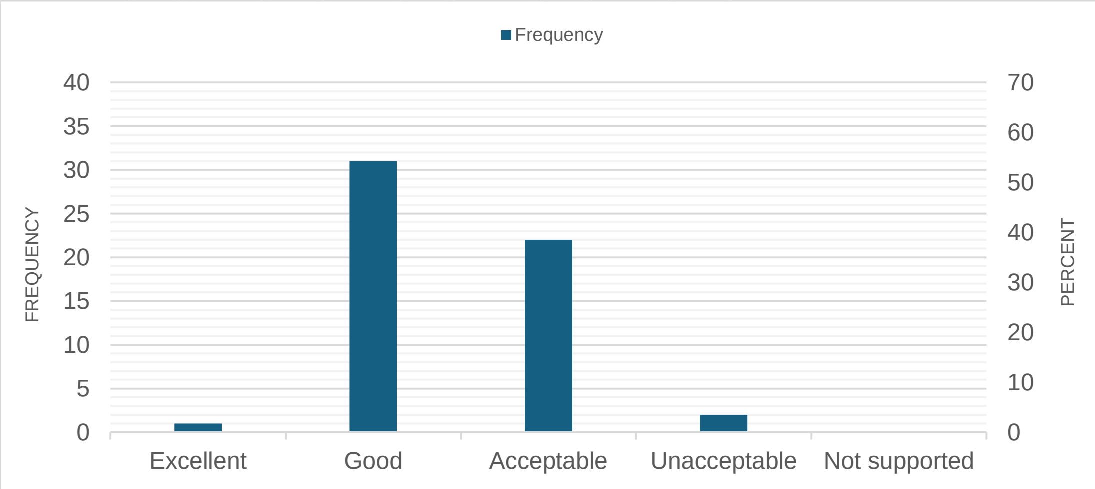

Figure 3.28: **The quality of available data used to estimate floods and their paths**

The answers of the participants in the questionnaire to this paragraph are as follows: excellent (1, 1.8%), good (31, 55.4%), acceptable (22, 39.3%), and unacceptable (2, 3.6%).

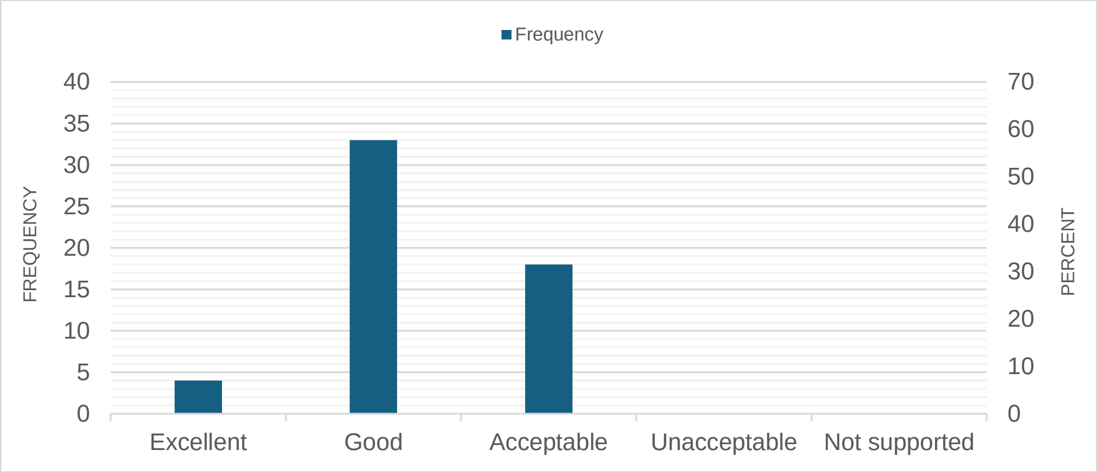

Figure 3.29: **Studies on testing and stabilizing barrage**

In this figure, the numbers of responses and percentages of participants in the questionnaire in this paragraph appear as follows: Excellent (4, 7.1%), Good (33, 58.9%), and Acceptable (18, 32.1%).

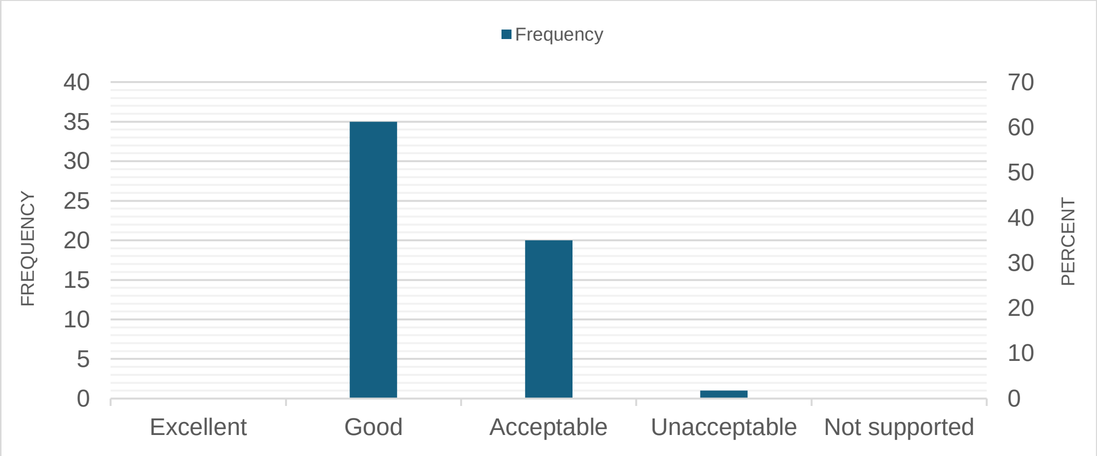

Figure 3.30: **Reports on roads, bridges, and communications**

The numbers and percentages of participants' answers are as follows: good (35, 62.5%), acceptable (20, 35.7%), and unacceptable (1, 1.8%).

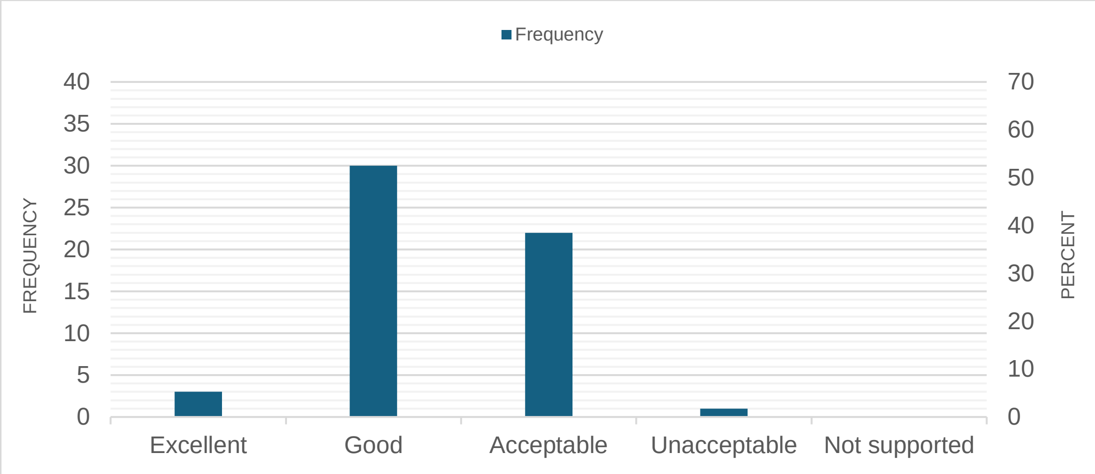

Figure 3.31: **Regular inspection before and after monsoon**

Those who chose excellent were (3, 5.4%), while those who chose good, who were the majority, were (30, 53.6%), and the number and percentage of those who chose acceptable were (22, 39.3%), while the rest chose unacceptable (1, 1.8%).

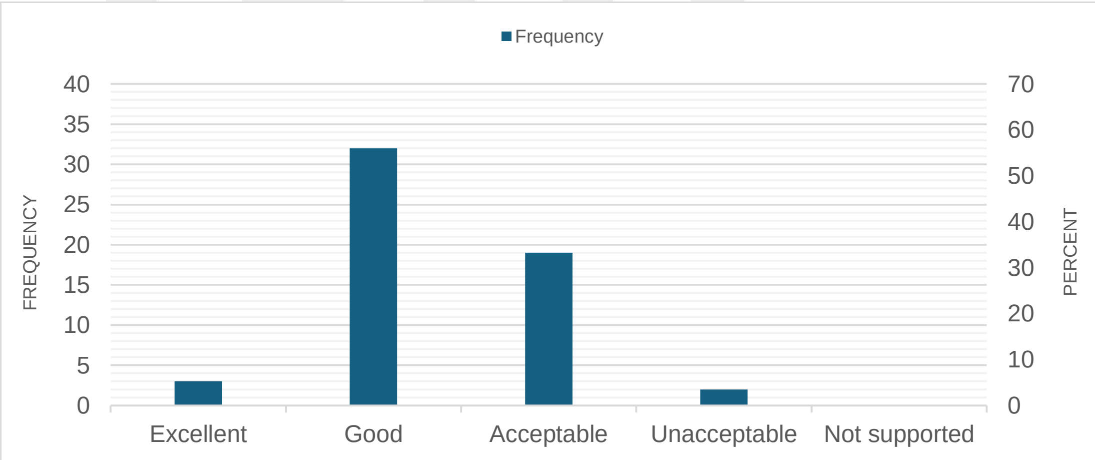

Figure 3.32: **Emergency inspection in terms of unspecified conditions and any unusual events in the project**

In this figure, the numbers of responses and percentages of participants in the questionnaire in this paragraph appear as follows: Excellent (3, 5.4%), Good (32, 57.1%), Acceptable (19, 33.9%), and Unacceptable (2,3.6%).

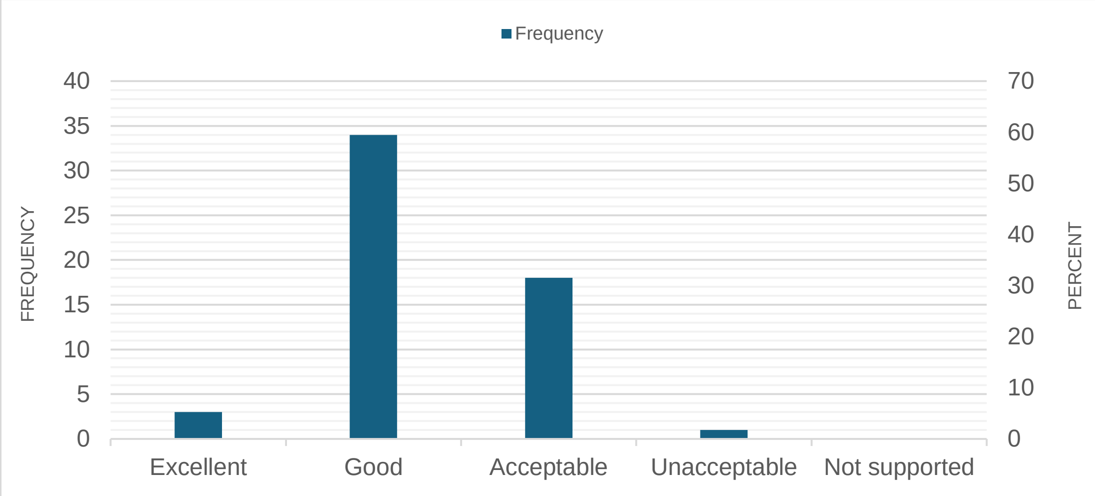

Figure 3.33: **Reports submitted to project authorities in special cases that could cause harm to the barrage**

The answers showed that most of them chose (good), so the number of choices and percentages were as follows: excellent (3, 5.4%), good (34, 60.7%), acceptable (18, 32.1%), and unacceptable (2, 3.6%).

C- Analysis of Phrases in Maintenance Procedures

The maintenance process is one of the most important processes for barrage stability, as regular maintenance has a major and effective role in the quality of work

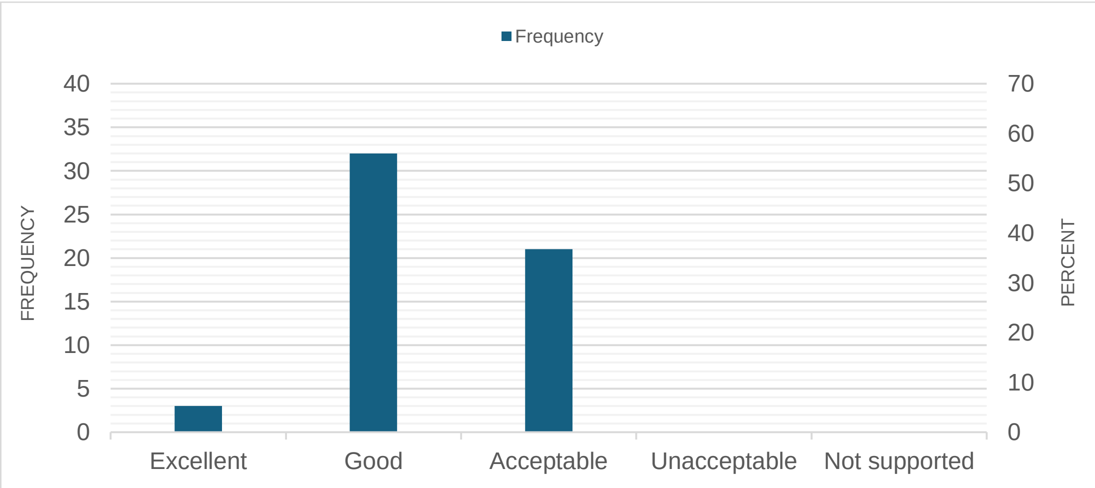

Figure 3.34: **The project authorities give priority attention to maintenance activities**

Those who chose excellent were 3 people, at a rate of (5.4%), and most of the participants chose good in this paragraph (32, 57.1%), and the rest went with the acceptable choice, which was their number and percentages (21, 37.5%).

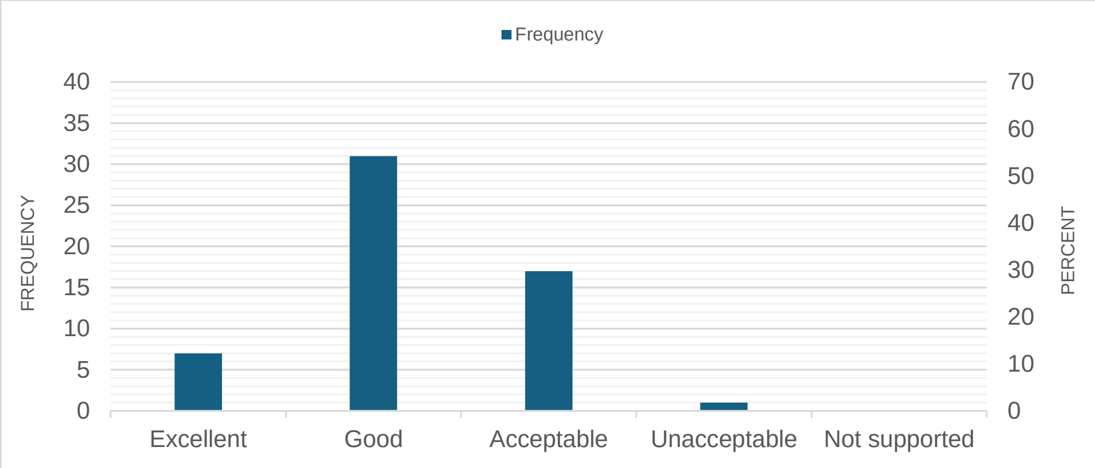

Figure 3.35: **Maintenance of cases that contain damage in general**

The figure shows that the numbers and percentages of participants' choices are as follows: excellent (7, 12.5%), good (31, 55.4%), acceptable (17, 30.4%), and unacceptable (1, 1.8%).

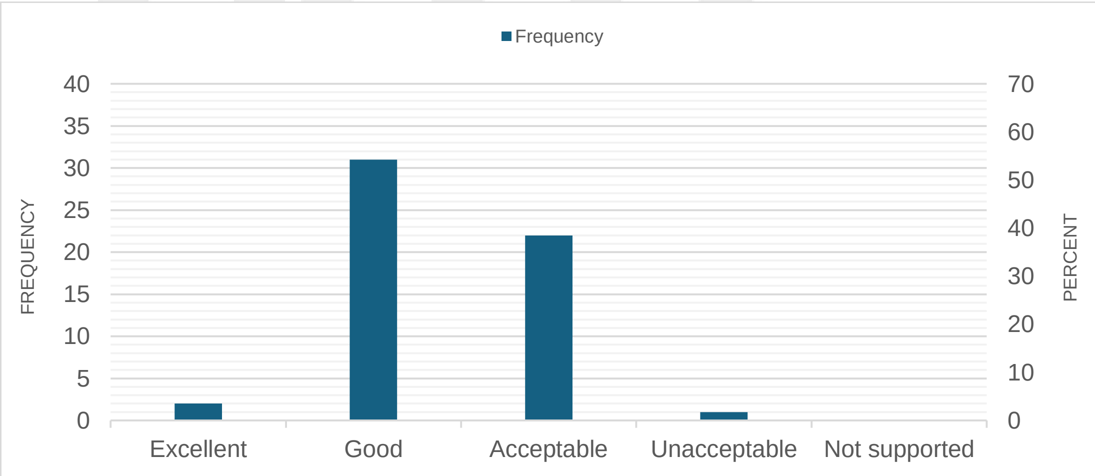

Figure 3.36: **Routine ongoing maintenance regularly**

Participants' choices between the two options, good and acceptable, were as follows: excellent (2, 3.6%), good (31, 55.4%), acceptable (22, 39.3%), and unacceptable (1, 1.8%).

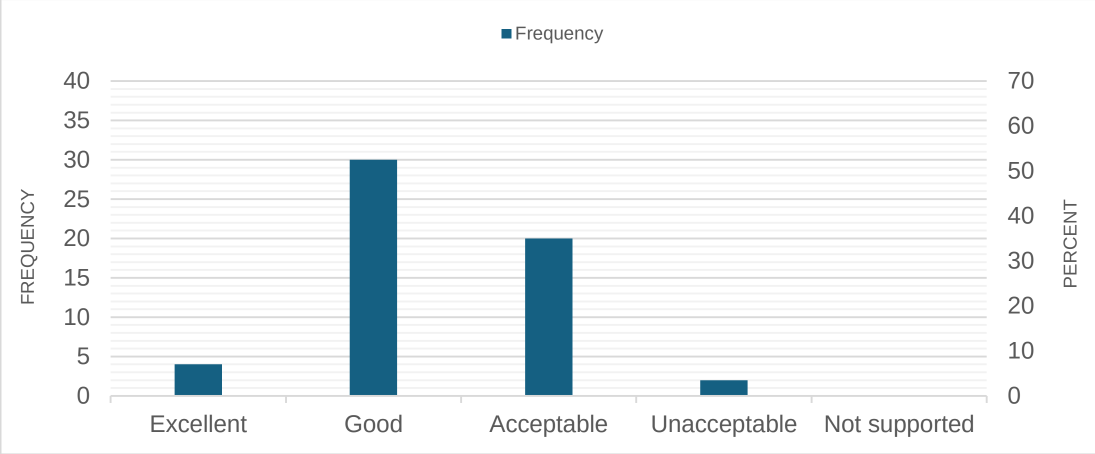

Figure 3.37: **Maintenance of gate openings and keeping them free of debris or plant growth**

In this figure, the numbers of responses and percentages of participants in the questionnaire in this paragraph appear as follows: Excellent (4, 7.1%), Good (30, 53.6%), Acceptable (20, 35.7%), and Unacceptable (2, 3.6%).

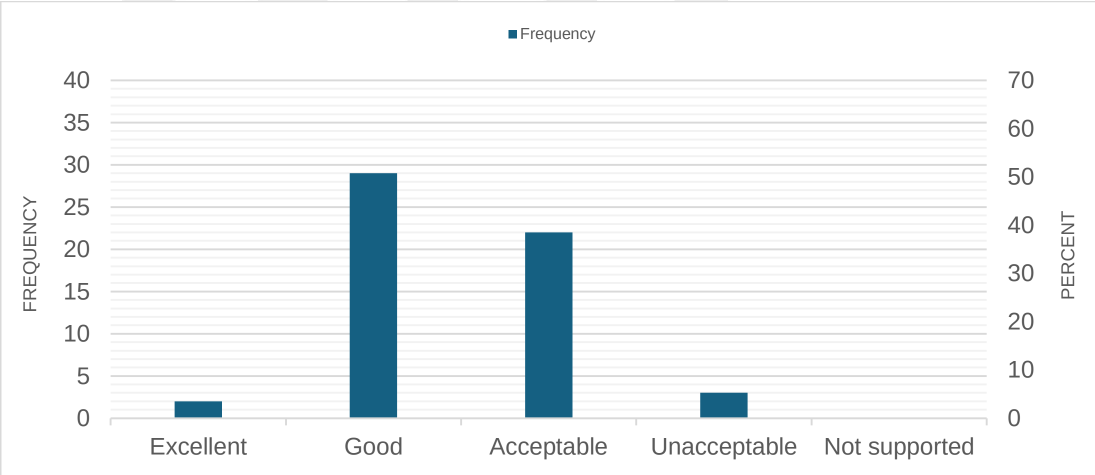

Figure 3.38: **Regular maintenance of the road leading to Barrage and communication devices**

In this figure, the numbers of responses and percentages of participants in the questionnaire in this paragraph appear as follows: Excellent (2, 3.6%), Good (29, 51.8%), Acceptable (22, 39.3%), and Unacceptable (3, 5.4%).

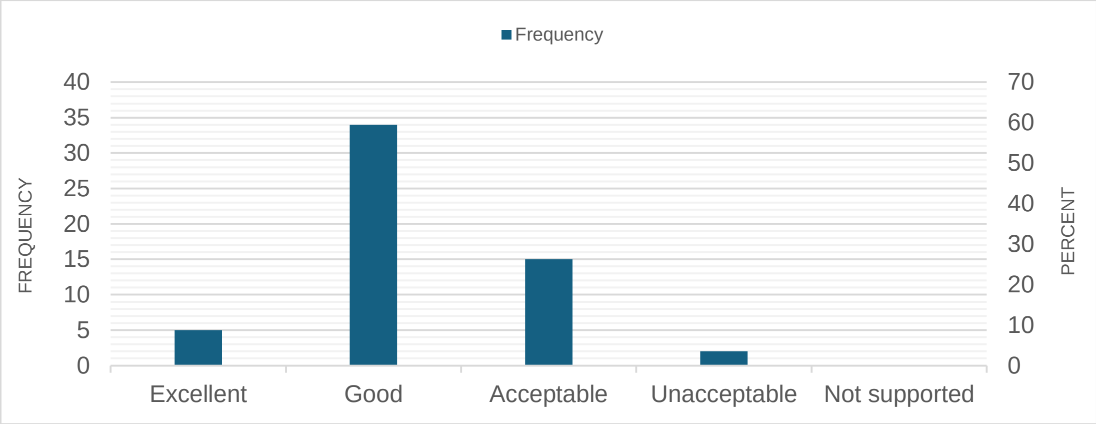

Figure 3.39: **The extent to which the guidance of the expert group for barrage is followed when maintaining it**

Participants' answers varied as follows: excellent (5, 8.9%), good (34, 60.7%), acceptable (15, 26.8%), and unacceptable (2, 3.6%).

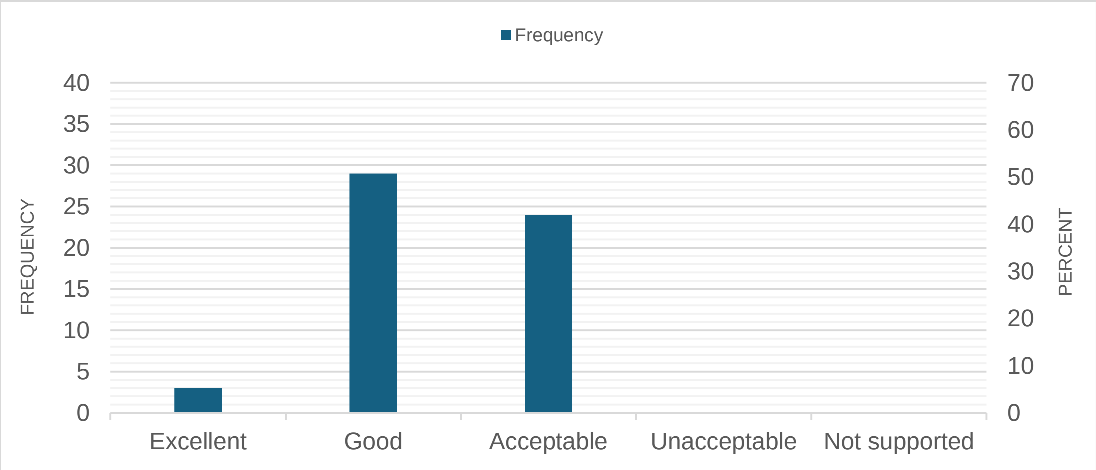

Figure 3.40: **Speedy maintenance of equipment when there is any need for maintenance according to the equipment manufacturer's manuals**

The two options, good and acceptable, were the most common in terms of the number of answers and percentages, but as follows: excellent (3, 5.4%), good (29, 51.8%), acceptable (24, 42.9%).

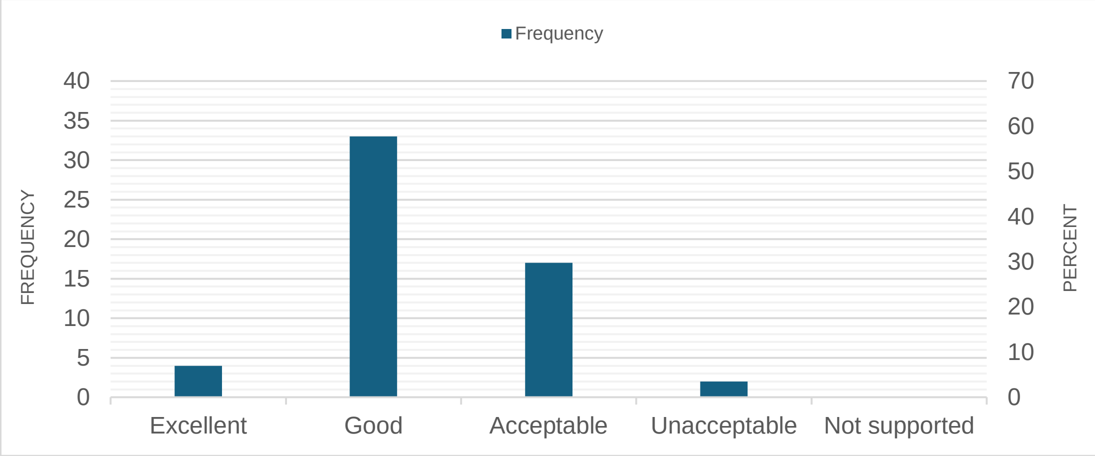

Figure 3.41: **Efficient daily maintenance of gates and cranes based on daily inspection when there is damage**

The number and percentage of those who chose excellent were (4, 7.1%) and those who chose good was (33, 58.9%) while (17, 30.4%) chose acceptable while the rest chose unacceptable which was (2, 3.6%).

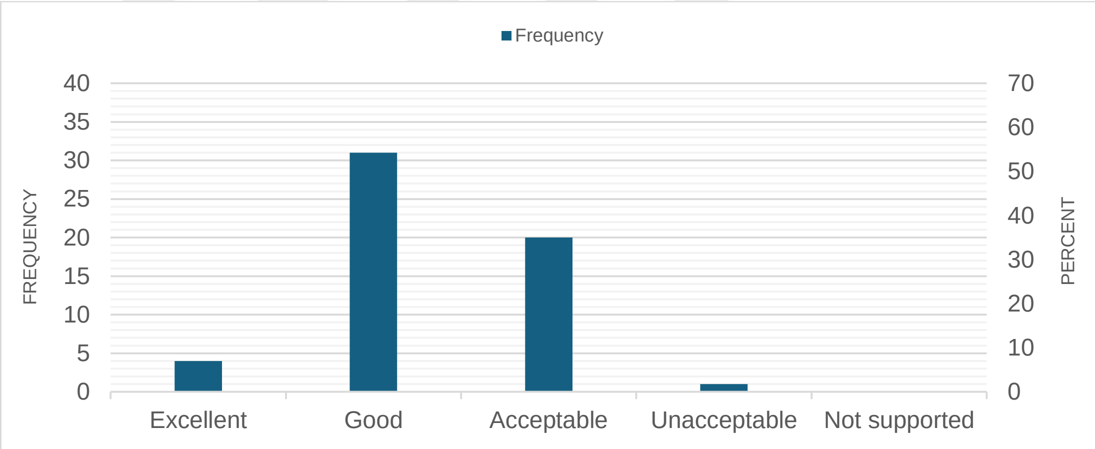

Figure 3.42: **Efficient monthly maintenance of gates and cranes and when parts need to be replaced**

The figure shows the answers to this paragraph, which were as follows: excellent (4, 7.1%), good (31, 55.4%), acceptable (20, 35.7%), and unacceptable (1, 1.8%).

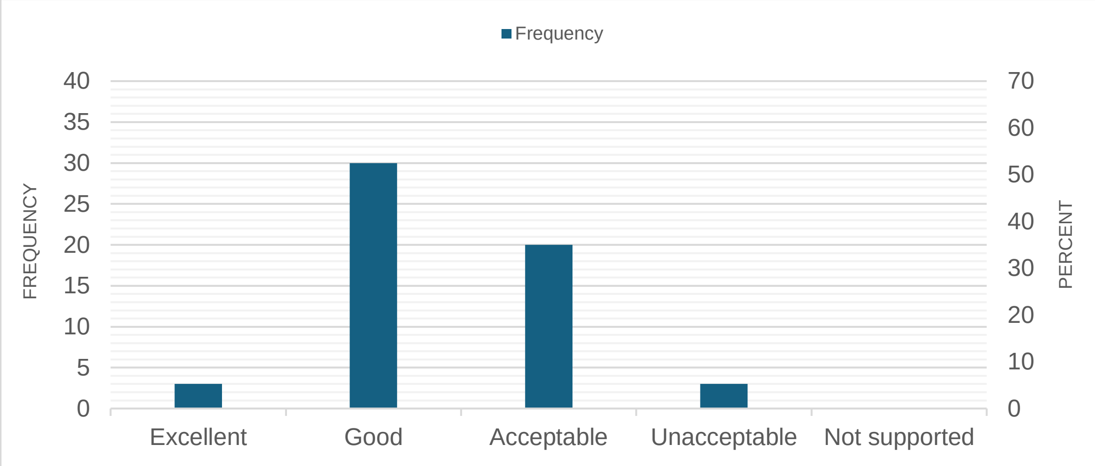

Figure 3.43: **Efficient annual maintenance of gates and cranes and replacement of damaged parts**

Most of the answers were between good and acceptable, and the total answers were excellent (3, 5.4%), good (30, 53.6%), acceptable (20, 35.7%), and unacceptable (3, 5.4%).

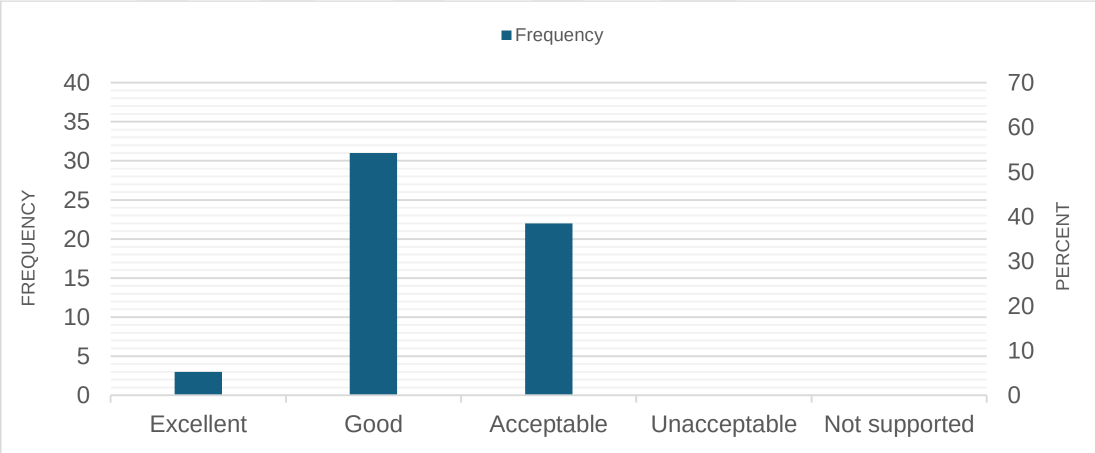

Figure 3.44: **Maintenance efficiency every three years**

The figure shows the numbers and percentages of the participants' answers to the questionnaire in this paragraph as follows: Excellent (3, 5.4%), Good (31, 55.4%), Acceptable (22, 39.3%).

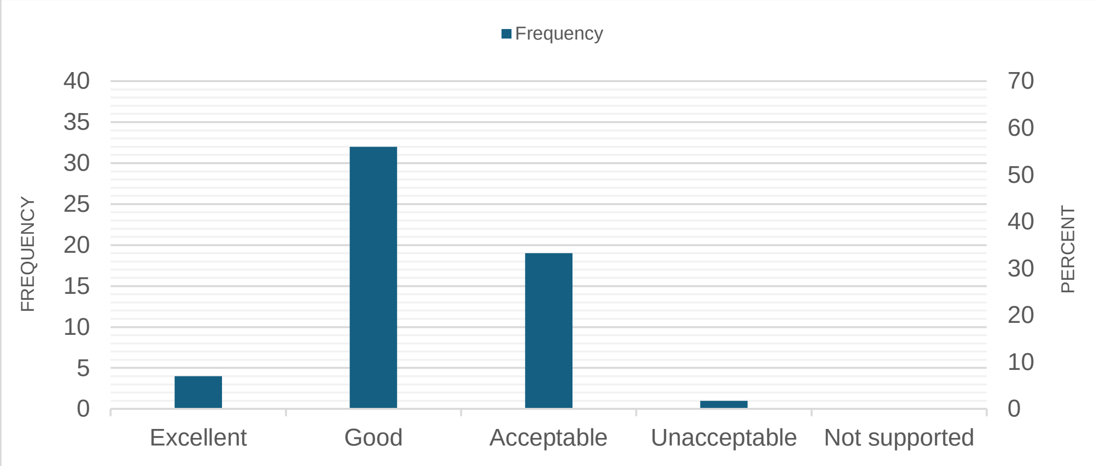

Figure 3.45: **Maintenance efficiency every six years**

This paragraph had answers for the numbers and percentages of choices: excellent (4, 7.1%), good (32, 57.1%), acceptable (19, 33.9%), and unacceptable (1, 1.8%).

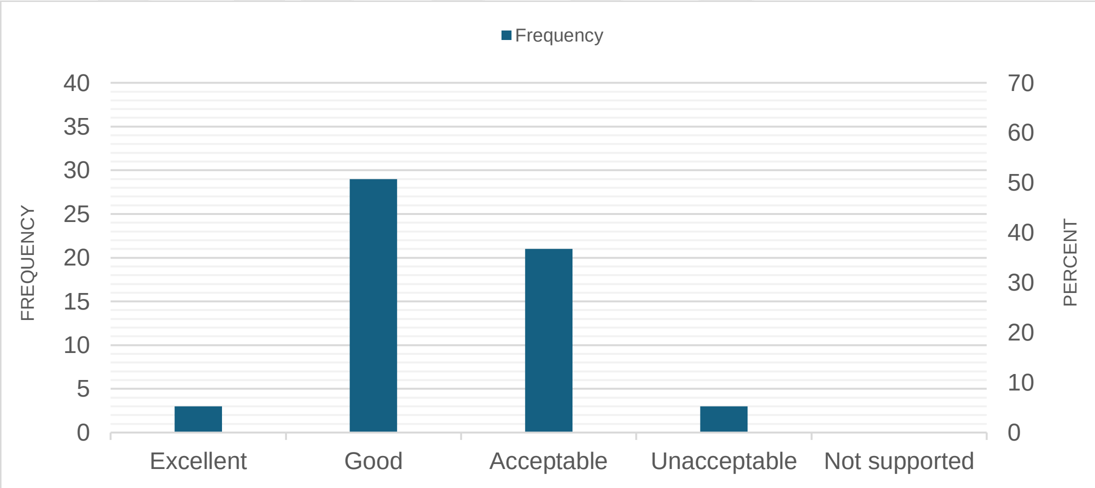

Figure 3.46: **Review basic spare parts periodically and update them**

The number and percentage of those who chose excellent (3, 5.4%), those who chose good (29, 51.8%), those who chose acceptable (21, 37.5%), and the rest chose unacceptable (3, 5.4%).

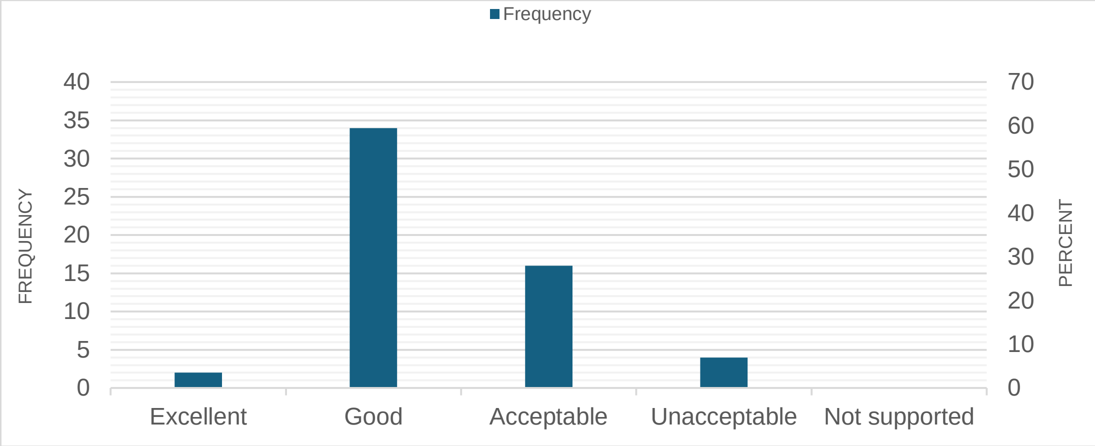

Figure 3.47: **Providing immediate maintenance materials in cases of emergencies and unexpected accidents**

This figure shows the numbers and percentages of the participants' answers to the questionnaire in this paragraph as follows: excellent (2, 3.6%), good (34, 60.7%), acceptable (16, 28.6%), and unacceptable (4, 7.1%).

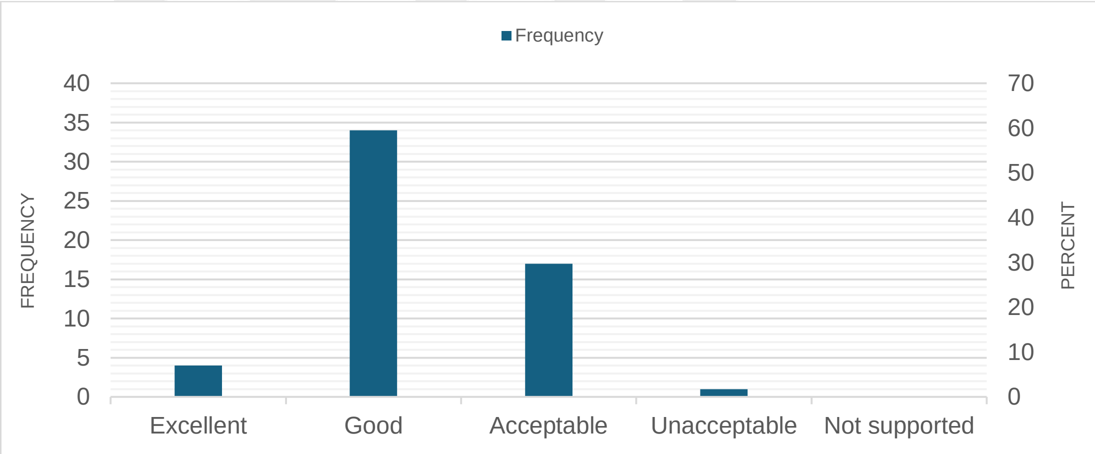

Figure 3.48: **The project authorities' interest in preparing for immediate maintenance at any time and continuous monitoring during periods of high tank level**

The numbers and percentages of answers in this paragraph appear as follows: excellent (4, 7.1%), good (34, 60.7%), acceptable (17, 30.4%), and unacceptable (1, 1.8%).

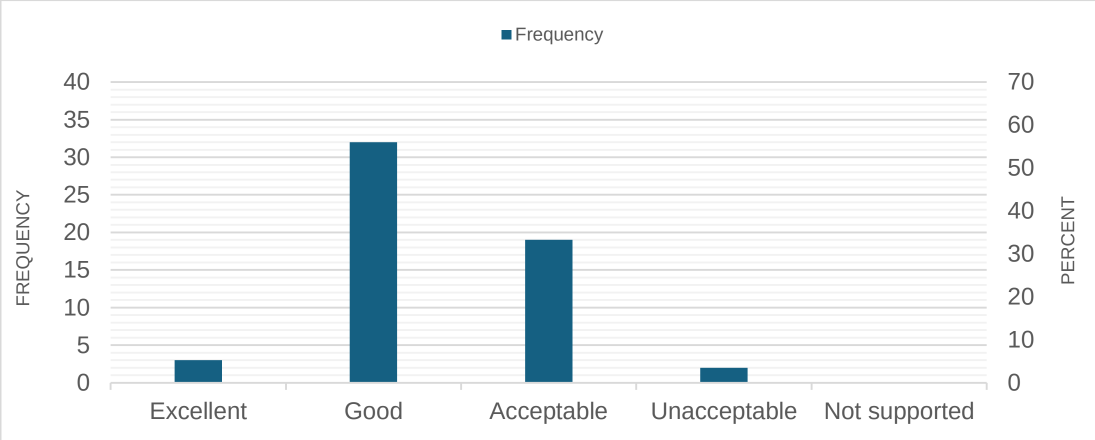

Figure 3.49: **Records of comprehensive maintenance work for recorded information**

The answers were mostly good, and in this form, the numbers and percentages of the participants' choices in the questionnaire in this paragraph appeared as follows: excellent (3, 5.4%), good (32, 57.1%), acceptable (19, 33.9%), and unacceptable (2, 3.6%).

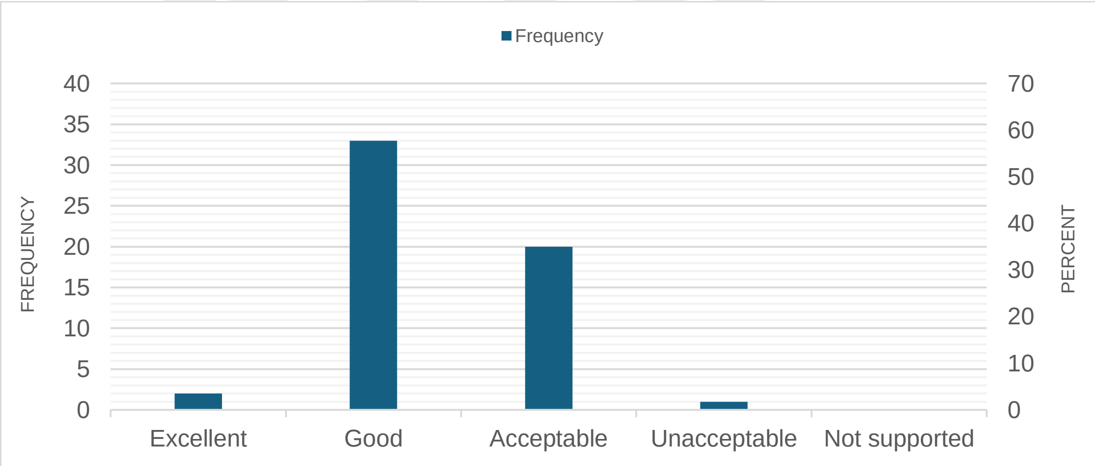

Figure 3.50: **For painting and repairing damaged surfaces**

The number and percentage of those who chose excellent was (2, 3.6%), most of them chose good (33, 58.9%), others chose acceptable (20, 35.7%), and the rest chose unacceptable (1, 1.8%).

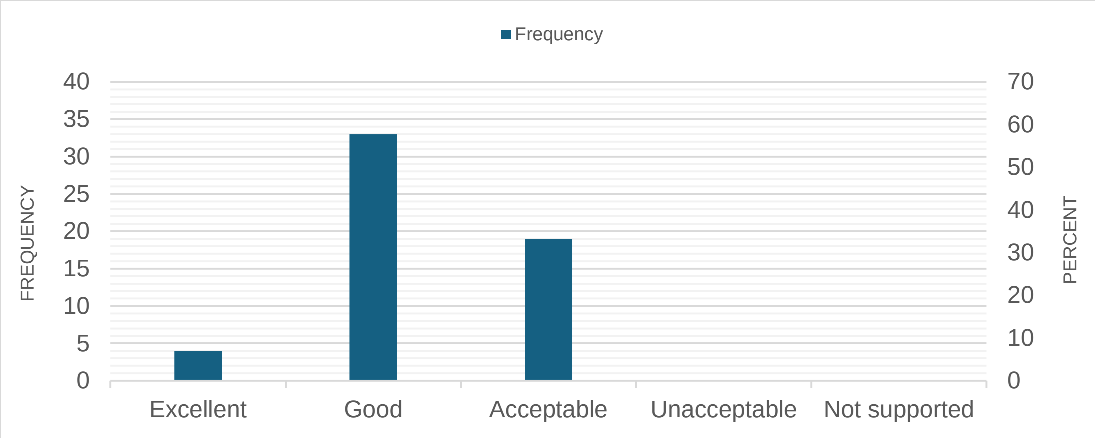

Figure 3.51: **Precautions to be taken for painting damaged surfaces**

The numbers and percentages of the participant's answers to the questionnaire in this paragraph are as follows: Excellent (4, 7.1%), Good (33, 58.9%), Acceptable (19, 33.9%).

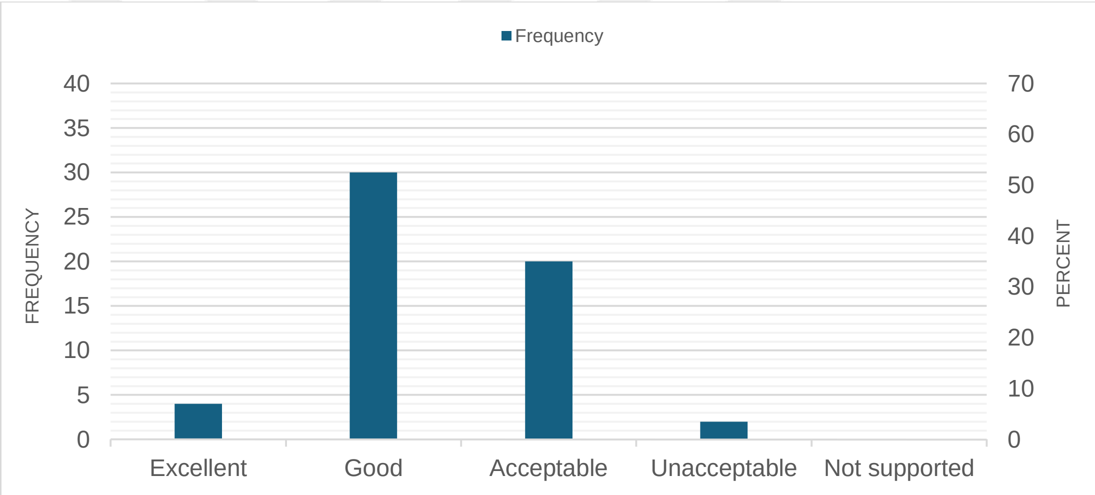

Figure 3.52: **The extent of attention to layers and type of paint used**

Participants' answers and percentages on the choices were as follows: excellent (4, 7.1%), good (30, 53.6%), acceptable (20, 35.7%), and unacceptable (2, 3.6%).

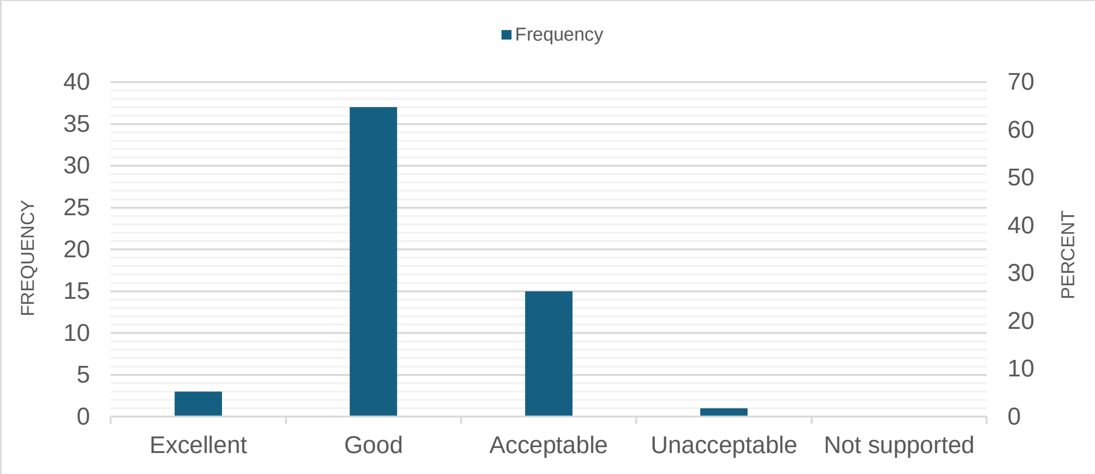

Figure 3.53: **When periodically maintaining electrical elements, care must be taken to follow the manufacturer's advice**

The numbers of responses and percentages in this paragraph are shown as follows: excellent (3, 5.4%), good (37, 66.1%), acceptable (15, 26.8%), and unacceptable (1, 1.8%).

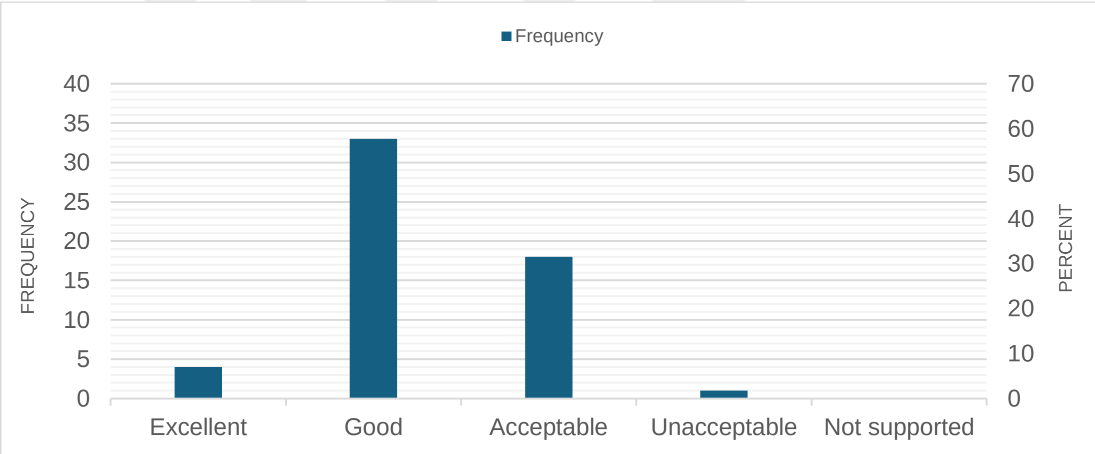

Figure 3.54: **Complete monthly and annual inspection and maintenance of all electrical parts (power lines, control panels, voltage, switch and communication points, motors, and lighting), identifying the damaged parts and taking remedial measures**

The percentages of answers and their numbers on the choices were: excellent (4, 7.1%), good (33, 58.9%), acceptable (18, 32.1%), and unacceptable (1, 1.8%).

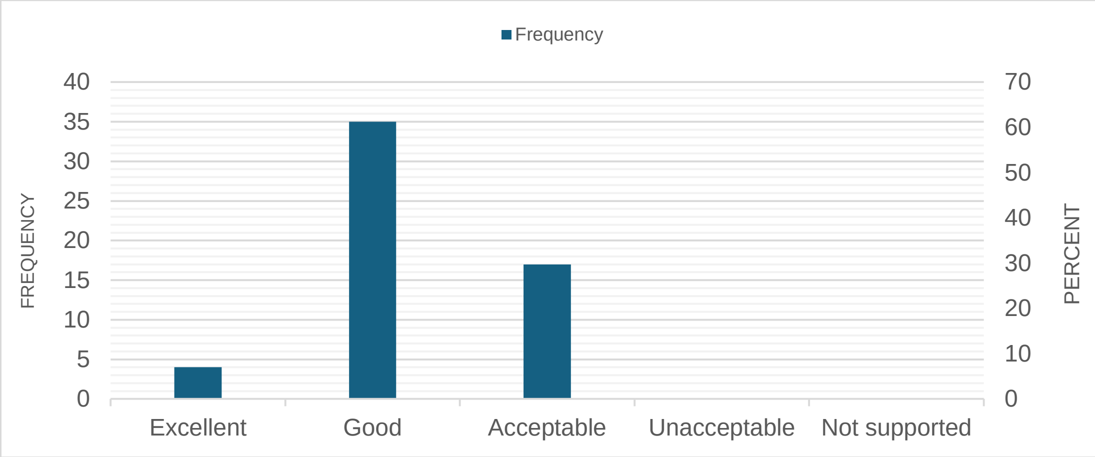

Figure 3.55: **Continuous maintenance of the electrical system used in operation**

Excellent was chosen by (4, 7.1%) participants, while most chose good (35, 62.5%) and the rest chose acceptable (17, 30.4%).

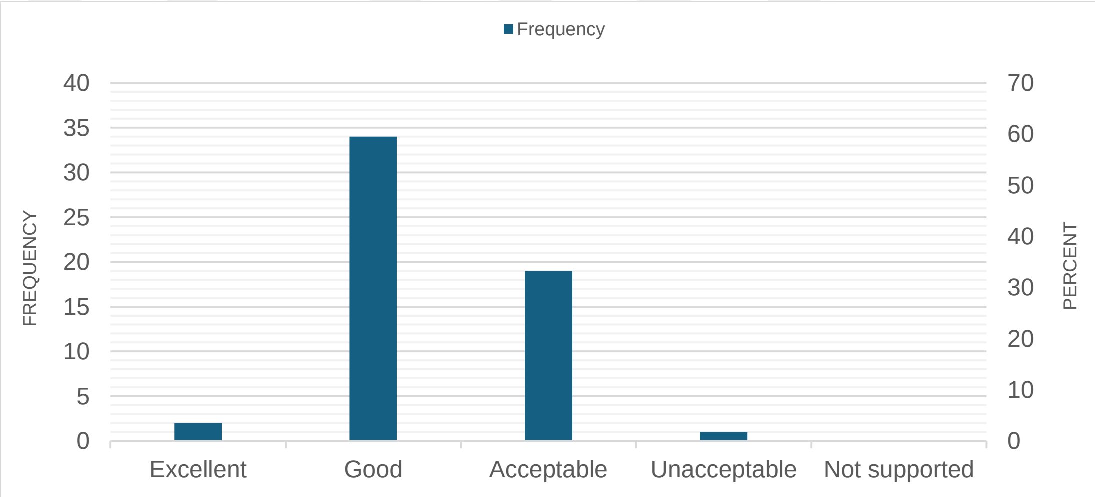

Figure 3.56: **Regular maintenance of generators used for additional power in emergencies**

The numbers and percentages of the participants' answers to the questionnaire in this paragraph varied, but most chose good, and the answers were as follows: excellent (2, 3.6%), good (34, 60.7%), acceptable (19, 33.9%), and unacceptable (1, 1.8%).

3- Analysis of Phrases in Operation and Maintenance Budget

One of the necessities of continuing work and providing the rest of the details that have a role in the development and stability of hydraulic projects is providing an adequate budget to cover the entire project and its continuation. Therefore, this part of the questionnaire clarifies the effectiveness and adequacy of the work budget in this project and its continuation with high quality. The participants' answers were explained in the following graphs.

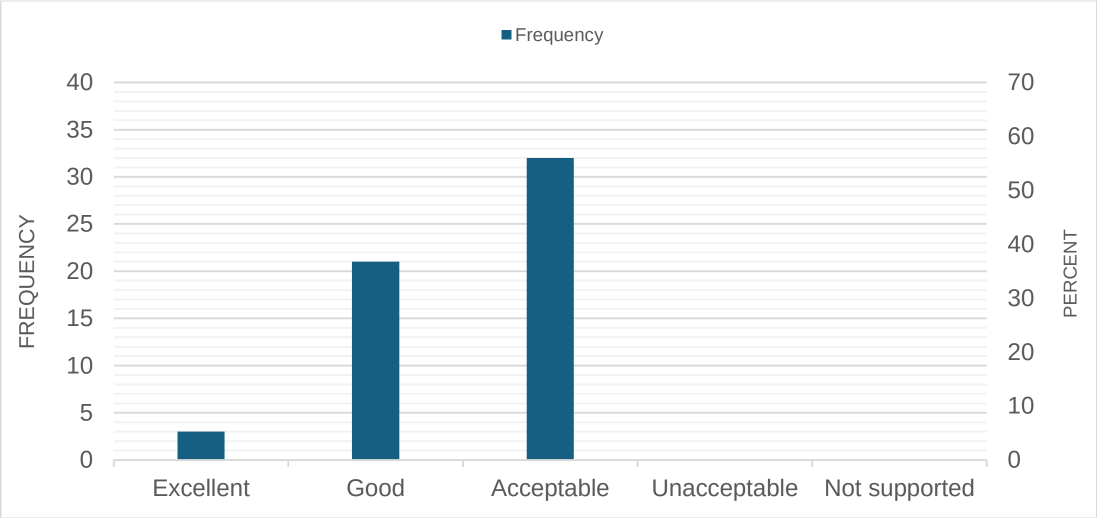

Figure 3.57: **Budget for costs associated with implementing the operation and maintenance program**

In this paragraph, those who chose acceptable were the majority, and the choices were as follows: excellent (3, 5.4%), good (21, 37.5%), acceptable (32, 57.1%).

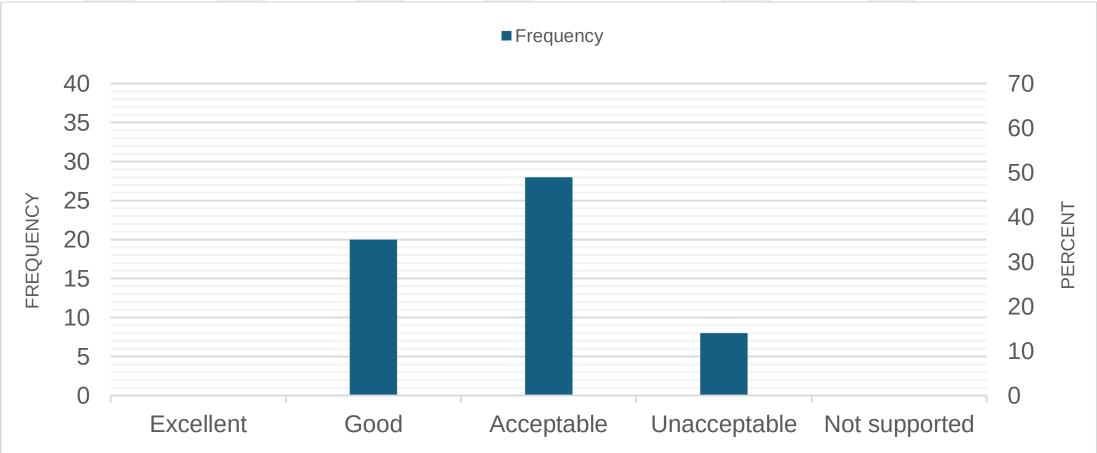

Figure 3.58: **The budget available for different labor offices**

Those who chose good (20, 35.7%) and those who chose acceptable (28, 50%) while the rest chose unacceptable (8, 14.3%).

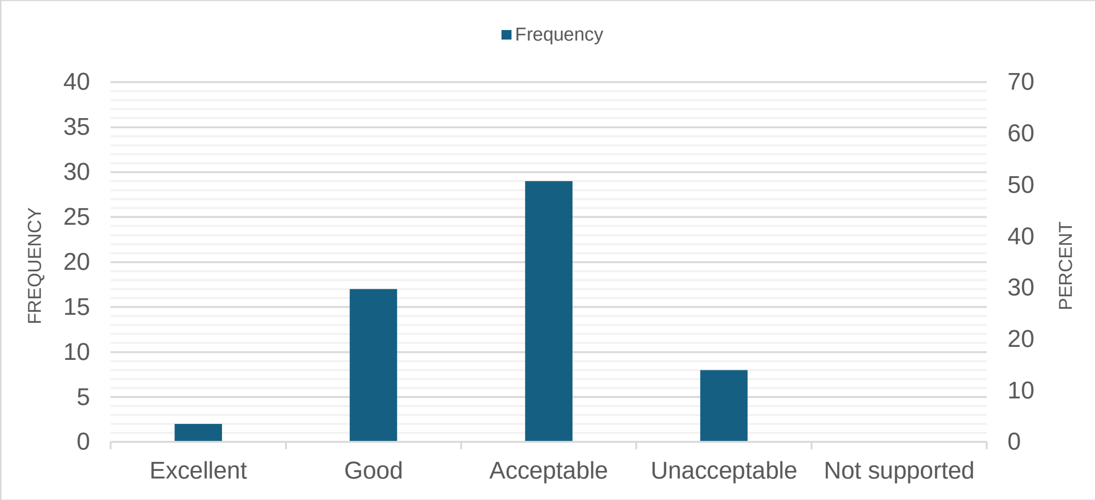

Figure 3.59: **Budget for employees working in different duties**

The percentages and numbers of answers of those who participated in the questionnaire were: excellent (2, 3.6%), good (17, 30.4%), acceptable (29, 51.8%), and unacceptable (8, 14.3%).

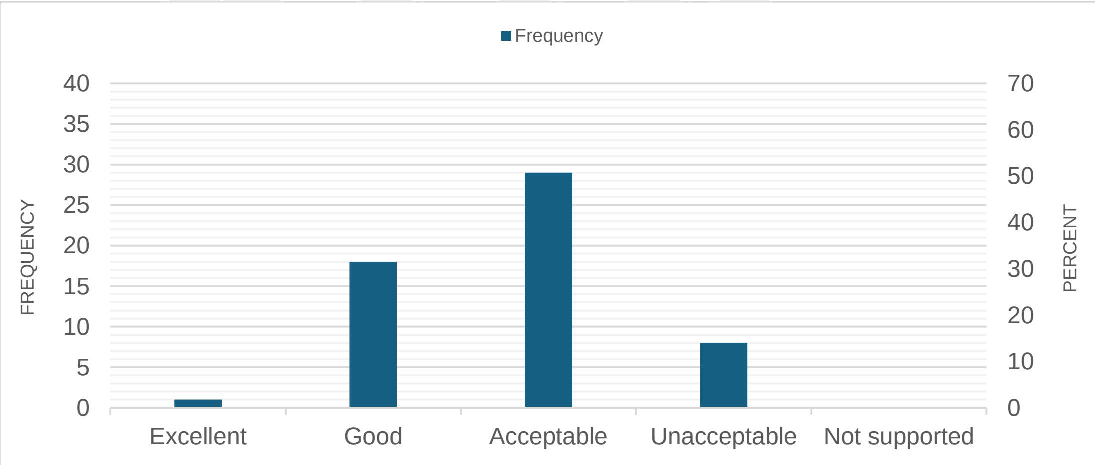

Figure 3.60: **Budget for operating and maintaining vehicles and equipment**

The choices were as follows: excellent (1, 1.8%), good (18, 32.1%), acceptable (29, 51.8%), and unacceptable (8, 14.3%).

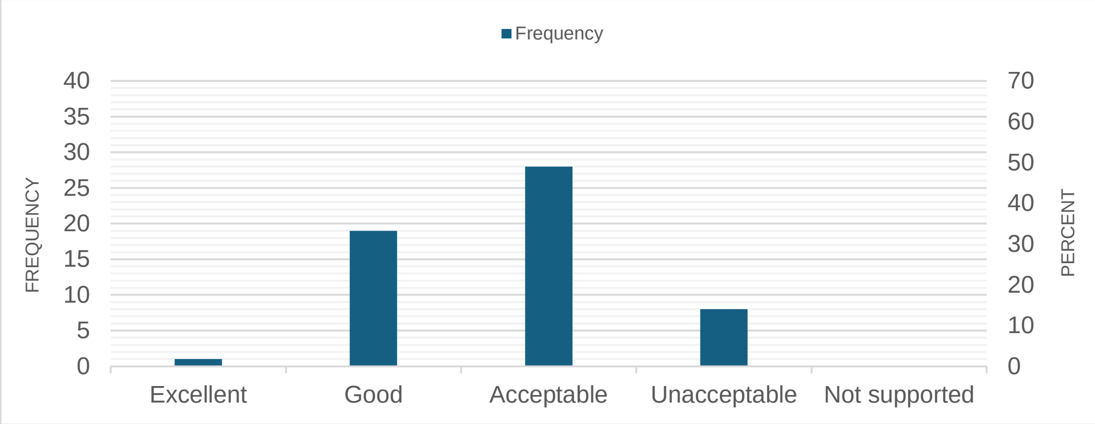

Figure 3.61: **Budget for providing the necessary systems and devices to obtain data**

The figure shows the different answers of the participants in the questionnaire, in which the most common choice was acceptable. The choices were as follows: excellent (1, 1.8%), good (19, 33.9%), acceptable (28, 50%), and unacceptable (8, 14.3%).

4- Analysis of Phrases in Training and Exercises

Training and exercises give a good and clear picture to the barrage employees about the nature and continuity of work and its mastery and familiarization with its details on an ongoing basis.

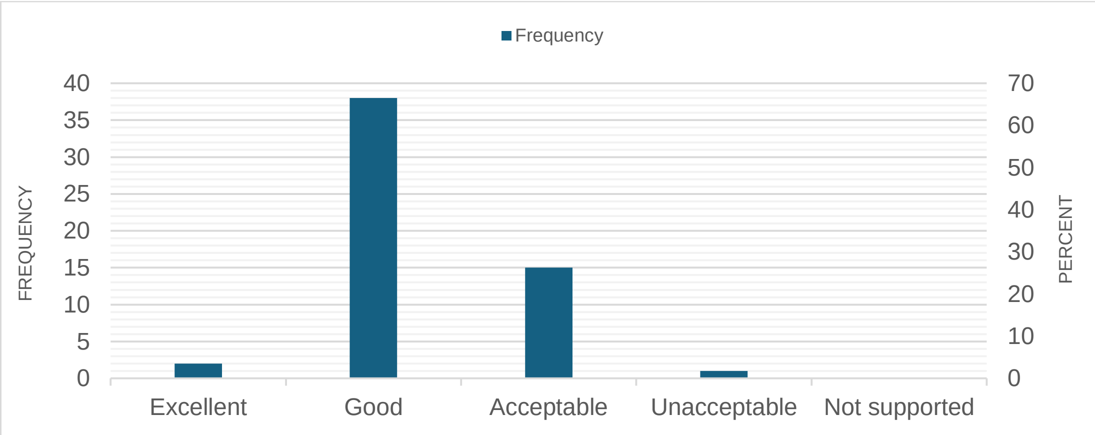

Figure 3.62: **The necessary training in implementing the operation and maintenance manual program**

The excellent choice was (2, 3.6%) in this paragraph, while the good choice was (38, 67.9%) and acceptable was (15, 26.8%), and the rest had an unacceptable choice (1, 1.8%).

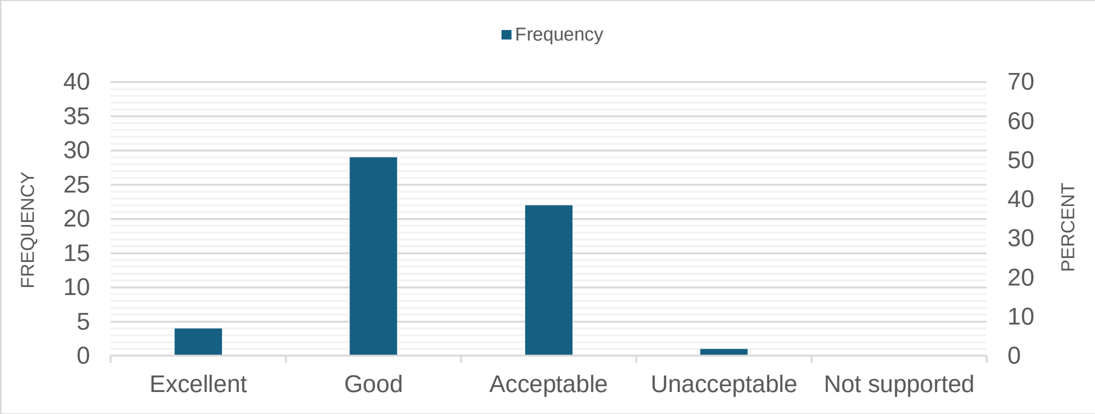

Figure 3.63: **Trainings that make employees familiar with the work plan, their responsibilities, and available equipment**

The numbers of participants' answers and their percentages in this paragraph were as follows: excellent (4, 7.1%), good (29, 51.8%), acceptable (22, 39.3%), and unacceptable (1, 1.8%).

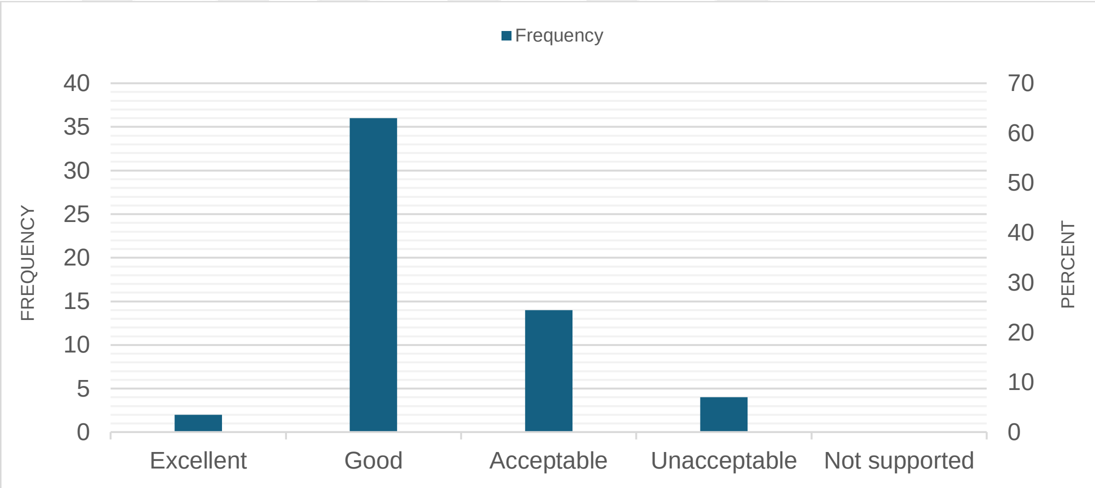

Figure 3.64: **Training to detect problems, damages, and remedial measures**

The figure above shows the numbers and percentages of responses to the questionnaire as follows: excellent (2, 3.6%), good (36, 64.3%), acceptable (14, 25%), and unacceptable (4, 7.1%).

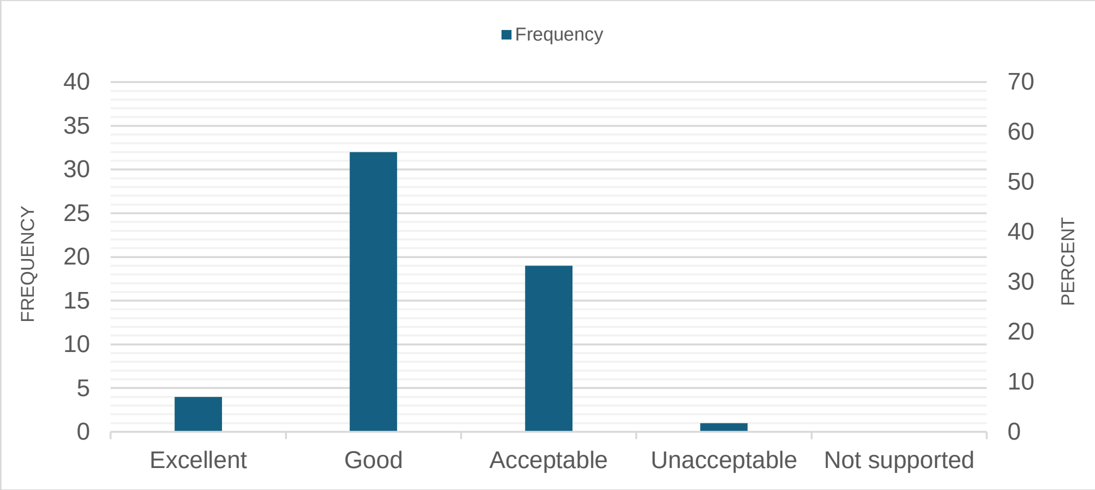

Figure 3.65: **Complete health and safety instructions exercises for employees in terms of instructions, signs, and alarm devices**

The figure above showed that the number of responses and percentages of participants in the questionnaire varied, but most chose good in this paragraph: excellent (4, 7.1%), good (32, 57.1%), acceptable (19, 33.9%), and unacceptable (1, 1.8%).

5- Analysis of Phrases in Safety and Security

One of the most important components of hydraulic projects is ensuring good safety and security for employees and residents in areas near hydraulic projects.

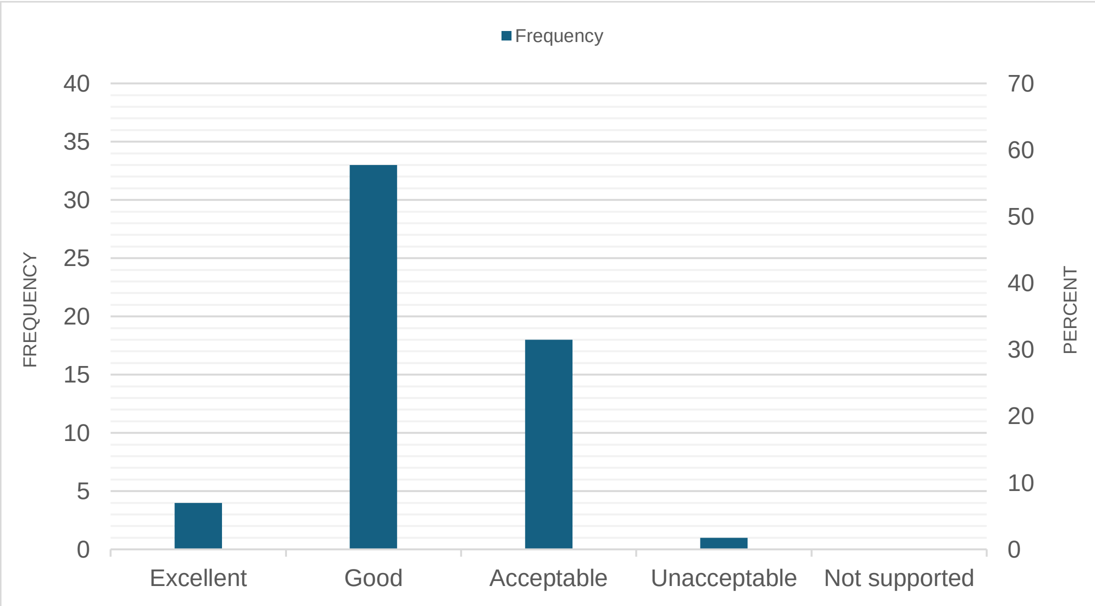

Figure 3.66: **Complete health and safety instructions in terms of instructions, signs, and alarms**

The numbers and percentages of answers to the choices in this paragraph appeared as follows: excellent (4, 7.1%), good (33, 58.9%), acceptable (18, 32.1%), and unacceptable (1, 1.8%).

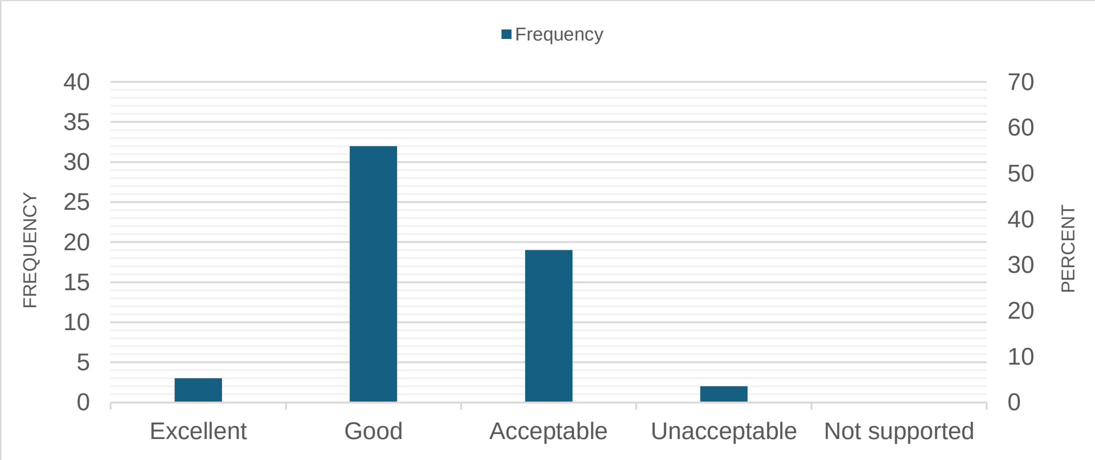

Figure 3.67: **Safety of roads connecting every detail of the barrage**

The number and percentage of answers to this paragraph varied, but most were good, as follows: excellent (3, 5.4%), good (32, 57.1%), acceptable (19, 33.9%), and unacceptable (2, 3.6%).

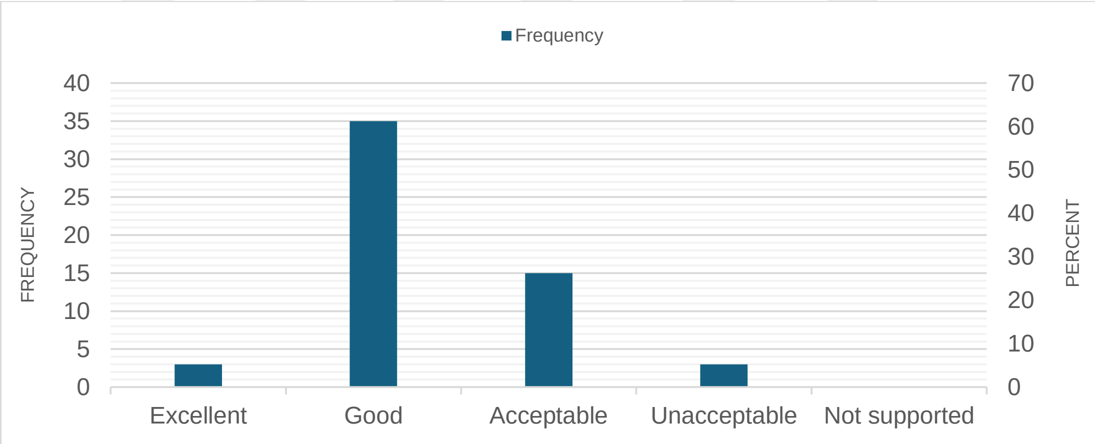

Figure 3.68: **Paying attention to the safety of residents of the areas around the barrage**

The answers to this paragraph for the participants in the questionnaire in terms of numbers and percentages were as follows: excellent (3, 5.4%), good (35, 62.5%), acceptable (15, 26.8%), and unacceptable (3, 5.4%).

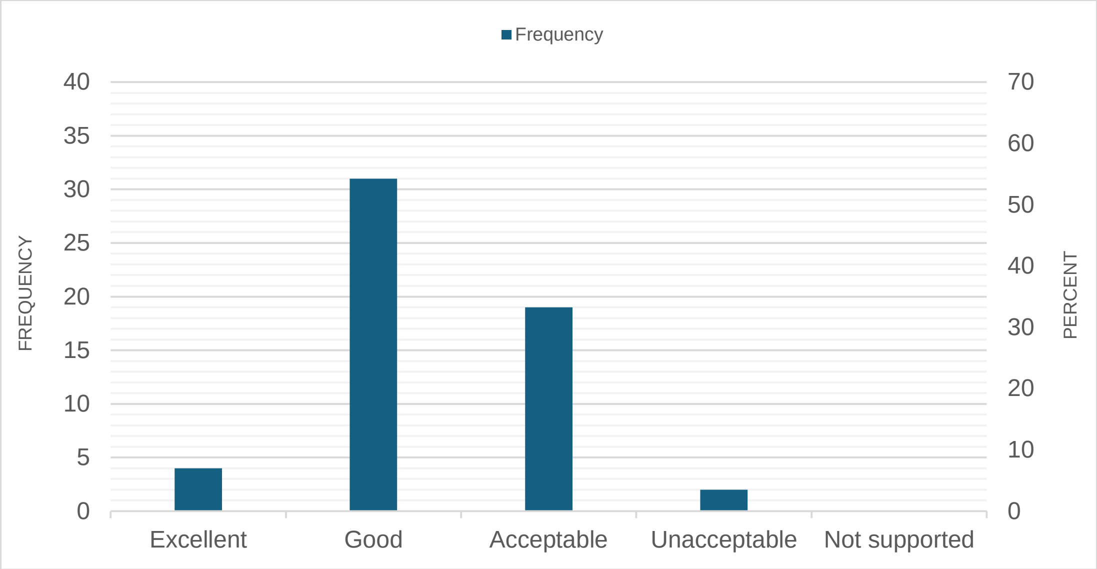

Figure 3.69: **Safety instructions in times of floods**

The figure shows that the numbers and percentages for choosing good were (31, 55.4%), which is the majority among the choices, while the choice was excellent (4, 7.1%), while the number and percentage of those who chose acceptable was (19, 33.9%), and the rest were unacceptable (2, 3.6%).

4. DISCUSSION OF RESULTS

4.1 Results of Research Data

After analyzing the data using the SPSS program and clarifying the frequency and percentage of participants' answers to the statements related to the Kufa Barrage data in the graphs in the previous chapter, the results of the analysis will be presented here in terms of the result of the expressions and sections to give the final evaluation for each statement and section based on the outputs of the SPSS program to show a clear picture of the correct evaluation of the management of the operation and maintenance process of the Kufa Barrages.

4.1.1 Results of Phrases in the Operation and Maintenance Manual

The results of the operation and maintenance manual for the statements are detailed in this table based on the output of the SPSS program and the data shown in the graphs.

Table 4.1: **Results of phrases in the Operation and Maintenance Manual**

Phrase	Percentage					The result
	Excellent	Good	Acceptable	Un acceptable	Not supported	
The extent to which the operation and maintenance manual covers every detail of the Kufa Barrage	7.1	64.3	28.6	0	0	Good
Providing a guide and distributing it to employees to know the necessary tasks well	3.6	62.5	32.1	1.8	0	Good
Commitment to and implementation of the procedures contained in the Operation and Maintenance Manual	8.9	55.4	33.9	1.8	0	Good
Employees' knowledge of the operation and maintenance manual and their interest in adhering to it	10.7	53.6	32.1	3.6	0	Good
Review and update the guide	3.6	57.1	37.5	1.8	0	Good

consistently with changes						

Source: "Prepared by the Researcher Based on Outputs from SPSS Software".

The results of the statements in the table show that the result in the Operation and Maintenance Manual section for the Kufa Barrages is **(Good)**.

4.1.2 Results of phrases in the quality of the operating and maintenance procedures for the barrage

Detailed results of the quality of operation and maintenance of the ferries are presented in these tables based on the data shown in the previous chapter. They are divided into three sections:

1- Results of phrases in Records

Details of the registration results for the phrases are shown in Table 4.2 based on the data shown.

Table 4.2: **Results of phrases in Records**

Phrase	Percentage					The result
	Excellent	Good	acceptable	Un acceptable	Not supported	
The extent of interest in recording daily activities in the site's records	8.9	57.1	32.1	1.8	0	Good
Records daily water levels and barrage flows	12.5	58.9	28.6	0	0	Good
Records of operation and periodic maintenance of the barrage	12.5	53.6	33.9	0	0	Good
Reservoir records hourly during monsoon periods and daily during non-monsoon periods	10.7	55.4	32.1	1.8	0	Good
Records of water releases for irrigation and supplies for the areas covered by the barrage	12.5	50	37.5	0	0	Good
Records of rainfall amounts on a daily and periodic basis	1.8	64.3	32.1	1.8	0	Good
Records of unusual situations that may occur and emergencies	3.6	60.7	33.9	1,8	0	Good
Daily meteorological data records	5.4	57.1	37.5	0	0	Good

Source: "Prepared by the Researcher Based on Outputs from SPSS Software".

In the quality section of the operation and maintenance process (records), the results of the statements indicated that the choice was good, so the result of this section for the Kufa Barrages was **(Good).**

2- Results of phrases in operation procedures

Details of the results for the operations of the phrases are shown in this table based on the data shown in the graphs.

Table 4.3: Results of phrases in operation procedures

Phrase	Percentage					The result
	Excellent	Good	acceptable	Un acceptable	Not supported	
Monitor tank levels and records	5.4	64.3	28.6	1.8	0	Good
Taking care of the public safety of the barrage regularly	7.1	58.9	32.1	1.8	0	Good
Operating procedures during monsoon and non-monsoon periods for barrages	3.6	55.4	41.1	0	0	Good
Emergency operating procedures	5.4	60.7	33.9	0	0	Good
Complete visual inspection of bridges and water levels in the tank	5.4	57.1	33.9	3.6	0	Good
Review meteorological data records on an ongoing basis	8.9	60.7	30.4	0	0	Good
Floodwater drainage procedures	5.4	60.7	30.4	3.6	0	Good
Different types of inspection in barrage safety inspection	8.9	55.4	35.7	0	0	Good
The extent to which different data devices are relied upon in evaluating barrage behavior	5.4	50	41.1	3.6	0	Good
appreciation for the comprehensive inspection of all civil structures, regulatory bodies, and all barrage facilities	1.8	64.3	33.9	0	0	Good
The quality of available data used to estimate floods and their paths	1.8	55.4	39.3	3.6	0	Good
Studies on testing and stabilizing barrage	7.1	58.9	32.1	0	0	Good
Reports on roads, bridges, and communications	62.5	35.7	1.8	0	0	Good
Regular inspection before and after monsoon	5.4	53.6	39.3	1.8	0	Good
Emergency inspection in terms of unspecified conditions and any unusual events in the project	5.4	57.1	33.9	3.6	0	Good

Reports submitted to project authorities in special cases that could cause harm to the barrage	5.4	60.7	32.1	1.8	0	Good

Source: "Prepared by the Researcher Based on Outputs from SPSS Software".

Quality Department for Operation and Maintenance (Operation) The table above shows the results of the statements for it in the Kufa Barrage **(Good)**.

3- Results of phrases in Maintenance procedures

Table 4.4 shows the details of the maintenance process results based on what was shown in the data in the previous chapter.

Table 4.4: **Results of phrases in Maintenance procedures**

Phrase	Percentage					The result
	Excellent	Good	acceptable	Un acceptable	Not supported	
The project authorities give priority attention to maintenance activities	5.4	57.1	37.5	0	0	Good
Maintenance of cases that contain damage in general	12.5	55.4	30.4	1.8	0	Good
Routine ongoing maintenance regularly	3.6	55.4	39.3	1.8	0	Good
Maintenance of gate openings and keeping them free of debris or plant growth	7.1	53.6	35.7	3.6	0	Good
Regular maintenance of the road leading to Barrage and communication devices	3.6	51.8	39.3	5.4	0	Good
The extent to which the guidance of the expert group for barrage is followed when maintaining it	8.9	60.7	26.8	3.6	0	Good
Speedy maintenance of equipment when there is any need for maintenance according to the equipment manufacturer’s manuals	5.4	51.8	42.9	0	0	Good
Efficient daily maintenance of gates and cranes based on daily inspection when there is damage	7.1	58.9	30.4	3.6	0	Good
Efficient monthly maintenance of gates and cranes and when parts need to be replaced	7.1	55.4	35.7	1.8	0	Good
Efficient annual maintenance of gates and cranes and replacement of damaged parts	5.4	53.6	35.7	5.4	0	Good
Maintenance efficiency every	5.4	55.4	39.3	0	0	Good

three years						
Maintenance efficiency every six years	7.1	57.1	33.9	1.8	0	Good
Review basic spare parts periodically and update them	5.4	51.8	37.5	5.4	0	Good
Providing immediate maintenance materials in cases of emergencies and unexpected accidents	3.6	60.7	28.6	7.1	0	Good
The project authorities' interest in preparing for immediate maintenance at any time and continuous monitoring during periods of high tank level	7.1	60.7	30.4	1.8	0	Good
Records of comprehensive maintenance work for recorded information	5.4	57.1	33.9	3.6	0	Good
For painting and repairing damaged surfaces	3.6	58.9	35.7	1.8	0	Good
Precautions to be taken for painting damaged surfaces	7.1	58.9	33.9	0	0	Good
The extent of attention to layers and type of paint used	7.1	53.6	35.7	3.6	0	Good
When periodically maintaining electrical elements, care must be taken to follow the manufacturer's advice	5.4	66.1	26.8	1.8	0	Good
Complete monthly and annual inspection and maintenance of all electrical parts (power lines, control panels, voltage, switch, communication points, motors, and lighting), identifying the damaged parts and taking remedial measures	7.1	58.9	32.1	1.8	0	Good
Continuous maintenance of the electrical system used in operation	7.1	62.5	30.4	0	0	Good
Regular maintenance of generators used for additional power in emergencies	3.6	60.7	33.9	1.8	0	Good

Source: "Prepared by the Researcher Based on Outputs from SPSS Software".

The data results of the Quality Department in the Operation and Maintenance Process (maintenance process) of the Kufa Barrage showed that the result is **(Good)**.

The results shown in the tables above, that the quality of the operation and maintenance process in the Kufa Barrages is **(good)**, and this is positively reflected in the management of this process in the Kufa Barrages.

4.1.3 Results of phrases in operation and maintenance budget

The results of the Operations and Maintenance Budget Department are shown in the table below.

Table 4.5: **Results of phrases in Operation and maintenance budget**

Phrase	Percentage					The result
	Excellent	Good	acceptable	Un acceptable	Not supported	
Budget for costs associated with implementing the operation and maintenance program	5.4	37.5	57.1	0	0	Acceptable
The budget available for different labor offices	0	35.7	50	14.3	0	Acceptable
Budget for employees working in different duties	3.6	30.4	51.8	14.3	0	Acceptable
Budget for operating and maintaining vehicles and equipment	1.8	32.1	51.8	14.3	0	Acceptable
Budget for providing the necessary systems and devices to obtain data	1.8	33.9	50	14.3	0	Acceptable

Source: "Prepared by the Researcher Based on Outputs from SPSS Software".

The results of the data shown in the table above indicate that the result of the Operation and Maintenance Budget Department for the Kufa Barrage is (Acceptable).

4.1.4 Results of phrases in training and exercises

Details of the training and exercise results are shown below based on the data analyzed.

Table 4.6: **Results of Phrases in Training and Exercises**

Phrase	Percentage					The result
	Excellent	Good	acceptable	Un acceptable	Not supported	
The necessary training in implementing the operation and maintenance manual program	3.6	67.9	26.8	1.8	0	Good

Trainings that make employees familiar with the work plan, their responsibilities, and available equipment	7.1	51.8	39.3	1.8	0	Good
Training to detect problems, damages, and remedial measures	3.6	64.3	25	7.1	0	Good
Complete health and safety instructions exercises for employees in terms of instructions, signs, and alarm devices	7.1	57.1	33.9	1.8	0	Good

Source: "Prepared by the Researcher Based on Outputs from SPSS Software".

All the phrases in the training and exercises section gave a good result, so the final result was **(Good)**.

4.1.5 Results of phrases in Safety and security

The details of the safety and security section are important in managing this process, as the results of the statements are explained in the table below.

Table 4.7: **Results of phrases in Safety and security**

Phrase	Percentage					The result
	Excellent	Good	acceptable	Un acceptable	Not supported	
Complete health and safety instructions in terms of instructions, signs, and alarms	7.1	58.9	32.1	1.8	0	Good
Safety of roads connecting every detail of the barrage	5.4	57.1	33.9	3.6	0	Good
Paying attention to the safety of residents of the areas around the barrage	5.4	62.5	26.8	5.4	0	Good
Safety instructions in times of floods	7.1	55.4	33.9	3.6	0	Good

Source: "Prepared by the Researcher Based on Outputs from SPSS Software".

The table shows the results for each statement according to the answers of the people who participated in the questionnaire, which gave the final result **(Good).**

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Kufa Barrage's operation and maintenance procedure is well-managed in most respects, according to the findings, and the budget's specifics are satisfactory.

These findings provide an accurate evaluation of the Kufa Barrage's operation and maintenance management, which is indicative of the overall performance of the barrage throughout central and southern Iraq.

The consistent and accurate operation and maintenance process management, guided by the operation and maintenance manual, is evident in the ongoing hydraulic projects. These projects lead to the efficient use of water and the mitigation of associated hazards.

Due to the high quality of their work, hydraulic projects in central and southern Iraq effectively store water and distribute it to agricultural fields on a regular basis. This is because the operation and maintenance process is correctly managed.

Academics, related departments, and hydraulic project authorities may see the big picture of each detail's strengths, limitations, and efficiency with these data and outcomes presented to them.

According to the study cited before, the projects in central and southern Iraq are providing high quality, and the efficiency of managing the operation and maintenance process is good as well.

5.2 Recommendations

- Focusing on the strengths and weaknesses and working to continue the good details in the barrage, in addition to supporting the details that have weak points, if any, and finding the necessary solutions based on the location and work of the barrage and the areas it covers.

- Paying attention to the financial budgets for hydraulic projects to reduce the shortage occurring in these sections, which reflects negatively on the management of the operation and maintenance process, as the results of the Kufa Barrage data showed that the operation and maintenance budget section was rated (acceptable), unlike the rest of the sections. Therefore, attention to financial support is necessary for the continuation of the good work of the barrage.
- The effective role that hydraulic projects provide in storing and distributing water and protecting residents of the areas around water projects from risks that may occur, so it is necessary to support and sustain these projects.
- Increasing efficiency and ease of work by using modern and smart devices and equipment to raise the level and speed of the process.

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RESUME

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Summary:

- Since graduating in 2015, I have worked in various private businesses and companies related to communications.

Education:

- The University of Kufa / College of Engineering / Department of Water Resources and Facilities Engineering in 2015.

Experience:

- 2016 - 2017: Engineer in the maintenance department of a private telecommunications company
- 2017 - 2018: Assistant Manager of the Administration Department.
- 2018 - 2020: Manager of the Maintenance Department in one of the company's branches.
- 2020 - until now: Assistant Manager of one of the company's

Branches. Skills:

- Office programming skills such as Word, Excel, and PowerPoint
- Good organization
- Leadership
- Communication and working under pressure skills
- 3D Max
- AutoCAD

Languages:

- Arabic my tongue language
- English very good