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# MANAGEMENT OF THE DIFFERENT PHASES OF AN IRRIGATION DAM CONSTRUCTION PROJECT: CASE STUDY

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## ABSTRACT

This article develops the procedural basis of documentary management of projects in different phases of development of a project, using an exhaustive bibliographic review, denoting some differences and particularities among countries and even among authors, especially in organization procedures.

A case study was conducted comparing the regulatory assumptions and bibliography on the subject, with the real management of a construction project of an irrigation dam. At first, it was undertaken a consultation of the various documents that constitute the dam design project along the different phases of its development. Subsequently, in order to complement the gathered information during the investigation, as well as to respond to other omissions research questions even after the documentary consultation, an interview supported by a questionnaire with the dam designer was conducted.

The main results of the research allow the convergence of scattered and unclear information about which documents are mandatory in each phase of the project, being this unclearly specified in the regulations.

The case study of a real construction project of a dam irrigation allows to analyze beyond the required documents at each phase of the development project. And also, the case study contributes to understanding the role of the different stakeholders throughout the process, and the criteria that supports their decisions to move forward to the next phases of a project.

**Keywords**: Management, Project phases, project design, irrigation dam, stakeholders

## 1. INTRODUCTION

The main goal of this research is to apply in a real study a correct application of the construction Project Design phases of an irrigation dam, from the Feasibility Phase, through various stages of the Project Design [1], specifically: Programming Phase, Schematic Design Phase, Design Development Phase, and Construction Document Phase. The basis of this discussion lies on trying to prove the existence of divergences between what is defined by the regulations and what is effectively developed in each phase during the Project Design applied in a real case of a irrigation dam.

In summary, three main specific objectives can be highlighted:

- Objective number 1 - To recognize and catch accordingly with current regulations, and based on the bibliographical review, the Project Design management life-cycle from the conception to the closeout, considering the particularities of the different stages.

- Objective number 2 - To explain the development of the different project phases of a real case study, based on an irrigation dam project design, located in Bragança (Portugal).

- Objective number 3 - To understand the differences between a theoretical Project Design management developed according to the current regulation and a real case of a Project Design.

## 2. METHODOLOGY

This research reported a qualitative approach methodology based on the case study method given the valuable information they reported, despite the reduced number of existant projects related to the topic [2]. This method aims to give answer to the unknowns that remained unsolved after the bibliographic review by undertaking a review of the Project Design documents in the different phases and by conducting an interview with the Project engineer to clarify some processual and documentary doubts [3].

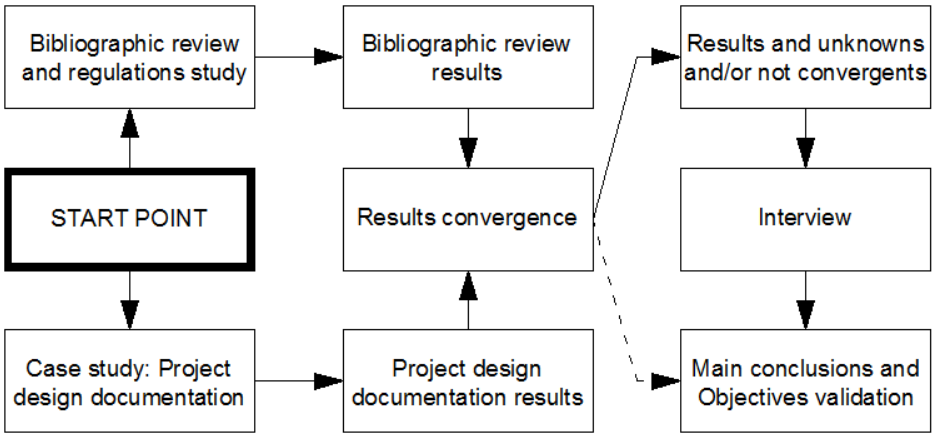


Figure 1: Schematic Design of the research methodology used

### 2.1. Case study framework

The construction project consists in the construction of a gravity dam built in concrete based on multiple objectives exploitation in the “Ribeira de Rebordãos” (Bragança). The main goal of this project is to serve as a deposit of water for crop irrigation, the main economic activity of the region. As a complementary objective, it was also considered the production of electricity and serving for emergency water deposit in case of forest fires. The following figure shows the location of the irrigation dam in “Ribeira de Rebordãos” (Bragança - Portugal).

Figure 2: Location of the irrigation dam construction site.

### 2.2. Project design documents review

The process of accessing project design documents began with a formal request to the promoter, who kindly accepted and provided the necessary information. After receiving the Project design documents out of the promoter courtesy, it was initiated the consulting and review to refute and complete the information gathered in the literature review.

The Rebordãos irrigation Dam Construction Project design consisted of only two phases: the Schematic Design Phase and the Construction Document Phase. The specific function of these documents phases was to reduce the degree of uncertainty and to consider all factors that were involved in the project design of the project [4].

### 2.3. Project design interview development

This part of the investigation develops the interview process along with the participants in the area of the execution of construction Project Designs and, in particular, of irrigation dam projects. The main goal of the interview is to analyze aspects related to the procedure of preparing the deliverables (project design outputs) and the deadlines that were not attended during the documentary consultation phase. Besides, the project design consultation allows detecting some doubts and differences between project design results in project phases studied and published regulations [5].

The interview request was selflessly accepted by the Project engineer of the dam Project Design in "Ribeira de Rebordãos". The purpose of this contact was to conduct an interview to complete the information gathered during the previous stages of bibliographic review and documentary consultation. The interview was prepared with a questionnaire attending specifics doubts and other interferences described previously. The questionnaire, contains 49 questions numbered from 1 to 49 organized in 7 different blocks corresponding to general questions in 1 block and 6 other blocks corresponding to the phases of a construction Project Design. The questions are mainly open questions, except five questions with answers "Yes/No" type questions and other five questions with a "Choose of a temporary range".

## 3. RESULTS

### 3.1. Results of the Project design documents review

The Rebordãos dam construction Project Design does not follow the theory of the Project Design management, because all the documentary base revolves around two phases, the Schematic Design Phase and the Construction Document Phase. The function of these documents is to reduce the degree of uncertainty and consider all the surrounding factors of Project Design studied.

The Schematic Design Phase includes as a deliverable the feasibility study, which analyzes the technical-economic feasibility of the construction of the dam in "Ribera de Rebordãos" as a system for crops irrigation and, as a complementary objective, the production of electricity [6]. The evaluation of the availability of the hydric resources, in terms of quantifying the daily average flow and the maximum flow, was done, due to the high costs and the complexity of their implementation in the area, by extrapolation of a similar basin. Once the technical study was finished, it was undertaken the economic analysis, to ensure the profitable production of electricity, in terms of costs of execution, maintenance and especially the return period of the investment, obtaining positive feedback.

The following table 1 briefly describes all the consulted documents in the Schematic Design phase.

Table 1: Results of the documentation reviewed in the Schematic Design Phase.

| DOCUMENT | MAIN CONTENT | DOUBTS AND PROBLEMS ABOUT THE DOCUMENT DESCRIPTION |
|---|---|---|
| FEASIBILITY STUDY | Technical and economic analysis and evaluation of the hydric resources availability | A1- Exist any document that has been considered and that conditioned the technical solutions submitted?<br><br>A2- Was it elaborated a Work Breakdown Structure (WBS)?<br><br>A3 - What is the estimated budget of the construction works?<br><br>A4 - Was it necessary to undertake a Project Design review during the Schematic Design Phase?<br><br>A5- What was the deadline to deliver the Schematic Design Phase?<br><br>A6- What was the established criteria by the Owner of the work to proceed with the completion of the Schematic Design Phase and the transition to the Design Development Phase? |

The other phase, related to the Construction Document Phase is based on the geological, geotechnical and hydrogeological study, topographic study, observation plan, Environmental Impact Assessment (EIA), Internal Emergency Response Plan (IERP).

The geological-geotechnical-hydrological study characterized the rock mass that will serve as a foundation of the projected dam by mechanical rotation soundings with sample collection and permeability tests. The analysis could be done thanks to the installation of rainfall stations in strategic points of the basin.

Defining the topography of the area was crucial to set a base for the implementation of the dam, its basin, the ducts for the cargo chamber and watering. The data was collected with precision GPS equipment and tablet pc by means of visual inspection of the elements in the field.

The observation plan offers a safety control during the initialization, the first exploration period, usually 5 years, and the subsequent exploration periods. This plan requires the availability of several sources of information such as visual inspection and installation of observation devices, frequent readings of the observation devices. Telecommunication facilities were planned to be installed in the dam allowing remote control.

The purpose of the EIA was to characterize the state of the environment in the area, as well as to evaluate the possible positive and negative impacts resulting from the construction, exploration and

deactivation phases of the project, like the underground hydric resources, surface water resources, noise production, flora and fauna, economic and social issues or landscape. The analysis of the impacts allowed to verify that the project does not present significant impacts, adopting minimization measures to reduce the impacts identified.

The Intern Emergency Plan develops the contingency plans that prevent, monitor and respond to any emergency in the dam, to protect the lives and property of the people living in the downstream valleys. The study of a situation based on the breakdown of the irrigation dam led to the development of an accident protocol including the alert and warning systems to alert the population and the authorities.

The following table 2 briefly describes all documents consulted in that Construction Document Phase.

Table 2: Results of the documentation reviewed in the Construction Document Phase.

| DOCUMENT | MAIN CONTENT | DOUBTS AND PROBLEMS ABOUT THE DOCUMENT DESCRIPTION |
|---|---|---|
| GEOLOGICAL-GEOTECHNICAL-HYDROLOGICAL STUDY | Characterization of the area rock mass | B1- What was the content of the contract dossier?<br><br>B2- What was the deadline to deliver the Construction Document Phase?<br><br>B3- What was the established criteria by the Owner of the work to proceed with the completion of the Construction Document Phase and the transition to the Project Closeout Phase? |
| TOPOGRAPHIC STUDY | Topographic definition of the ground as base for the implementation of the dam. | |
| OBSERVATION PLAN | Safety control during the initialization and the exploration period. | |
| ENVIRONMENTAL IMPACT ASSESSMENT | Characterization of the state of the environment in the area, in terms of risks and impacts. | |
| THE INTERN EMERGENCY PLAN | Contingency plan development to prevent, monitor and respond. | |

By undertaking only the Schematic Design Phase and Construction Document Phase, there are some details related to all document elaboration process, their deadlines and the acceptance decisions that cannot be approached exclusively through the documentary consultation, being necessary to resort to other research methods to get more detailed results. Even, these 2 different phases developed do not clarify all the process of project design irrigation dam development [7].

### 3.2. Results of the Project design interview development

Since the Project Design did not develop all the phases, not all the questions of the interview could be answered, giving a response only to the questions related to the Project framework and the Schematic Design Phase and the Construction Document Phase.
This aspect did not allow to conclude some information about all different phases in project design as expected in the start point of this research.

On the other hand, the questions that were answered, allowed to gather extra information that led to a deeper approach to the Project Design that was not the main objective of the interview, like technical information or environmental considerations. Thus, the information had to be qualitatively shorted in order to remain with information related to the topic of the research.

The following table described in brief some interview questions and answers given by the project designer of the irrigation dam studied.

Table 3: Unknowns resolution by the interviewer

| QUESTION CODE | PRINCIPAL CONTENTS DESCRIPTION BY THE INTERVIEWER |
|---|---|
| A1 | No, there were not special restrains that conditioned the technical solution. |
| A2 | Yes, but only in the Construction Document Phase. |
| A3 | Approx. 3.600.000€. |
| A4 | Not necessary, because it is not included in Class 5 activities. |
| A5 | 3-6 Months. |
| A6 | Prove of Feasibility |
| B1 | Geological Study, Geotechnical Study, Hydrogeological Study, Topographic Study, Observation Plan, EIA, IERP |
| B2 | > 6 Months |
| B3 | The considered criteria by the promoter. |

## 4. DISCUSSION RESULTS

### 4.1. General results

The questionnaire of this research, given the conditionings of the Project, only explains a particular life cycle of a dam construction Project Design, showing the timings and deadlines of all the processes involved, and where the delays and errors may occur. But it does not attach to the theoretical structure that it should contain. Thus, this questionnaire only solved the unknowns of the Schematic Design Phase and Construction Document Phase, but not the unknowns of the rest of the life cycle phases.

In general, the interviewer answered and gave answers related to:

- The explanation of the removal of some of the phases of the Project Design.
- The document's content of the deliverables that should be included to move on to the following Project Design phases.
- Deadlines to deliver the documents and do the transition to the next phase.

The information-gathering method of the case study, turned out to be a useful way to complete and increase the information about a given topic, allowing a direct approach thanks to the interaction with the people involved in the construction Project Design. Nevertheless, having access only to one Project Design, which is not the most positive situation, makes the information collecting method, not the most suitable one, reaching a greater value when there is a higher number of samples. In any case, the life cycle of a real Project Design and how the content of the documents deliverables was managed could be refuted.

### 4.2. Research objectives analysis

Regulations and technical specifications are irrefutable sources of information. They must be taken into direct consideration in any research. However, in real situations, the standard structure can be modified according to the conditionings and particularities of each Project Design, giving for example, more relevance to the last phases because they concentrate the core of the documents deliverables, licensing requirements and Project Design regulation constraints [8].

The single case study applied in this research was not enough to refute the life cycle of the Project Design, because the Rebordãos Project Design consisted only in the Schematic Design Phase and the Construction Document Phase.

The conclusion about the interview process is that the more people interviewed, more points of view can be analyzed, despite the subjectivity implicit in their opinions, which requires a post-treatment of that information to separate the unreliable and the trustable information. Thus, and considering the initial objectives of this research, can be concluded that the objective number 1, based on recognizing and catching accordingly with current regulations, and also on bibliographical review, the Project Design management life-cycle from the conception to the closeout, considering the particularities of the different stages, was not accomplished. The main reason is that bibliographic review itself cannot be considered as the unique source of information, given the wide number of authors and information subjectivity. It is necessary to look for other information-gathering methods in order to complement and check the available information.

The objective number 2, based on the explanation of the development of a real case study, based on an irrigation dam project design, located in Bragança (Portugal) was satisfied. This accomplishment could be possible thanks to the existence in Portugal of an irrigation dam construction project in progress, the dam in "Ribeira de Rebordãos", and the access to the Project Design from the design company. For that, the content of the documents contributed succinctly to figure out the structure that they should present, in terms of deliverables and stakeholders, to meet the requirements and to be accepted to make the transition to the next Project Design phase. On the other hand, the content of the documents lacks information related to the deadlines to submit the deliverables and the responsibilities of the stakeholders in each one of the phases.

Lastly, the objective number 3, to understand the differences between a theoretical Project Design management developed according to the current regulation and a real case of a Project Design, could not being accomplished due to the fact that the irrigation dam in "Ribeira de Rebordãos" only was submitted in two of the phases of a theoretical life cycle of a Project Design, turned out impossible to make a trustable comparison. Thus, it is necessary to collect information from more case studies or to apply a different gathering-information method more specific.

## 5. CONCLUSIONS

This last chapter aims to present the final conclusions about the research that has been undertaken. There are some restraints in this research that made not possible to fully accomplish the objectives, such as, the few constructions of dams in order to complement and add information about the topic and, as a consequence, the number of participants in the interview process [9].
This research was intended to serve as a baseline in order to understand all the framework of a complete construction Project Design management.

The following research contributions can be related:

- The current regulation is brought up in this work, regarding the phases that the Project Design must contain, the duties of the stakeholders, as well as the documents that are required, when they should be submitted and by who.

- To understand the basis of some decisions, documents and processes that allow the transition to subsequent phases of the Project Design.

As a solution to improve the results of this research, the range of study can be extended to other kind of construction projects, besides the construction of dams, which is a highly limited kind of project, in order to have access to more case studies and, thus, extend the information about the process and management of other kind of Project Designs.

Moreover, it can be developed a support guide to develop this kind of Project Designs, with higher complexity than the building construction Project Designs. In addition, it would be helpful to this research, to further detail the decisions and status of the documents that allow the passage to subsequent phases.

## 6. ACKNOWLEDGMENTS

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## 7. BIBLIOGRAPHY

[1]Architects, Royal Institute of British. BIM Overlay to the RIBA Outline Plan of Work. RIBA Publishing. 2012.

[2]Kothari, C. Research Methodology. Methods and Techniques. New Age International Publ. 2004.

[3]University, W. M. (n.d.). Design Phase. https://wmich.edu/facilities/design-phase (acc: June 2019).

[4]Esquirol-Caussa, J., Sanchez-Aldeger, J., & Dalmau Santamaria, I. A bibliographical review: the basis of our research. Physiotherapy Updates; 2017.

[5]Yin, R. K. Case Study Research. Design and Methods. Sage. 2003.

[6]Basias, N., & Pollalis, Y.Review of Integrative Business & Economics Research. GMP. 2018.

[7]Benbasar, I., Goldstein, D., & Mead, M. The Case Research Strategy in Studies of Information Systems. MIS Quarterly. 1987.

[8]J. Smith, N. (2002). Engineering Project Management. Blackwell Science Ltd. 2002.

[9]Gerard Whelton, M. The Development of Puropose in the Project Definition Phase of Construction Projects. University of California, Berkeley. 2004.