

Promotion of Risk Management in the “Água Doce” Program Based On The PMBOK®

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Abstract From the 1990s onwards, the installation of desalination equipment using reverse osmosis membranes in the wells of the semi-arid region of Brazil began to provide drinking water to communities in this area. Currently, this process is being used by the federal government Program named “Água Doce”, with an investment of approximately R\$ 252 million. Thus, the fundamental question answered in this paper is: What are the main risks to which the Água Doce Program of the State of Bahia is exposed and which should be treated with the highest priority? The PMBOK® 6th ed. was used as a guide to support the methodology of this work. In practical terms, the main contributions of this research are: a) A proposal for a risk methodology aimed at the scenario of the Água Doce Program in the state of Bahia; b) Development of an Analytical Risk Structure for the Program; c) Survey of a list of 36 risks, categorized and ranked according to the urgency of their treatments. As a recommendation for future research, it is suggested to develop plans to deal with these risks, monitor the identified risks, monitor residual risks, identify new risks and evaluate the effectiveness of the risk process throughout the project.

Keywords: Keywords: Risk Management 1; PMI 2; Reverse Osmosis 3.

1. Introduction

The high level of salinity found in groundwater in a large part of the semi-arid region in Northeastern Brazil demands its removal to make it suitable for human supply. In this sense, from the 90's onwards, the installation of desalination equipment using osmosis membranes began (BRASIL, 2012).

Currently, this process is being used by the Federal Government Program “Água Doce”, object of this study. Its objective is to provide subsidies for a public policy of perennial access to drinking water for diffuse communities in this region. Developed by the federal government of Brazil, it aims to implement a total of 1357 reverse osmosis plants in the semi-arid region by 2020, totaling an investment of approximately R\$ 252 million (BRASIL, 2012). The state of Bahia received the largest capital contribution of the Program, approximately R\$ 62 million, until 2020 (BRASIL, 2012). However, the volume of resources from the Ministry of the Environment has not yet been sufficient to meet the demand in the semi-arid region and, thus, a new contribution of R\$ 158 million is expected in 2020, to serve another 200 locations in Brazil (BRASIL, 2019).

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The Program “Água Doce” was conceived and elaborated from the Program “Água Boa”, its predecessor, which did not use management tools to guarantee the achievement of its objectives, therefore it was not efficiently structured in its planning and execution. This lack of management resulted in risks that culminated in the discontinuity of the Program (BRASIL, 2001).

The managerial differences between the Program “Água Doce” and Program “Água Boa” were the creation of a Base Document and an integrated management system. The document describes the entire planning, objectives and justifications of the Program, being published in 2012. The management is done through SICONV - System of Management of Agreements and Contracts, where they are defined, budgets, deadlines, planning of the stages of the project and controls during its execution (MMA, 2012; SICONV, 2017).

Even with the application of a project management scheme, the complexity of the “Água Doce” Program, requires a risk management approach. This complexity is due to two main factors: I) several governmental levels are involved, since it was developed by the federal government, coordinated by the Ministry of the Environment (MMA) and executed in partnership with several federal, state, municipal and civil society institutions; II) The systems are delivered to the communities, after being implemented, to be managed by them. This fact is complex, since the continuity of treated water supply still depends on several factors, such as: commitment to management, the need for technical knowledge to operate and maintain this equipment, the economy to manage the cash generated from the collection of desalinated water, and the commitment of the municipal government to support this community with the Program (BRASIL, 2012).

However, even with the complex scenario surrounding this Program, no form of systematization was observed to survey, classify, analyze and treat the risks to which the Program is susceptible, through preliminary studies to this work, on the Água Doce Program in Bahia. A risk approach to the project management has not been applied.

One of the main diffusers of project management practices is PMI - Project Management Institute. PMI has developed a guide with a set of knowledge in project management, the PMBOK® Guide (Project Management Body of Knowledge). It works as a basis that orientates, but does not determine, the creation of methodologies, policies, procedures, guidelines, tools and techniques for project management in organizations. According to this Guide, risk management is fundamental for project or program management, as well as managing integration, scope, time, costs, quality, human resources, communications, acquisitions and stakeholders. This research limited its contribution to the area of risk management, based on the premise that the other areas of management are carried out by the Água Doce Program, as PMI (2016) suggests.

Several studies point out the importance of risk management guided by PMBOK®, such as: Paranhos et al. (2016), Santos and Cabral (2008), Girardi et al. (2018), Miranda (2017). These authors demonstrated the achievement of concrete results of the application of this type of management, such as: Risk Analytical Structure, list of categorized risks, probabilities and impacts and list of action for the mitigation/elimination of these risks. Thus, risk management according to PMI will be adopted in this work.

According to the PMBOK® Guide 6: “risk is an event or an uncertain condition that, if it occurs, has an effect on at least one project objective”. These goals can be influenced both negatively and positively. Thus, the management of these risks aims to increase the probabilities and impacts of positive events and to reduce the probability and impact of negative events (PMI, 2016).

Thus, the fundamental question to be answered in this work is: What are the main risks that the Água Doce Program of the State of Bahia is exposed to and which should be treated as a higher priority?

In this panorama, one can see that there is a gap in the work for risk analysis of projects in the scenario of the Água Doce Program. Therefore, the general objective of this work is to identify the risk scenario in which the program is inserted, so that future work can be developed to deal with these, increasing the probability of achieving the Program's objective of providing continuous drinking water to communities. To achieve this, the following specific objectives are sought: i) to develop a specific methodology based on what the Project Management Institute - PMI indicates and described in its guide PMBOK® 6th ed. through it; ii) to identify; iii) to classify and iv) to order the priority in the treatment of these risks.

The Risk Management Process, defined by the PMBOK® Guide 6th edition, has successive and feedback steps. Based on this flow, Figure 1 was created to represent all steps of this management: planning, identification, analysis, response development, monitoring and risk control of a project. This process must be applied throughout the entire life cycle of a project, that is, it follows the phases, from its planning, execution and control to its completion and closure (PMI, 2016; SILVA & CRISPIM, 2014).



Fig. 1. Risk management process

The steps from the quantitative analysis of Fig. 1. will not be the scope of this study. Nevertheless, the complete process is described for knowledge: identification of corrective actions, development of risk response plans, monitoring of identified risks, monitoring of residual risks, identification of new risks and assessment of the effectiveness of the risk process throughout the project (PMI, 2016; Battistuzzo and Piscopo, 2014).

With PMOBOK® 6° ed, a methodology was developed directed to the scenario of the Água Doce Program, since a specific data collection strategy, Risk Analytical Structure and specific dimensions of impact analysis were developed.

The collection of program data, according to Fig.1, was done through a qualitative methodological strategy, of applied nature with descriptive objective, since it tries to show risk scenarios to the Program, using the following techniques: questionnaires and interviews (Gil, 1994).

The reliability criteria used for this work are based on the parameter definitions of the subjects to participate in the survey, pre-treatment of the questionnaires and interviews collected, and tabulation for analysis of the answers (Gehardt and Tolfo, 2009).

2. Methodology

Data collection:

The study universe was limited to 145 communities covered by the Água Doce Program, in its first stage. The following premises were used to define the sample: Research subjects should be members of the group that manages the system in their community or operates it, be accessible, and in order to contribute to the research.

Because the communities are diffuse within Bahia, it was not possible to visit each community, the questionnaires were applied by telephone and online.

To conduct the interviews, the opportunity for face-to-face meetings was sought. Thus, these were carried out during the following meetings: Visit to the municipality of Uauá in May 2017; II State Meeting of the Água Doce Program (Salvador, April 26, 2017); III State Meeting of the Water Program (Feira de Santana, held on May 17 and 18, 2018); VII National Meeting of the Água Doce Program (Salvador, held on November 27 and 28, 2018).

Data processing

Pre-analysis - analysis to check the quality of the materials answered: out of the 50 questionnaires received, 29 questionnaires were discarded due to gaps in the answers. Therefore, 21 were analysed. Of the 25 interviews, 7 were discarded due to gaps in knowledge of the interviewed subjects and thus 10 were considered in this study. Thus, 31 materials went to the data processing stage.

Data processing - systematization of interview and questionnaire responses: The answers were placed in a spreadsheet, where the analysis of content was carried out, through the thematic analysis about the failures of the systems, periodicity of these failures, their possible causes and consequences

Risk Identification and Analytical Structure

After the survey of risks and for their detailed categorization, a Risk Analytical Framework was developed, schematized according to Figure 2. The purpose of this framework is to facilitate the direction of actions for the treatment of risks. This structure was divided into three levels or subcategories, the 1st and 2nd levels were extracted from the PMBOK® 6th edition. For the construction of the 3rd level we used information gathered from questionnaires, statements and analysis of documentation of the Program.

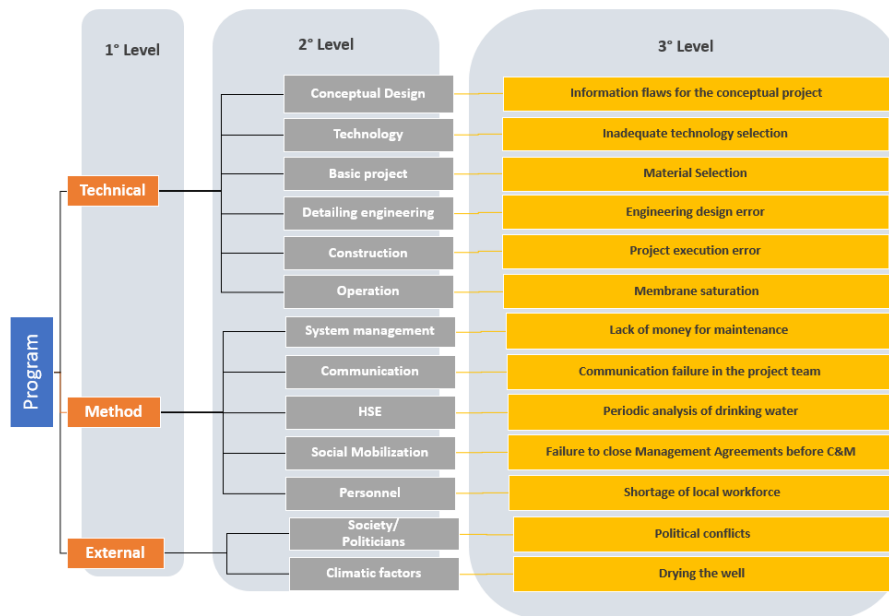


Fig. 1. Risk Analytical Structure of the “Água Doce” Program in Bahia.

After the construction of the Risk Analytical Framework, the root causes and effects of the identified risks were determined, based on all questions answered and testimonials.

The prioritization in the treatment of risks, according to this methodology, should occur using combinations between the probability of an event occurring and the impact of its consequences. Thus, the next step performed was qualitative risk analysis, which is composed by: (a) assessment of probabilities and impacts; (b) application of the severity matrix and classification of risks (PMI, 2016).

Likelihood of occurrence (P)

For the determination of Probability (P), an analysis was made of the periodicity that the risks under study appeared in the tabulated data and then classified according to Table 1, which was adapted with data from PMBOK® (2016) and Pironte (2018).

Table 1. Auxiliary matrix for determining the probability of occurrence

Classification	P	Description
Very low	0,10	Extraordinary event, with no history of occurrences.
Low	0,30	Not likely. It may occur at some point.
Medium	0,50	Possible. It must occur at some point.
High	0,70	Usual event with a widely known history.
Very high	0,90	Repetitive and constant event

Impact (I)

In this case, in order to calculate the Impact (I), the matrix exposed in Table 2 was developed, considering the categories that can cause impact on the objectives of the Program “Água Doce Bahia“. Thus, impact on the scope and quality of the projects, operation and maintenance costs of the system, water supply and Health, Safety and Environment (HSE) were considered. The impact values and their classification were adopted from the PMBOK Guide 6^a. Ed, as well as the degree of the Scope/Quality, Cost and HSE

categories. The description of the degree of impact on desalination plants production was developed according to the first stage of this work.

Table 2. Auxiliary matrix for determining the severity of risk on PAD

Risk impact category					
I	Value	Scope / Quality	Cost	Production	HSE
Very low	0,05	Almost imperceptible change.	Minor change in cost	Stop <24 hours	Increase or reduction in negligible impacts.
Low	0,1	Only minor areas or more demanding applications are affected / benefited.	Cost change <5%	Stop> 24 h and <48 h	Increase or reduction of low relevance impacts.
Medium	0,2	Modification of impact on end user / customer approval.	Cost change <5 - 10%	Stop> 48h and <120h	Increase or reduction of relevant impacts or risk to people.
High	0,4	Modification of great impact for the customer.	Cost change <10 - 20%	Stop> 120 h and <360 h	Increase or reduction of important impacts or personal accidents.
Very high	0,8	Changes that imply revision of the project's strategy.	Modification cost> 20%	Stop> 360 h	Increased or reduced material losses / major environmental impacts

Risk Matrix

The risk matrix is developed by multiplying the probability (P) and impact (I) weights, resulting in what PMBOK 6th ed. calls risk severity. After this calculation, the classification of each risk is located in the matrix (Table 3). The Green area represents low priority risks, yellow area moderate priority risks and red area high priority risks (PMI, 2016).

Table 3. Risk Matrix

Probability	Impact				
	0,05	0,1	0,2	0,4	0,8
0,9	0,05	0,09	0,18	0,36	0,72
0,7	0,04	0,07	0,14	0,28	0,56
0,5	0,03	0,05	0,10	0,20	0,40
0,3	0,02	0,03	0,06	0,12	0,24
0,1	0,01	0,01	0,02	0,04	0,08

The results were displayed in a table, as shown the model presented in Table 4, adapted from Pironte (2018), is usually used in the application of qualitative analysis of risk management. The application of this Table provides a systematic view of the relationship between risk and its category (levels), root cause and effects. As well as probability, impact and ranking or order of prioritization.

Table 4. Adapted model used for qualitative analysis of risk registration

1 st level	2 nd level	3 rd level	Root Cause	Event	Effects	PxI	Ranking	Order

3. Results and Discussion

Due to the great difficulty in contacting the members of the communities to be interviewed in the rural area of the semi-arid region of Bahia, the rotation of members of the managing nucleus and mainly of operators, it was possible, during the period of construction of this work, to carry out 31 interviews that represent 21.38% of the systems.

Table 5 was developed as a result of this study, which is shown here to demonstrate the visualization of the system resulting from the application of Risk Management and for this reason exposes only 3 risks. This table allowed the analysis of the 36 risks raised, of which 17 are of high exposure, concentrated in: (a) technical related to the operation of the system; (b) methodological related to maintenance of desalination plants and identification / definition of limits of responsibility among the parties involved. The classifications come from several sources, which would not be systematized without the application of Risk Management.

Table 5. Results of the qualitative analysis of the 3 main risks of the “Água Doce Bahia“ Program

1 st level	2 nd level	3 rd level	Root Cause	Event	Effects	PxI	Ranking	Order
Method	HSE	Failure to perform periodic analysis of desalinated water	Failure to identify / define limits of responsibilities among the parties involved	Inappropriate water consumption	Occurrence of disease outbreaks	Very high	0,72	1
Technical	Operation	Failure to execute work routines	Technical ignorance	Inadequate system operation	Water supply failure	Very high	0,56	2
Technical	Operation	Inadequate operating frequency	Operator availability / water demand	Pump bearing incrustations	System shutdown	Very high	0,58	3

After the qualitative analysis of the risks (according to Table 5), the results were compiled into graphs, discussing the risks according to their classifications in the levels and sub-levels of the Risk Analytical Framework. Thus, considering the total risks raised, 16 were classified as high exposure, or severity (PxI > 0.18), 17 as medium severity and 3 as low severity, as shown in the graph of Figure 3.

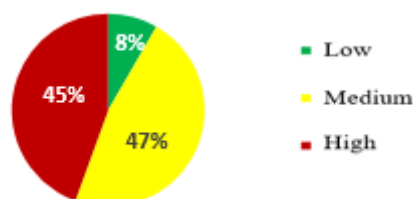


Fig. 3. Severity of risks

The risks identified were in their majority (52%) classified as risks related to the management factors to which the Program is inserted. Technical risks come in second place (38%) and external risks in third place (10%), as shown in Figure 4.

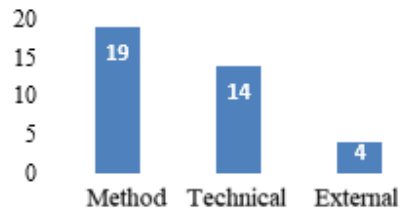


Fig. 4. Risk classification according to level 1

The risks of the "Methods" category are related to processes of social mobilization, management group, training, material acquisition, etc. Through the analysis of the graphic in Figure 5, it is identified that the risks are concentrated in "people" (26%) and "HSE" (21%).

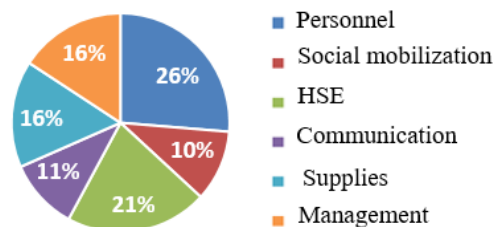


Fig. 5. Distribution of risks related to the Program's management methods

The risks of classification "People" (Figure 5), are related to: local workforce shortage, lack of commitment of personnel, low level of technical qualification of the operator, absence and change of people in management groups, payment or not for consumption of treated water. These facts present as root causes: the scenario of low schooling; some operators can only operate the system when they are absent from their remunerated activities, since not all operators are remunerated to put the system into operation and distribute the water. This fact leads to discouragement and consequent disengagement of the operators and, sometimes, even abandoning of the Program by them.

The risks classified as "HSE" (Figure 5), are related to: negligence in the disinfection of the system for water supply; occurrence of accidents or process incidents; occurrence of accidents or work incidents. Presenting the following root causes: Non-understanding of the importance of this process for the health of water consumers; short circuit/leakage in the containment tank/deficient physical structures/chemicals used incorrectly; unpreparedness of the operator regarding the risks he is exposed to/low perception of the risk. These may promote the following effects: water supply off the potability standards; suspension of desalination plant operation; shock, biological contamination, accident with rotating equipment.

The "technical risks" identified are related to the planning, implementation, operation and maintenance factors of the desalination plants, such as: conceptual, basic design, construction and assembly, among others (Figure 6).

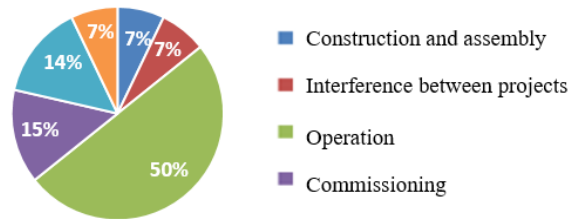


Fig. 6. Distribution of risks related to the techniques applied in the Program.

The concentration of technical risks occurs during system operation (50%) (Figure 6). These risks present as main impacts: failure in the execution of work routines, inadequate operation frequency, and loss of operational performance. In general, the root causes of these risks are due to the technical ignorance of the designer or operator, failure to control variables such as pressure and flow, failure to execute the backwash of the desalination plant, incompatibility of materials. These causes lead to potential system downtime events due to failures in the pump bearings and the formation of fouling by precipitated salts or microorganisms under the membrane.

The "external" risks identified are related to climatic, social and/or political factors (Figure 7). This one presents as root causes: political conflicts (national, state or municipal), lack of consumption of desalinated water due to pre-conceived impressions of the community about its intake or lack of awareness about the quality of desalinated water compared to other sources, such as cisterns. The most significant climatic effect concerns the drying of the well with the desalination plant, with the root cause being the sizing of the system incompatible with the maximum raw water flow.

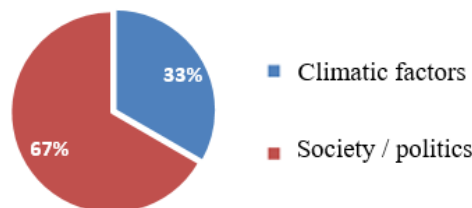


Fig. 7. Distribution of risks external to the Program

The PMBOK® Guide supported the use of tools that enabled the survey and discussion of the exposed risks scenario. The degree of complexity in which the Água Doce Program is inserted is reinforced through the results that it demonstrates, the technical (desalination), social (community) and political relations (national, state and local management groups). This is due to the use of reverse osmosis desalinators in semi-arid communities that, through a management agreement, are responsible for the management of the system (through a local management group), together with the needs of articulations between all institutions involved in the model of management adopted by the Program, sufficiently for implementation, monitoring and support for the continuity of the Program.

4. Conclusion

The accomplishment of this work made it possible to answer the question: what are the main risks that the Água Doce Program of the State of Bahia is exposed to and which ones should be treated with more priority. Supporting to cover the lack of studies on this topic in the Program scenario. In practical terms, the main contributions of this research are:

- a) The proposal for a risk methodology aimed at the scenario of the Água Doce Program in the state of Bahia;

- b) Development of an Analytical Risk Structure for the Program;
- c) Survey of a list of 36 risks, categorized and ranked according to the urgency of their dealings;
- d) Presentation of useful information that serves as a basis for analysis of deals and quantitative analyzes of risks such as failure tree, etc.

The limitations found during the development of this research were compounded by the amount of data collected, resulting from the impossibility of going to each community, since they are located in a rural area and are very distant from each other, due to the difficulty of contact with members of the group. manager, and the low contribution of those who got in touch. Thus, 50 questionnaires and 25 interviews were collected, but only 31 of these were considered to guarantee the reliability of the study. Thus, it is not possible to ensure the representativeness of the results for all installed systems. The research strategy did not seek to generalize the results, but to present a methodology that systematizes wealth management for the Program and the risk scenarios to which it is inserted. Thus, it is hoped that this research may pave the way for new studies on the subject addressed.

From this observation, the following recommendation for future research complementary to the risk management of the Água Doce Program emerges: it is suggested to deepen discussions on each risk factor linked to the Program, investigate its impacts, developing plans to address these risks, monitoring the risks identified, monitoring residual risks, identifying new risks and assessing the effectiveness of the risk process throughout the project.

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