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The financial and legal feasibility of a desalination project

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HIGHLIGHTS

- Desalination plant projects from three countries with a significant development of the sector are studied.
- The public sector involvement in the project is of great importance for the feasibility of the project.
- The form of public sector involvement also has an important impact on the feasibility of the project.
- The feasibility of a desalination project is closely related to the way and the intensity of the government involvement.

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ABSTRACT

There is an extensive bibliography that analyses the structure of a desalination project from the perspective of chemical engineering, but there is another "engineering" that has been much less studied, which is just as decisive for the plant to be able to operate. The aim of this work is to analyse the economic and legal factors that condition the proper operation of a project and, to this end, we will place special emphasis on the usual agents and contractual agreements. We intend to arrive at a general model of operation that we will construct from the study of three particular cases: Algeria, Tunisia and Egypt. These three countries represent different ways of structuring a project, with the involvement of the public sector being the main element that varies between them.

1. Introduction

Desalination is already a consolidated technology in countries such as Spain where, in the medium term, it will not be necessary to build large-scale plants [1]. The next improvements in terms of economic efficiency are expected from energy solutions (especially renewable sources) that lower the cost of the process [2]. The experience gained, as well as the exhaustion of national demand and the consolidated technology, have resulted in a strong process of construction of desalination plants by Spanish companies in a large number of countries with water scarcity problems [3]. Some countries with severe water scarcity are carrying out an extraordinary effort in investment and also, in some cases, research through dedicated desalination centres such as the Center of Excellence in Desalination Technology (CEDT) at King Abdulaziz University, Jeddah, Saudi Arabia [4]. Desalination is an essential technology when water demand exceeds available resources, as could be the case in Saudi Arabia, Tunisia, Algeria or Egypt, among others [5–7]. The global product is fairly homogeneous and moderate[1] reductions in economic and energy costs are still expected [8]. Moreover, technological advances in renewable energies produce potential synergies [9] that have aroused the recent interest of many researchers. The purpose of this paper is not to analyse the technical characteristics of a desalination plant where, by the way, there is a great homogeneity. What we want to study is the degree of economic differences that can occur in projects carried out in different countries as a result of the contractual articulation of the project, the costs of financing, the performance of the public sector and the costs of energy and distribution [10]. Some destinations, as is the case in Chile with the BICE bank's Project Finance [11], are relatively easy, but others show difficulties, as for example in Jordan, where it is necessary to have a local partner [11]. Sometimes the differences between markets go beyond the national level, for example, in Israel the European Investment Bank is going to finance the construction of one of the largest plants in the world [12]. Project financing is an essential element that can make a difference even more than the technology itself and, thus, two key determinants of the ease or difficulty of making the project bankable are the risk and the size of the project [13]. After having studied different desalination projects in various destinations, the purpose of this article is none other than to

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[1] Cost reductions that are not of the magnitude that have occurred in the last decades.

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learn about the agents and contractual agreements that appear in a desalination project. The documentary basis for the elaboration of this work is based on the observation of the original contractual documents provided to us by valuable primary sources.

Water resources are a basic human need and are of vital importance for the environment, which is why minimum levels for society and the environment must be guaranteed. At the same time, water resources are scarce and must therefore be managed in an economically efficient way [14–17]. In this article we are going to analyse how the financing of a desalination project is carried out, with special emphasis on the process that takes place from the time the company enters the bidding process until the financial closure of the operation takes place. We will describe the different forms of organisation that can be used for the economic operation of the project, from the creation of Project Companies in which the State participates directly with part of the shares to private systems in which the public sector is not present. There are three types of organisational models: private, public and mixed, but a generic structure can be drawn from them. The different financing structures that we are going to analyse are built with the aim of making the project viable in economic terms, so that these organisational formats largely answer the question we are trying to answer — What conditions are necessary for a desalination project to be economically viable[2]?

As we will see below in the different models, the key is in the guarantees that secure the credit needed to build and maintain the plant. As long as the bank or financing institution is guaranteed to be able to recover its money, the project will be eligible for funding. One way in which such a guarantee can be provided is through a government guarantee, but there are some nuances here. One of them is that governments often do not directly guarantee the project, but a public entity to which they delegate does, although this entity does not always have sufficient financial capacity to guarantee the financing of the project.[3] In the event that the entity providing security for the project does not have sufficient capacity to do so, the banks or the financiers will require another security with a higher guarantee. In this situation, the State may appoint another institution with greater financial capacity as guarantor.[4] Generally, the activity is carried out through a non-recourse project, i.e., the promoter does not have to provide its own guarantee. Since the developer does not provide guarantees, the bank will require the State to provide them, while the developer also needs a guarantee that the sale of the water will be properly remunerated, which will be done through the *take or pay* contract,[5] on the basis of which a minimum amount of water must be paid for even if they do not need it. We are going to analyse how the pieces of the puzzle of financing a desalination project fit together based on three projects carried out in Algeria, Tunisia and Egypt. This type of analysis is novel and draws on precise information from three very interesting case studies, thus taking into account many aspects and making it possible to formulate a general model while highlighting some particularities. This accurate information comes directly from industry players, who have been very helpful in providing high quality details, and gives this work a unique character. Thus, the following section will briefly discuss the three case studies used, then the general model obtained will be presented and, finally, the conclusions reached will be presented.

2. Three distinct funding models: Algeria, Egypt and Tunisia

Algeria, Egypt and Tunisia are three of the main markets for Spanish desalination companies [3]. In the different countries where desalination is used, there are different ways of understanding the optimal management of water resources and this fact, together with political and economic differences, means that the degree of government involvement in a desalination project is somewhat heterogeneous. On the other hand, there are also clear differences in the way water resources produced are distributed, with greater or lesser weight given to market allocation mechanisms [18]. The reason for analysing these three cases is that they represent three different models in terms of the structure that allows the plant to operate economically.[6] Based on these clearly differentiated models, we intend to describe the general structure through which the economic operation of a desalination project is articulated. The cases of Algeria and Tunisia represent two extremes because in the Algerian case the public sector is present in the shareholding and decision making of the Project Company while in the case of Tunisia the public sector is not part of the project company.[7] The Egyptian case is an intermediate option between them, as the public sector has a presence in the Project Company but is not present in the shareholding of this Company. We will therefore analyse the differences between the three projects. In addition to the specific differences mentioned above, it should be noted that projects are generally subject to the legislation of the country in which they are carried out [19] (pp. 10 “Loi applicable”).

2.1. The case of Algeria

Algeria is one of the countries with the greatest demand for desalination and, as they do not have technicians or companies with experience in this sector, they have commissioned foreign companies (most of them Spanish) to build and operate several plants. As of 2020, Algeria has in operation 80 dams, 11 desalination plants, 21 water transfers, 177 water treatment plants and 23 demineralisation stations [20].

The main difference between the Algerian case and other cases in which the state is involved is that the role of the public sector has not been limited to guaranteeing the viability of the project through contractual agreements and the purchase of water. In the case of Algeria, the public sector is part of the Project Company, which has a mixed character [21]. A similar case of public sector involvement can be found in Spain with the plants carried out by the public company Acuamed. Acuamed has 12 desalination plants in operation in Spain with an investment of more than 1.7 billion euros (it should be noted that a third of the resources of this public company come from European funds). Among the company's plants, the most important are Valdelentico (Murcia), Águilas/Guadalentín (Murcia), Carboneras (Almería), El Atabal and Marbella (Málaga), Torrevieja (Alicante), Mutxamel/El Campello (Alicante), Sagunto (Valencia) and Moncofa (Castellón), Oropesa (Castellón) and Campo de Dalías (Almería) [22]. In Algeria, the state has a 49% share in the desalination project. This contribution allows him to participate in important decisions about the desalination plant, but the technologist has a sufficient majority for routine decisions. The Algerian state participates in the project through the public company AEC (Algerian Energy Company). Therefore, the project company

[2] We will understand that a project is economically viable as long as banks or other public or private entities are willing to finance it. This is a necessary condition for the project to be carried out.

[3] In this respect, we will see the case where the Tunisian company SONEDE initially presented itself as a guarantor, being its financial capacity insufficient to provide the necessary level of guarantee.

[4] This situation has arisen in the Algerian case, where the company SONATRACH acts as a guarantor without having a role in the project beyond providing guarantees.

[5] The *Take or Pay* contract is a firm purchase contract whereby the buyer has to pay for the product. In this case, the water produced by the plant must be paid even if it will not be consumed in the end.

[6] It should be noted that there may also be differences in the financing structure of projects depending on other variables such as the country's culture or political organisation, among other factors.

[7] It should be noted that a priori the intention of the public authority is always to be present or to control as much as possible a project that is going to be in charge of producing drinking water, however, there may be financial limitations to this will.

is made up of the Spanish company and AEC as shown in Fig. 1.

One of the last contracts in Algeria involved a partnership between a Spanish company and a Canadian company, which resulted in the creation of the AWI Ltd. corporation.[8] This corporation makes up the private and international part of the project, while the public part is made up of the company AEC. The company AWI Ltd. is incorporated in Spain, which is why, although it is the result of the association of a Spanish and a Canadian company, we have described it as the Spanish company in the above diagram. It is common for the technology company to be made up of several companies, as was the case in the Algerian Skikda project in which the Spanish part was made up of Befesa, Cobra, Codesa and Sadyt, each with a 25% share [23]. Therefore, from the partnership between AEC and AWI Ltd. the project company is born. This is the first piece of the puzzle; the next fundamental piece is the sale of the water. The company that buys and distributes all the water produced in this plant is ADE (Algérienne Des Eaux). On the other hand, at the time of making the project viable, the problem is that ADE does not have enough financial capital to guarantee its compliance with the water purchase contract. In order to solve this problem of guarantees, the Algerian public company SONATRACH[9] has entered as guarantor of the water purchase contract. This company is dedicated to the commercialisation of hydrocarbons and has sufficient financial capital to guarantee the purchase contract between ADE and the Project Company.[10] This is particularly important as it facilitates the financial viability of the project, since it is a public company interested in the success of the project that will guarantee a significant part of the resources, thus reducing the risk associated with the project. Thus, Algeria's ability to contribute to the project makes it easier to develop both the construction and operation phases of the desalination plant. There are many specific aspects whose development would be too extensive, so the figures included will present the operating schemes with the key aspects. In this sense, the presence of local and external suppliers and the business carried out with other companies should be valued, so there are direct and indirect costs related to the significant number of participants in the project. Finally, there is the missing piece corresponding to the bank or investors, in this case it is the Algerian public bank Popular Credit of Algeria (Crédit Populaire d'Algérie) that finances the project with 80% of the capital.[11] These relations are regulated in the contractual agreement signed by AEC, ADE and GEIDA called "Projet de Dessalement d'Eau de Mer de Beni Saf",

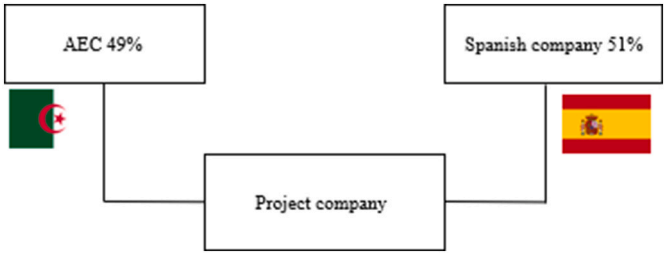

Fig. 1. Distribution of the shares of the Project Company in the Algerian case.

which we were able to access by courtesy of some of the signatory institutions [24]. On the other hand, the terms and duration of each of the contractual relations are another key element that conditions the entire project; in this case, the Framework Agreement signed has a duration of thirty years [25]. In Fig. 2 we can see this information in a schematic form.

In order to expand on the information available on the financial situation of the Algerian project, Table 1 shows the sources of financing and the uses of these funds. On the use side, the situation is clear, with 96% going to the initial investment associated with one of these projects. However, the sources of financing present a completely different situation. As can be seen, own funds amount to 42.1% of the total resources needed, which means that debt must be raised. It is at this point that the involvement of the public sector allows the operating company to guarantee profits. In this case, we are talking about obtaining 57% of the total funds through debt, which means that the operating company assumes a high risk if it does not obtain any guarantee from the public sector. Thus, the public sector's involvement in the project, as in the Algerian case, maintains the financial viability of the project in this situation through avoiding leaving all the risks on the operating company. Moreover, it should be borne in mind that, given the need for heavy initial investment in this type of project, this is a common situation, so that the non-involvement of the public sector can in many cases have a major impact on the project.

In the above diagram we can see which are the agents involved in the case of Algeria, but in this case, it is just as important to know how they relate to each other as it is to know who they are. The framework agreement that regulates the basic conditions for the operation and construction of the plant and the rights and obligations in the project of the Project Company, AEC, ADE and SONATRACH. On the other hand, the partnership agreement regulates the relations between the Spanish promoter-investor, AEC, ADE and the Project Company. One of the most important agreements from the point of view of the objectives of this work is the financing agreement, through which the repayment of the debt will be regulated. Moreover, a direct agreement between the lenders and SONATRACH by which the latter guarantees the payment of the water is also linked to the financial agreement. However, the payment of the water is not 100% guaranteed, the payment of the debt and the shareholder remuneration is guaranteed, but the operating part remains to be guaranteed.[12] Two contractual agreements that appear in Algeria and must be present in all projects are the construction and operation agreements. The purchase of water is formalised through a contract that regulates the purchase-sale relationship between the producer (Project Company) and the distributor (ADE), whose payment is guaranteed by SONATRACH. The use of the land on which the plant is going to be located is regulated by a contract between AEC and the Project Company. It is important to highlight the fact that AEC must own the land or at least have the capacity to assign the land with the real and mortgage rights, as the bank will ask to mortgage the land. Fig. 3 shows a schematic representation of this relationship.

The construction and operation contract is carried out with the developer insofar as it is assumed that the developer is a specialist, has the capacity to build and operate and can provide the guarantee for both contracts. However, for various reasons, the promoter may have to partner with or subcontract specialised companies equipped with the necessary technology for each of the contracts.[13]

It should be noted that the construction and operation contract is signed between the Project Company, an operating company and a

[8] For privacy reasons, as this is sensitive information, we will omit the names of the entities.

[9] SONATRACH stands for "Société Nationale pour la Recherche, la Production, le Transport, la Transformation et la Commercialisation des Hydrocarbures SPA", a joint stock company whose registered office is Djenane El Malik, Hydra, Algiers, Algeria, and which was represented by Mr. Ali Rezaiguia, Executive Director of Finance, under the powers vested in him [35].

[10] In a sense, it can be understood that the state is reinvesting part of the profits obtained from the sale of oil in order to guarantee the project.

[11] This bank has been endowed with capital by the state with part of the profits obtained from oil exports. Once again, we can see the great importance of the profits obtained from oil sales in the financing of the project.

[12] The part that must always be guaranteed is the repayment of the debt to the bank.

[13] In other words, although it is assumed and usual for the developer to carry out the construction of the plant, the developer may subcontract part or all the construction of the plant. However, the responsibility for the proper operation of the plant remains with the developer.

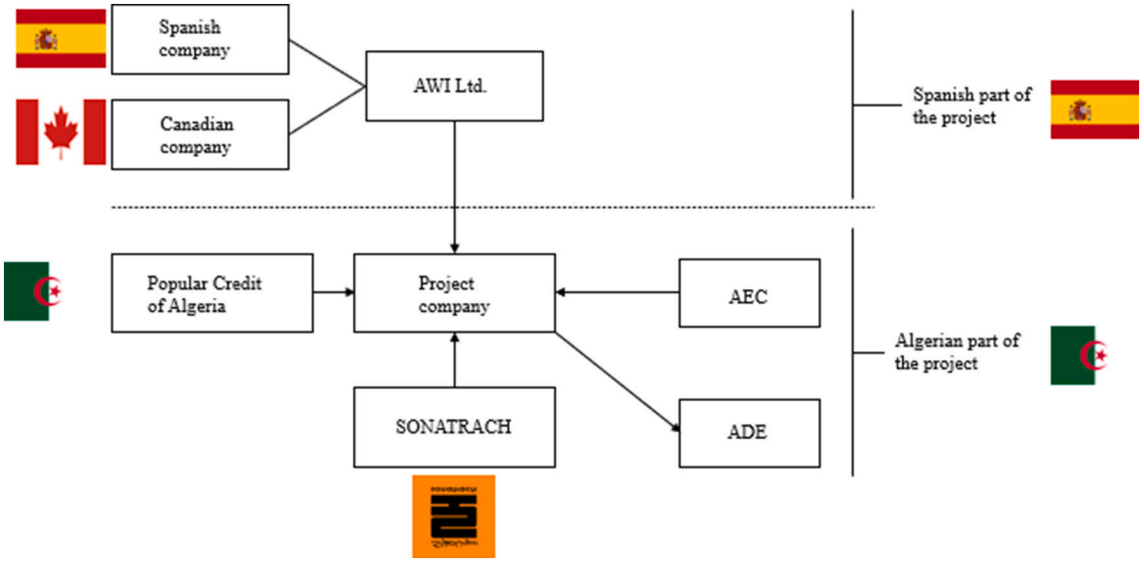

Fig. 2. Companies and entities that are part of the financing structure of the project in the Algerian case.

Table 1
Source and uses of funds during the construction phase (millions €).

Sources of funds		% of total	Uses of funds		% of total
Equity	58.296	10.1	Land	0	0
Subordinate debt	24.984	4.3	E.P.C.	500.106	86.4
Grant	141.844	24.5			
Debt service reserve L/C	18.385	3.2	Working capital	3.126	0.5
Total own funds	243.509	42.1			
			O&M	4.726	0.8
Revenue interim water	5.156	0.9	Financial interest cap.	35.229	6.1
Senior debt			Financial expenses cap.	12.231	2.1
A	139.022	24.0	Cash	185	0.0
B	59.573	10.3	Total investment	555.603	96.0
C	99.297	17.2	Debt service reserve	18.385	3.2
D	32.183	5.6			
E	0	0	Contingency - Variations	4.752	0.8
Total senior debt	330.075	57.0			
Total sources of funds	578.740	100	Total uses of funds	578.740	100

Yellow is the sum total of funds both used and raised. The values with the blue shading sum up to the final result in yellow. The blue colour is the sum of the values without shading colour that are above and before the next blue value.

Source: own elaboration based on official project contracts.

construction company, being the construction company generally the same as the operating company. The corporate purpose of the project company is to establish and operate the plant in order to sell the water and to this end it will manage the construction and operation. All responsibility for construction and operation will be transferred to the company that builds and operates, i.e., the developer, which in our case is the Spanish company. The transfer of all responsibility for the construction and operation of the plant to the developer constitutes a disguised guarantee, the construction "guarantee" ends two years after the plant has been built, so that if everything is working properly at this date it is assumed that any subsequent failure of the plant is not the responsibility of the developer.

We know the main actors and the contracts that link them, but it is also of great importance to know the involvement of each of these actors in the different agreements, as well as their financial participation. AWI Ltd. is the investment company that represents the Spanish part of the company that is carrying out the project in Algeria. It is incorporated in Spain with the capital of the Spanish and Canadian companies with 50% of the investment each, for a total of 18.4 million US dollars. The project company's capital is made up of 20% of own funds (USD 36.1 million) and the remaining 80% corresponds to the debt incurred with Popular Credit of Algeria[14] (USD 144.4 million). This 20% is made up of 51% contributed by AWI Ltd. and 49% contributed by AEC, so AEC's contribution in monetary terms is USD 17.7 million. It follows from the above that the total equity of the project company is USD 180.5 million. The construction of the plant has a total cost of 153.8 million dollars. Once

[14] CREDIT POPULAIRE D'ALGERIE ("CPA"), located at 2, boulevard Colonel Amirouche, Algiers, registered in the commercial register of the wilaya of Algiers under number 99 B 0009292, NIS: 096716010000552, represented by its Chairman and Managing Director, Mr. Mohamed Djellab [36].

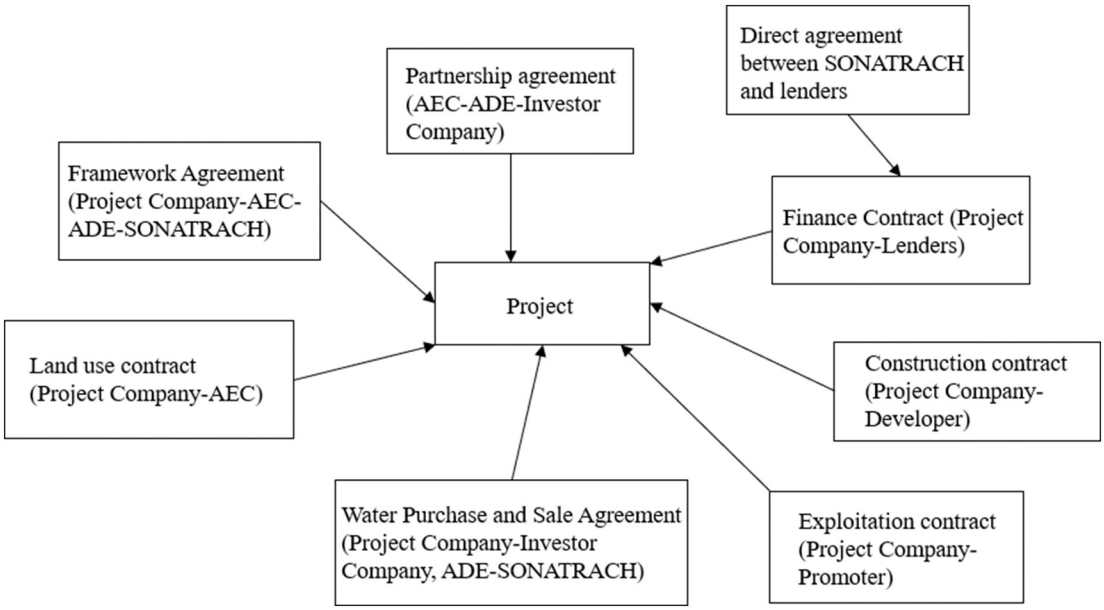

Fig. 3. Contractual arrangements in the Algerian case.

the plant is built, the water purchase and sale contract will be implemented, in which the selling price of the water will be 0.7513 $/m3. In Fig. 4 we can see this information synthesised.

If we carry out an analysis in which the order of contractual relations is less important than the organisation of the market, we can distinguish between demand and supply. The producers of the water are the supply side of this market, these are the Project Company and the investors. The Project Company is in charge of producing the water, while the investors provide the guarantee for the technical part of the project. On the demand side are ADE and SONATRACH. The public company ADE is in charge of buying water from the producers and distributing it to the Algerian population; SONATRACH's role is to provide the financial guarantee that ADE will pay for the water, as ADE's economic capacity is not sufficient to provide such a guarantee. The water purchase and sale contract is the relationship between supply and demand that articulates this entire economic model. Fig. 5 schematizes these relationships.

The general model has two key levels of operation. The first level would be the set of socio-economic agents that make up the project and determine its functioning. The second level is determined by the contractual structure that links and interrelates the actors involved in the project. This general model has the same basic structure in all countries, although nuances in each project can be found in the involvement of the public sector in the project, in the existence of guarantors in the different contracts or in the structure of the project company. Fig. 6 shows the complete structure of one of the desalination projects that has taken place in Algeria.

The peculiarity of this project is that the Algerian public sector is actively involved in it, obtaining part of the economic benefits generated by the project. Regarding the ease with which the project will be financed, this is always a plus as the involvement of the Algerian government gives a greater guarantee to the project. An earlier project in Algeria was financed by US banks. In the project we are analysing here, the banks that were approached in the first place were not Algerian (some of them were Spanish), these banks argued that the contracts and guarantees had to incorporate some modifications in order to be viable. However, the Algerian government did not want to carry out the modifications demanded by the banks, so they provided the Algerian banks with capital from oil profits in order to finance the project through the banks. Finally, consideration should be given to the presence of some aspects that directly affect the financial viability of a project, although they do not involve a structural modification of the operating system. In particular, the payment of customs duties, compliance with the country's tax regulations and the interest to pay for the financing are additional costs that may vary from case to case. The risk associated with the project, which affect the financing conditions, and the tax and trade regulations of each country will have a major impact on the financial success of the project. In the case of Algeria, the payment of customs duties was a major cost, as was the payment of VAT (Value Added Tax). However, this type of payment is unique to each country and, fortunately, it is easy to estimate before the project is carried out by simply consulting the regulations, so its study is an important aspect of the planning.

2.2. *The case of Egypt*

As in the case of Algeria, Egypt is a country that has decided to increase the capacity of non-conventional water resources to cope with scarcity [6]. The Egyptian government identified three key challenges for water supply: financial constraints, institutional challenges, and technical and managerial inefficiencies. With regard to financial problems, it should be noted that in 2003 a deficit of USD 1.2 billion was accumulated for water management, requiring the Egyptian National Investment Bank to invest USD 1.3 billion. Institutional problems include a large number of institutions in the water sector with unclear responsibilities, a lack of coordination between them and an excess of staff due to duplication. The main technical and management problems in the water sector are high water losses, technological mismatch, lack of skilled labour, suboptimal metering and monitoring systems and lack of efficient operation and management systems [26].

Eighty per cent of the Nile water consumed goes to agriculture [27] and, as we know, not every crop can afford the costs of desalinated water. Egypt's growing freshwater supply needs due to population growth and industrial demands, as well as other challenges, require alternative water resources other than Nile River water. Desalination of salt or brackish water is the most suitable option to meet these challenges. The energy required to carry out the desalination process is a challenge due to the higher cost of fossil fuels and their negative environmental impacts. Therefore, renewable energy resources are an alternative source of sustainable energy supply [28]. In Egypt, there is great potential for solar energy in the desalination sector, as it can be used to desalinate brackish water wells located in areas with high amounts of solar radiation [29]. Furthermore, while we will be looking

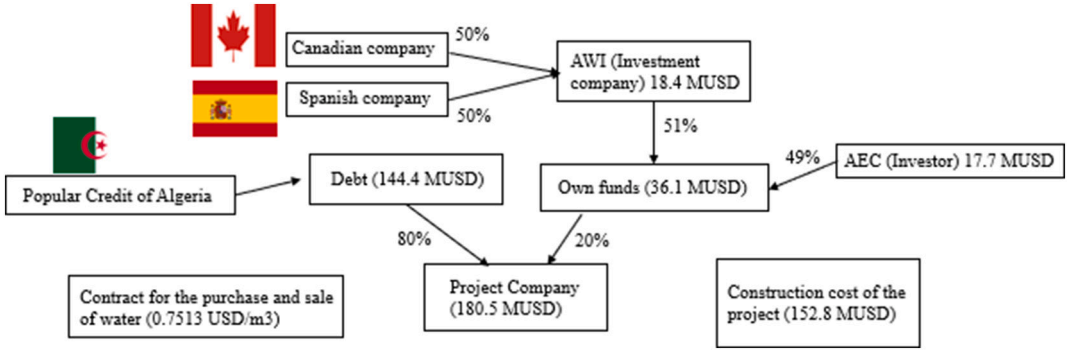

Fig. 4. Project financing in the Algerian case.

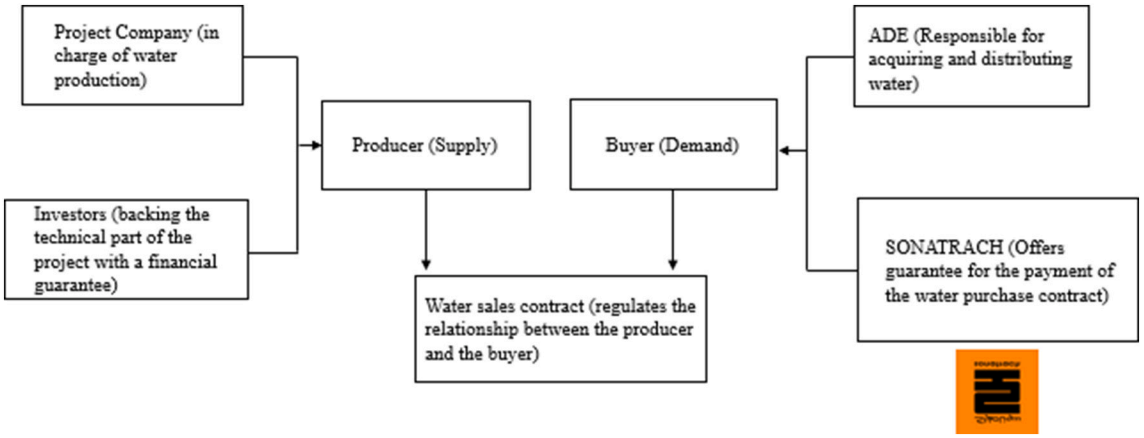

Fig. 5. Relationship between supply and demand in the Algerian case.

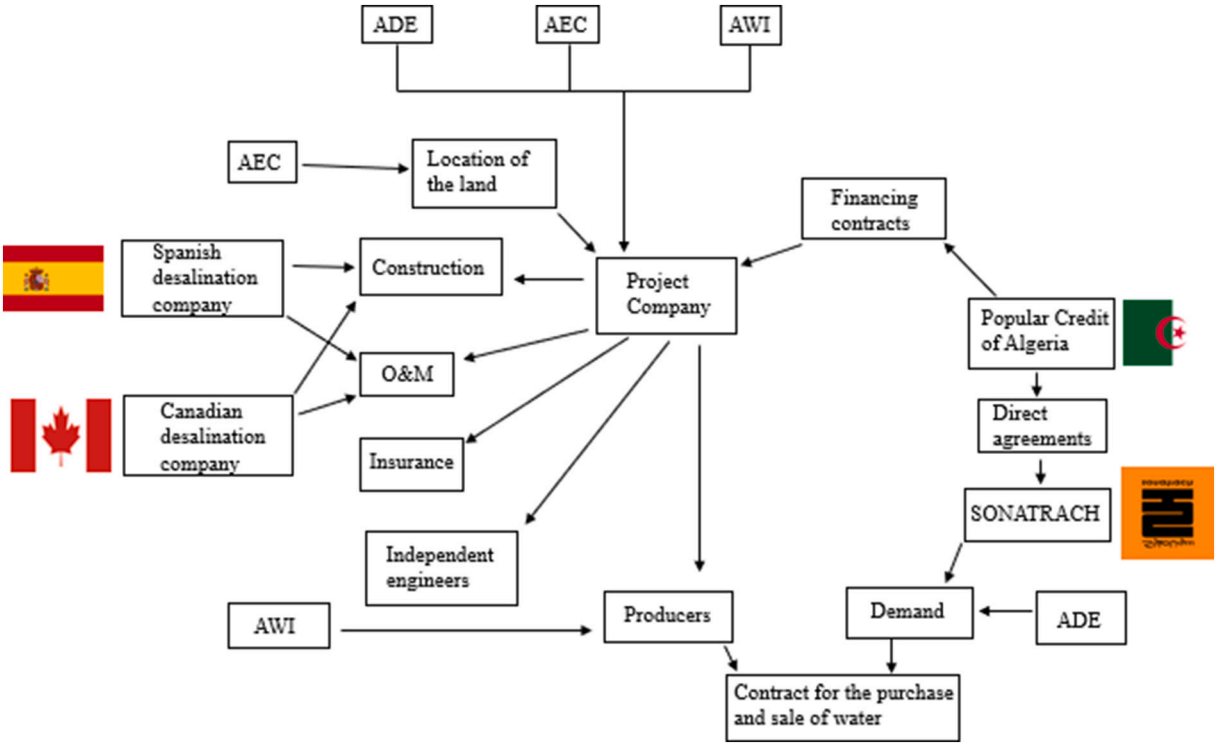

Fig. 6. Complete structure of the Algerian Project.

at projects that have already been implemented, Egypt represents more future than past in the market as it will build an additional 19 new desalination plants by 2022 [30,31]. The wastewater treatment and reuse project in Egypt that we are going to analyse is an intermediate case between the Tunisian and Egyptian projects in terms of public sector intervention. Two Egyptian ministries are involved in the development of the project, the Ministry of Urban Planning and Development and the Ministry of Finance. The Ministry of Finance is responsible for guaranteeing the project vis-à-vis the financiers. On the other hand, the public sector is present in this desalination project, but does not participate in the financing of the project beyond the endorsement of the Ministry of Finance.[15] Although the Ministry of Urban Planning is involved in the project, it does not participate directly, but through a representative, the Public Waterworks Company.[16] The public water and sewage company is a partner in the operation and construction contract but does not contribute capital to the project. In this project, the land on which the plant is built is public land, but Egyptian law provides the State the capacity to pass on real rights and mortgage capacity over the land and whatever is on it to the Project Company.[17] The Project Company in this case is financially supported by shareholders' and lenders' capital. The Project Company will be responsible for the construction, operation and maintenance of the plant. As mentioned above, the main difference with the Algerian project is that there is no capital contribution to the project, however, the government participates financially in the project insofar as a public company is part of the project and the project is carried out on the basis of a government concession. Regarding the financing of the project, the Ministry of Finance, the Egyptian Waterworks Construction Company, the Project Company and the investors are the contract participants. Fig. 7 shows the structure of the project.

It is interesting to note an important difference between the Egyptian project and those of Algeria and Tunisia in terms of the way of participating in the tender. In the Algerian and Tunisian projects, it is the promoter who is awarded the contract, but once it is known which promoter will carry out the project, the Project Company is created either with the promoter alone or with one or more public companies. This implies that in the tender documents there must be a guarantee that with the award of the contract all rights and responsibilities of the State pass to the Project Company. In the case of Egypt, it is the Project Company that bids for the tender, which forces the promoters to form the Project Companies. All promoters had to set up the Project Company with the same public company and, on the other hand, each promoter had to have its local partners.[18]

2.3. The case of Tunisia

Tunisia has also resorted to augmenting available water resources through non-conventional means with reverse osmosis, nanofiltration and electrodialysis plants currently in operation [32]. Desalination is a live market in this country, in 2018 Aqualia, in consortium with GS Inima, completed the construction of the desalination plant on the island of Djerba in Tunisia [33]. This is perhaps one of the most difficult and complicated cases in which to build the financing structure of the project due to the reduced financial capacity of the government, but it is one of the countries where an alternative to increase the supply of water resources was most needed [7]. In the case of Tunisia, the Project Company is wholly owned by a private company. In previous cases, we have seen that public companies have been shareholders in the Project Company, which means that regardless of whether the public companies have invested capital in the company, the company can offer a higher level of guarantee. The consequence of not involving any public company or the State in the project is that the guarantees are not clear and, therefore, there is less willingness to finance the project on the part of the banks, to the point that in this project it is required that the Project Company's own funds be around 50%.[19] In the case of Tunisia, the state is not involved in the construction and operation of the desalination plant. The problem in these cases is that, as the state is not an active part of the project, it tends to demand greater involvement of the company in the investment. In Tunisia, the Spanish company taking over the project is required to invest the 50%, which is much higher than the usual 20–30%, and the technical promoter is not an investor, as his working capital is used to buy materials such as pumps or pipes. The problem the Tunisian government argues with the state providing guarantees is that it is a very small country where any borrowing can greatly increase the country's debt. However, it should be noted here that, if the debt is exclusively owed to a public enterprise, this debt might not be counted as country debt but as the debt of that enterprise. It was this concern that led the state to require the promoter to contribute 50% of the capital with its own funds. The Spanish developer has agreed to put up this amount of money after much negotiation, which it will probably do with an investment partner from Kuwait, and will carry out the project, among other reasons, because it is not a very large plant, otherwise the financial commitment required of the developer in this project would not have been affordable. Technology companies are generally unwilling to invest more than 30%, which makes the financing of the project difficult to address. In this case, if neither the technologist nor the public sector gives in, the only solution is for the technologist to team up with one or more investment partners.

The desalinated water is sold in its entirety to the Tunisian public company SONEDE. However, it is SONEDE itself that signs the contract without the Tunisian government being bound by it, which means that the water purchase contract has a very low level of guarantee. SONEDE is a private company that was set up by the government with the social objective of distributing water as a monopoly. The problem for the economic viability of the project is that the statutes do not stipulate that the government must bear the losses of the company, although in practice the government had put in the necessary money when losses had occurred. Without the formal guarantee that the Tunisian government will support SONEDE, the only guarantee that exists for the fulfilment of the water purchase contract is SONEDE's assets, but these are insufficient for this purpose. In such cases, the most common solution is to finance the project multilaterally, with entities such as the African Development Bank or the World Bank. The whole financing complication arises from Tunisia's unwillingness to commit to guaranteeing the project in order to avoid worsening its country risk. The main actors in this project are the Tunisian government (granting authority), which organises the tender process, the Spanish company that wins the tender, SONEDE, which is the public company that buys and distributes all the water produced in the plant, the possible partners that join the project as capital partners of the technology company and, finally, the

[15] Fundamentally, the difference with the Algerian case is that the Egyptian government is not a shareholder in the Project Company and will therefore not share in the profits.

[16] As we can see, it is not often the government as such who participates in the Project Company, but a public company. This is the case in all countries, not only in the ones we are analysing here.

[17] This possibility is not present in all countries, in fact, in the Tunisian case, legal modifications were purposely made in this regard in order to make the financing of the desalination project possible.

[18] This means a much greater effort for the promoters when it comes to bidding or not, since regardless of whether they are awarded the project, they will have to set up the Project Company with a public company and also form a partnership with local companies, bearing in mind that the local partners are of equal or greater importance than the desalination project itself.

[19] This percentage of investment makes the project unattractive for the promoter, as the level of risk to be assumed is too high, so the promoter will generally only be willing to participate in a project requiring this level of investment if he has a partner who provides capital or if it is a very small project in which the equivalent of 50% represents a low level of investment.

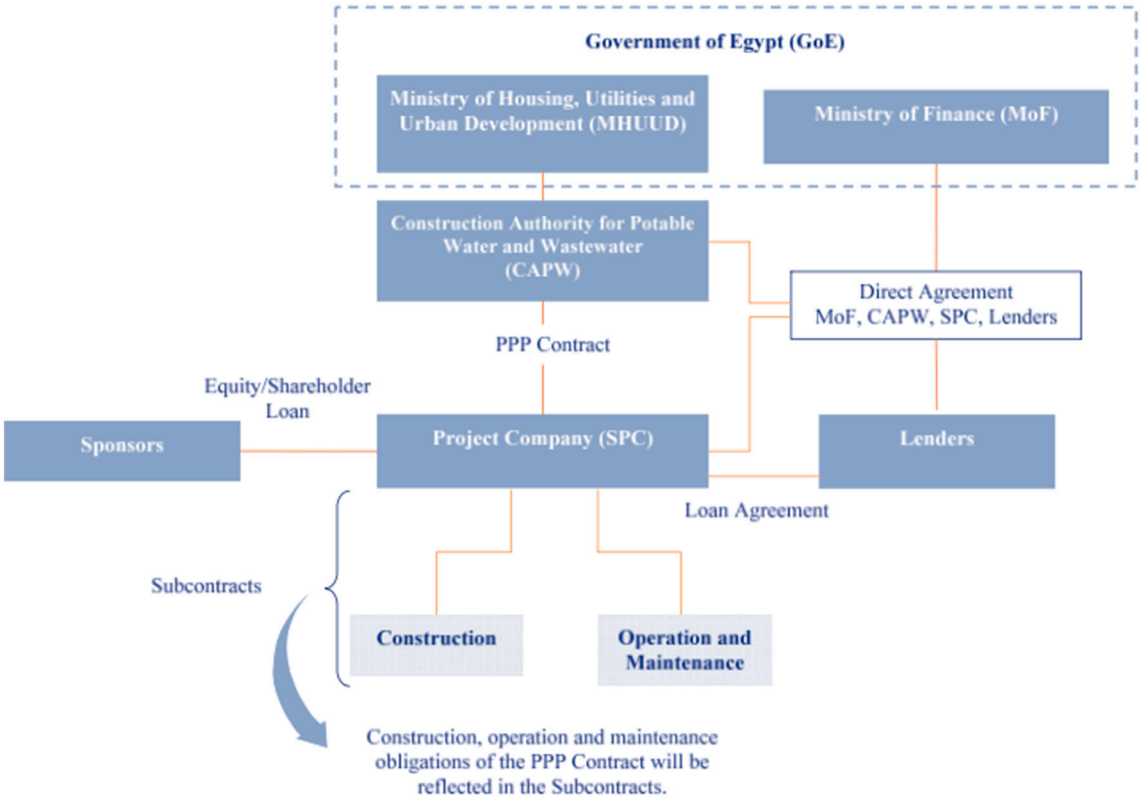

Fig. 7. Structure of the Egyptian Project.
Source: [26].

banks. In reality, the Tunisian government is the granting authority because the government is actually the owner of SONEDE. The problem that arises in the economic viability of this project is that the government's intention to make the concession through SONEDE is not solid.

The fact that the Spanish technology company is considering looking for an investment partner rather than a partner that also provides technology and management has a lot to do with the fact that it is quite complicated to coordinate the project with another technologist, as each one works with its own suppliers, management and methodology.

In this type of project in which the public sector is not part of the Project Company, the participation of a technologist is particularly complicated because it requires to him to provide all of his own funds. For this reason, it may be the case that, if a capitalist partner cannot be found to share the project risks, the technology company may decide not to carry out the project.

Another aggravating factor in terms of the ease of financing the project is that the Tunisian government does not want to guarantee the project by providing guarantees for the company buying the water, which makes both the technologist's investment and the bank's financing more difficult. The fact that the Tunisian government does not want to guarantee the project is due to the small size of Tunisia and consequently its small budget. Fig. 8 shows the structure of one of the projects carried

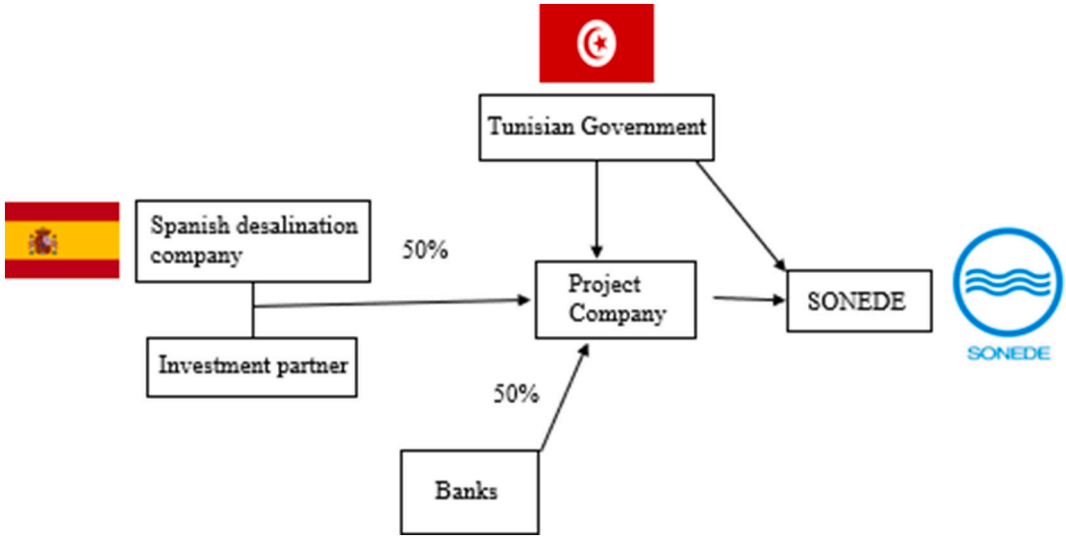

Fig. 8. Project structure in Tunisia.

out in Tunisia.

3. The general model

As we have seen, there are general guidelines for all desalination projects. In the structure of a desalination project, the same agents and contracts always appear. The agents common to all projects are the following:

- **The technology company or companies**, which are the ones that will carry out the project, generally enter the country through a competitive bidding process, although in very exceptional cases they may enter a country through a direct contract. The objective of this actor is to obtain an economic benefit either through the industrial profit or otherwise. This actor is at the centre of the whole project, the other actors are directly related to the technology company.
- **The government of the country where the project is to be carried out and the companies or bodies to which it delegates the authority**. The government's objective is to obtain additional water resources. The government usually acts through a proxy, usually a public company. For the project to be eligible for financing, the public company representing the state must be financially and economically sound, otherwise there would be a problem in financing the project, as if the public company defaults on its part of the contract, the bank would not be able to recover the debt. This is why, when the financial capital of the public companies that represent the State does not provide sufficient guarantee for the payment of the debt, it is common for another public company with greater solvency to guarantee the previous one. Depending on the level of public sector involvement in the project, the public company may or may not participate technically and/or financially. The functions of this agent are to provide guarantees, to participate in the project where appropriate, to control internally the implementation of the project and, if it provides capital, to make a profit.[20]
- **The company that buys and distributes the water**. As with the public companies involved in the project, this company must have sufficient solvency to guarantee payment for the water, otherwise another company will be required to guarantee it, as mentioned above. The objective of this agent is to distribute water to the end user, as this company is appointed by the State as the official and sole distributor and therefore the State endorses and supports it so that it can guarantee a take or pay contract and guarantee payment.
- **Banks or other financial institutions**. This agent is a vital piece for the functioning of the project, as well as for answering the questions we ask in this paper. The banks make it absolutely necessary for the project to have certain collateral, insurance and other guarantees, otherwise there will be no funding from them.
- **Other actors involved in the project structure**. Other actors may be involved in the project as guarantors of certain contractual agreements or as partners on the technology side who are merely investors.

The other part of the overall model is the contractual agreements that regulate the relationships between the actors involved in the project. The main contractual arrangements are:

- **The partnership agreement**. This contract regulates the relationship between the companies and organisations that will form the project company. The public, private or mixed nature of the project depends to a large extent on the presence of the state through the public companies in the partnership agreement. In the Algerian project, the Algerian public company AEC is a partner in the partnership agreement. In the Egyptian case, the public sector is present in the partnership contract through the Egyptian Waterworks Company, while in the Tunisian case the State is not involved in the partnership contract. Another important difference with respect to the partnership contract is whether there is only one technology company or more than one, as well as the possible involvement of investment partners.
- **Framework Agreement**. This agreement establishes the contractual relationship between all actors involved in the project, including those involved merely as guarantors. In the case of Algeria, the Project Company, AEC, ADE, and SONATRACH are part of this agreement. In the Egyptian case, the Project Company and the Egyptian Waterworks Company would be active part of the framework agreement. In Tunisia, the parties to the framework agreement are the Project Company, the Tunisian State and SONEDE.
- **Direct agreements between lenders and guarantors**. While in the day-to-day operation of the plant these agreements are not very important, for the purpose of this research the direct agreements between the banks and/or the entities that will finance the project and the guarantors are of great importance. How and when the guarantor will have to meet the guarantor's liabilities will be set out in this contract. In the Egyptian case, the Ministry of Finance guarantees the project. In the Algerian project, the level of guarantees is lower because there is no direct guarantee, but by introducing a very solvent company such as SONATRACH that guarantees ADE's payments, the *take or pay* is still guaranteed. The problem in projects where the involvement of the public sector is lower, as in the case of the Tunisian project, is that it makes the bank demands a greater financial responsibility from the project company (this is the case where the guarantees are weaker). In the Egyptian project, although the public sector does not commit capital for its operation, there is a guarantee contract signed between the Ministry of Finance and the lenders.
- **Financing contract**. This contract is one of the most important for our purposes. Reaching an agreement for this contract depends to a large extent on the existence of sufficient security for the repayment of the debt owed to the lender. This contract is always between the Project Company and the lenders, no other agent is involved in this contract. Whether or not the public sector is involved in such a contract will depend on whether the public sector is part of the Project Company and whether it also commits its own funds. In the Algeria project, the State is part of the financing contract as it is part of the Project Company and also contributes with the 49% of its own funds. The Egyptian project is an intermediate case, although the public sector is part of the Project Company, it does not commit its funds, although, on the other hand, if the project were to fail and the technology company were exempt from liability, it would have to pay the debt since it is the guarantor. In the Tunisian project, the state is not part of this contract in any way. In the case of Egypt, the State has a stake in the Project Company through the Egyptian Waterworks Company, which is why the public sector is involved in the financing contract, however, since no public funds are committed to the project, the degree of public sector involvement is very low. The willingness to finance the project depends to a large extent on state support, so that we can rank the three projects analysed from the highest to the lowest support as follows: Algeria, Egypt, Tunisia.
- **Construction and/or operation contract**. This contract is between the Project Company and the company in charge of construction and operation (the developer or a subcontractor of the developer). In the structure of this contract and in terms of the signatories, there is practically no difference in the three cases studied. In the Tunisian project, the construction and operation contract is signed by the Project Company (in which the public sector does not participate) and the developer. In Egypt, the contract is between the Egyptian Waterworks Company (acting on behalf of the Ministry of Urban

[20] The Government will always have a degree of control over the activity of the Project Company. The difference is that depending on the degree of participation in the Project Company, its control will be greater or lesser.

Planning) and the Project Company. In the Algerian case, the signatories to this project are the Project Company and the developer.

- **Contract for the purchase and sale of water**. This contract is of vital importance for the project, as the bank or whoever is financing the project will require that the payment of the water is guaranteed, either by the buyer or by a guarantor. In order to guarantee the purchase and sale of the water, a *take or pay* contract is concluded whereby the payment of the water is secured at least for the part corresponding to the repayment of the debt to the bank and the payment to the shareholders. The only case in which payment will not be made is when water is not produced because of the developer. In the sale and purchase contract in Algeria we have on the one hand the offer, represented by the Project Company, and on the other hand the demand, which is ADE, while the guarantor of the contract is SONATRACH. In Egypt, the Project Company is the offer, the Egyptian Waterworks Company is the demand and the guarantor of the contract is the Ministry of Finance. Finally, in Tunisia, the supply side is the Project Company and the demand side is SONEDE. In this case, although there is an endorsement by SONEDE, it is diffuse and not well founded.
- **Lease and land use contract**. This part is of particular importance whether or not the Project Company has the capacity to mortgage the land and the plant. This will happen when the landowner becomes a shareholder in the Project Company or when he/she transfers the rights of the land and what is built on it (this will not always be possible, depending on the legal framework of the country). If we go back to our objective and assume that one of the factors that make the project viable is that the land is mortgageable, we see that there were additional difficulties in the Tunisian project, as the Project Company does not own the land and therefore cannot provide additional security through the mortgage. In the other two projects we have analysed, the land is mortgaged.

Fig. 9 shows the general structure of a desalination project. The actors involved in the project are surrounded by a rectangle and the contractual agreements by a circle. On the other hand, agents in contractual relationships with each other are connected by continuous and dashed straight lines. Continuous lines denote contractual relationships that occur virtually all the time, while dashed lines denote relationships that occur some of the time.

The more unharmed the Project Company is, the easier it will be for the bank to agree to provide financing. Once all the project forces are present and articulated, i.e., the State, the buyer, the guarantor and the Project Company, the bank will have the technical project guarantee analysed by means of a *Due Diligence*.

Due diligence consists of the bank asking an independent engineering firm to analyse the technical feasibility of the project, which will analyse the potential problems that the plant may have in its operation. In this respect, it should be borne in mind that the plant is generally intended to operate continuously, therefore, there must be a technical guarantee that the plant design is capable of ensuring such continuous operation except in cases of force majeure.

The *Due Diligence* confirms the soundness of the project, as an independent expert certifies that the technical planning of the plant is adequate and will also include a plant operation study which will analyse whether the way in which the plant will be operated, given the plant's characteristics, allows for continuous operation. On the other hand, there is always the possibility of the plant catching fire, an earthquake, a strike or similar, which is why the bank will ask the Project Company to cover certain risks with one or more insurance companies. The bank will analyse whether the insurance provided is sufficient, which will lead to higher costs for the project. However, despite having insurance, the bank will ask for additional guarantees, usually by requiring that the shares of the Project Company be pledged, i.e., that the bank can keep them as collateral.

The delegation of the Project Company's collection rights is also usually required, i.e., in the event of a default on the debt owed to the bank, the bank can exercise the Project Company's collection rights. Generally, a contract is drawn up to regulate the bank accounts to be used in the project, in this respect four bank accounts can be distinguished:

- **Account A**: is the account where the payment for the sale of water is received. Once the payment is received it will be automatically diverted to three accounts which we will call B, C and D.
- **Account B**: in this account will be paid the proportional part of the debt contracted with the bank, usually this amount is around one third of the money paid in. The money in this account is not available to the Project Company. The only money that comes out of the B account is the money to pay the debt contracted with the bank, which will come out every six months. It should be noted that, in the event of an accident that would require the insurance policy to be collected, this money would be paid into this account.
- **Account C**: this account is intended for shareholder remuneration, usually representing another third of the payment received from the sale of water. The money in this account is also not freely available to

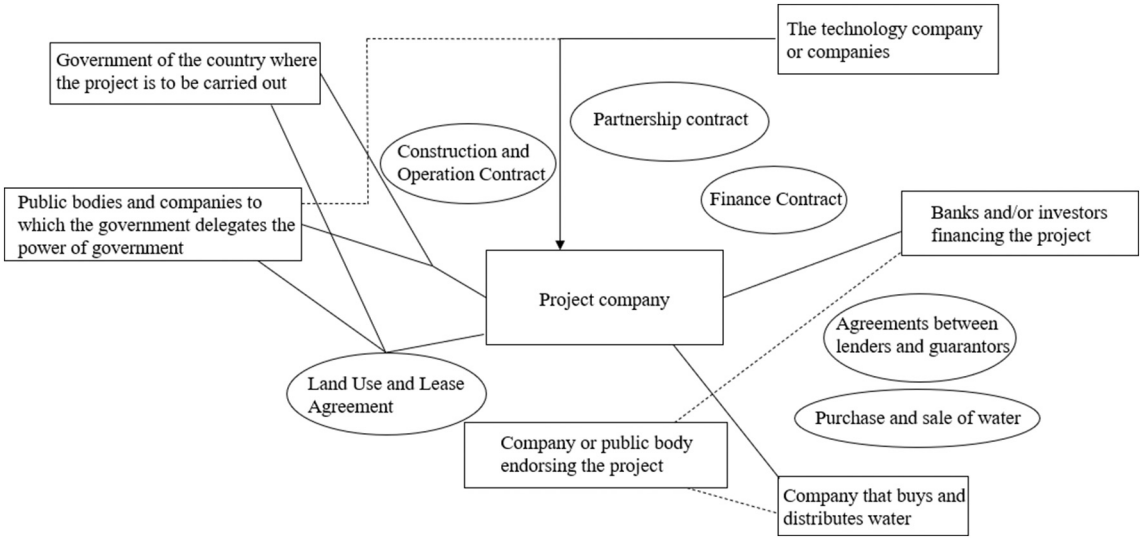

Fig. 9. Actors and contractual arrangements that make up the generic structure of a desalination project.

the Project Company. If there is a default on the debt owed to the bank, the bank is generally entitled to use the funds in this account to collect its money. Therefore, there are two ways in which the money will come out of this account, the first way is to pay the debt and the second way is pledging.

- **Account D**: this account is used to pay the Project Company's operating expenses and usually collects one third of the money that goes into the A-account. This account is the only account that is freely available, i.e., the Project Company can withdraw money from it whenever it wants.
- **Account X**: this additional account will only be active for the duration of the construction of the plant. The bank pays into this account the money needed for the construction of the plant according to a payment schedule that is included in the technical project and coincides with the various milestones in the construction phase. In addition, the definition of the monthly milestones and the ratification of their fulfilment by the independent engineer are indispensable conditions for the bank to make disbursements.

Once the technical project has been approved, financial and legal *due diligence* is required. Once the project has been approved from a financial and legal point of view, the financial closure takes place, i.e., our question is answered, the project is now viable.

Only at this point the bank makes the first disbursement into account X, at which point the instalments set out in the financial model start to run. In this way, based on the payment schedule established for the construction period, the project generates interest which, together with the debt, must be repaid within the operating period. The financial model, which is the culmination of the project's *due diligence*, is the real answer to our question. If we take into account that there are some contracts that are always given, we can intuit that they are not the most important part in determining whether the project is viable or not. In this sense, we have not analysed the influence of one of the assumptions that is obviously elementary for the project to be viable, which is the fact that the Project Company is the holder of the right to produce desalinated water, having been awarded the contract in a public tender project, otherwise it will not be viable. Another contract that must exist is the contract for the purchase and sale of water, which we have analysed with caution and which practically always exists, otherwise the Project Company would not want to take the risk of carrying it out. If there is no contract whereby the production of the plant is purchased by a public or private company or body, the banks will not finance the project. The question is, will the desalination project be viable when such a sales contract is in place? Well, not necessarily, as this requires that the signatories of the contract of sale have sufficient financial solvency to guarantee the fulfilment of the contract, since the repayment of the debt contracted with the lenders depends to a large extent on this. If the financial situation of the signatories is enough to guarantee the repayment of the debt, the bank will require a series of additional guarantees such as insurance, pledging of shares, preferential collection rights, seizure of bank accounts and so on. Once these additional guarantees have been satisfied, the bank will carry out a technical, economic and financial *due diligence*. Fig. 10 shows schematically the key aspects that determine the feasibility of a project.

Based on the above, we can ask ourselves what is the level of risk assumed by each of the parties or, more specifically, what are the risks assumed by each actor? Fig. 11 gives us the answer in a schematic way.

To recapitulate, first an international competition is launched in order to retain the most suitable candidate. Once the initial phase is over, the main objective is to obtain funding for the project and the conditions of the funding contract require the definition of the following:

- A technical construction and operation project capable of ensuring the construction of a quality plant, which can be adapted to different operating conditions during the life of the contract.
- The companies involved in the process.
- Contracts and agreements between companies to enter into relationships.

Finally, financial closure takes place, the first financial disbursement is executed and the contracts come into force [34]. Fig. 12 shows a schematic representation of the process.

4. Conclusions

While we have seen that the public sector is an actor involved in most desalination projects, the degree of public sector involvement varies from project to project. Greater state involvement in the project company increases the guarantees of the company, which makes the operation easier to finance. In addition to the role of the nation concerned, other organisations such as BICE in Chile or the European Investment Bank in Israel can also play a role. The technology company is a central player in the project partnership and its knowledge of the technology is a

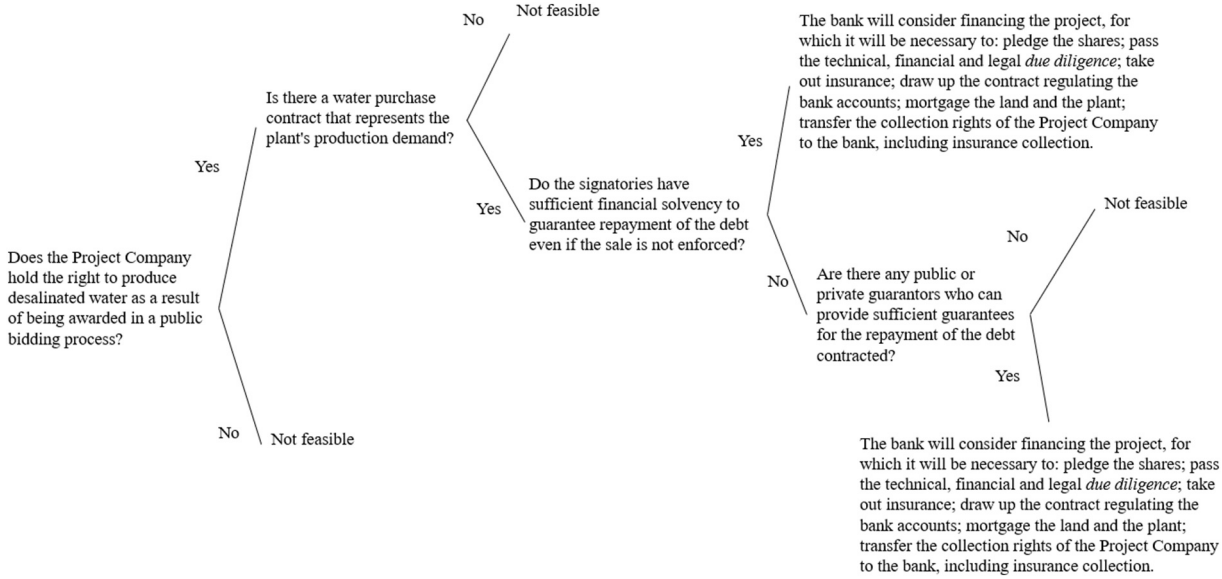

Fig. 10. Fundamental questions that determine the economic viability of the project.

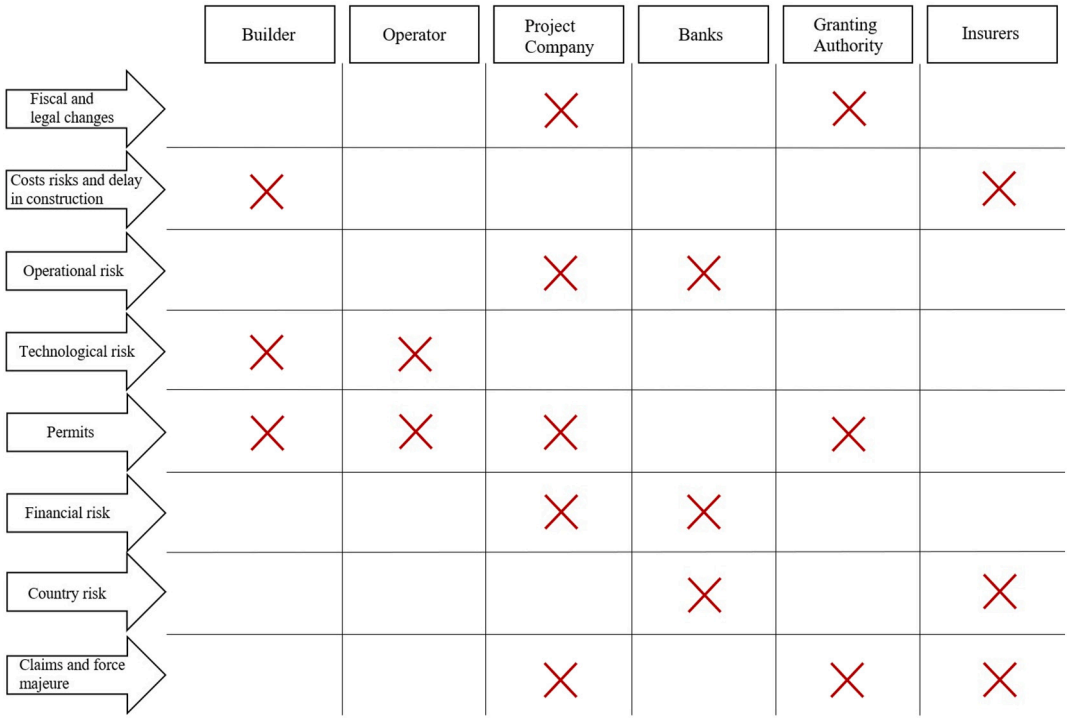

Fig. 11. Risks analysis of a desalination project. Source: own elaboration based on official project contracts.

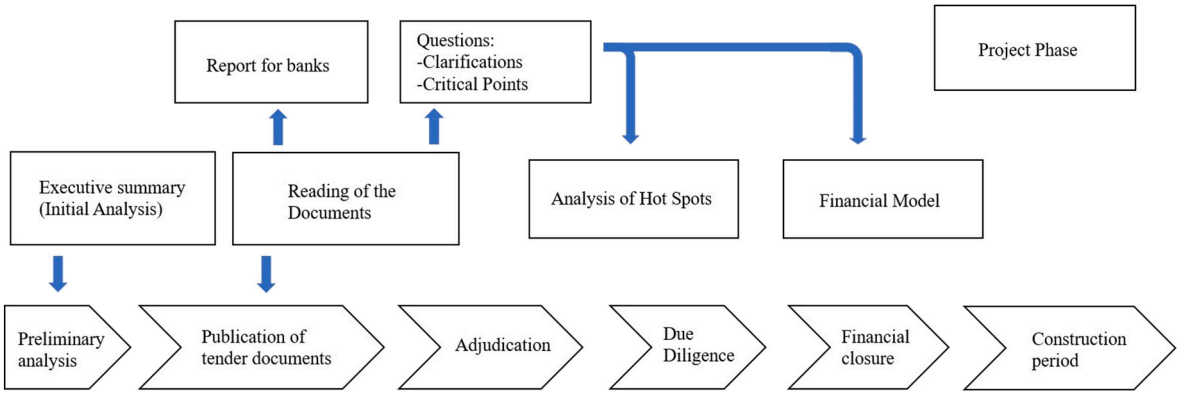

Fig. 12. The phases of a desalination project. Source: own elaboration based on official project contracts.

fundamental condition for the project, but the technical part is subject to the greatest competition and poses the fewest potential problems. The project company will produce water that will be purchased by the demand, this sale has to be guaranteed and sometimes the public body that will purchase and distribute the desalinated water is not able to offer sufficient guarantees of the economic fulfilment of its obligations, which means that other bodies must guarantee this sale. To formalise the operation of the project, there are basic contracts such as the project company framework agreement, the water purchase and sales contract or the contract for the construction and operation of the plant. However, depending on how the various relevant issues of the project are dealt with, other partnership contracts, guarantees, etc., may be necessary to formalise the Project. It is not easy to answer what are the conditions that make the project economically viable, but essentially it is a question of all the actors involved having sufficient guarantees that they will get what they expect from the project. The company that builds and operates the desalination plant wants to be guaranteed payment for its service even if the water is not demanded in the end. The bank or entities financing the project share with the company building and operating the plant their interest in being paid for this service, but they also need to be sure that the technology company will be able to fulfil its obligations under the project. The water demand side needs to have sufficient guarantees that the technology company(ies) will fulfil all its obligations, thus not jeopardising the operation of the project either technically or financially. Whether all the guarantees described above are sufficiently assured depends on the "who and how", i.e., it is determined by the actors involved in the project and the way they do it. In this paper we have carried out a study with three cases that differ in the degree of public sector involvement and we have been able to see how important this involvement is for the viability of the project.

This paper can serve as a guide for a company wishing to carry out a desalination project, as the information provided is very complete and useful for minimising the costs and uncertainty associated with the project. Moreover, it is of great academic use since the evolution of this business sector has hardly been studied and no general functioning system has been obtained so far. The performance of the sector can be a benchmark for other sectors to make changes to improve their efficiency. The public planner can better understand the role of the public

sector in the economic viability of the project, which can make the process cheaper by not incurring in excessive cost due to an increased (and unnecessary) complexity of the project from a legal and financial perspective. Over the last decades, a large number of studies have been carried out on the economic costs of desalination, always focusing on its constraints from an engineering perspective. However, other elements that can optimise the economic cost of the project have been addressed in this work.

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CRediT authorship contribution statement

Borja Montano: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Visualization, Writing - original draft.
Marcos García-López: Funding acquisition, Investigation, Resources, Visualization, Writing - review & editing.
Joaquín Melgarejo: Funding acquisition, Investigation, Project administration, Resources.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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