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A DECISION SUPPORT SYSTEM FOR THE RE-EQUILIBRIUM OF PPP CONTRACTS

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DEDICATION

I dedicate this research to my wonderful parents, to whom I am very grateful for their love, support, time, effort, and prayers. They believed in me during the different and difficult phases of this research. Without them, I would definitely not have made it so far. I also dedicate this research to my small family. A special dedication goes to my spectacular husband and my lovely daughter who motivated me through the journey, and I hope this research inspires them, as well.

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ABSTRACT

Public Private Partnership (PPP) contracts tend to have longer contract durations compared to other conventional procurement methods. Due to their prolonged nature, PPP contracts are extremely prone to contract renegotiation along their lifecycles in comparison to other forms of contracts with shorter durations. The common outcomes of the renegotiation process may include: increasing the service charges, increasing the concession period, or paying a lump sum amount to the party of concern in order to maintain a fixed rate of return and keep the return on equity constant. In this research, a framework is developed in order to calculate the renegotiation process outcomes and facilitate the decision making process of choosing the optimum scenario that preserves the rights and the interests of all the stakeholders. This is done using a weighted sum model to calculate the weights and ranks of a number of factors influencing the stakeholders' decisions. A Decision Support System (DSS) is developed with the aid of Microsoft Excel 2013, Visual Basic for Applications (VBA) programming language, and the Precision Tree 5.5 for Excel add-in. The data for the model is obtained from a case study of a wastewater treatment plant in Egypt. The results obtained from the model are close to the ones obtained from the Independent Financial Expert (IFE) of the wastewater treatment plant.

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CHAPTER 1 : INTRODUCTION

1 . 1 Public Private Partnership (PPP)

Public Private Partnership (PPP) is recognized as a mechanism that achieves cooperation between the public sectors and the private sectors. The agreement is usually referred to as the "concession agreement" while the duration of the contract is the "concession period". The durations of PPP contracts tend to be very long compared to other conventional delivery methods. The heart of PPP agreements is that the private sector finances a PPP project on behalf of the public sector, with the project ownership retained by the public sector, retained by the private sector or transferred to the public sector at the end of the project. Moreover, PPP agreements also include design, build, operate, maintain, develop, buy, or refurbish agreements. PPP contracts have many types that are basically combinations of the previously mentioned agreements. Examples of PPP contracts are design-build-finance-operate (DBFO) contracts, build-operate-transfer (BOT) contracts, and build-own-operate (BOO) contracts.

The choice between the Public Private Partnership delivery method and other conventional delivery methods depends on many factors that should be looked at thoroughly. One of the main factors is the value for money (VFM). The value for money is the difference between the project value that is incurred by the private sector in case of choosing the PPP option and the project value if executed by the public sector. Although the cost of borrowing for the private sector is usually much higher than the cost of borrowing for the public sector, the PPP option, in many cases, may have a higher value for money for several reasons, such as the ability of the private sector to provide better and more efficient services than the public sector. Private sector know-how is another reason for choosing a PPP approach. A value for money study should be conducted to determine whether the PPP option is more efficient in the long run than other procurement methods.

In order to assess the value for money, the private sector is required to submit a financial model along with the bid that includes detailed calculations of all expected costs and revenues for the project. On the other hand, the public sector prepares a public sector comparator, which is a mirror of the private sector financial model but with the

public sector conducting the project by conventional procurement methods. If the comparison between the two models proves that the value for money is higher in the case of the private sector taking over the project, then the Public Private Partnership option is to be chosen. The risk sharing mechanism provided by the PPP method and the lower whole life cost of procuring services, which compensates for the higher cost of finance in the private sector, are the reasons for the higher value for money in the private sector option. Although the PPP option seems to be the expensive option, the efficiency and quality provided the private sector usually lead to great savings for the public sector.

1 . 2 Importance of PPP

As stated in the previous section, the public sector should only choose the PPP option over conventional procurement methods when the private sector is providing a better service with more efficiency; in other words, when the private sector is providing a higher value for money (VFM).

In addition, governments strive to enhance the economic growth of their states. This requires enhancing existing services and working on developing beneficial strategic projects, such as infrastructure projects. According to the Construction Management Association of America (CMAA), Public Private Partnership is one of the mechanisms that governments employ to engage private sector financing in the development process (The Construction Management Association of America, 2012) .

The importance of the Public Private Partnership approach is that it supports and helps governments achieve their strategic plans in shorter time periods. The private financing provided through the Public Private Partnership model helps in allocating governmental funds to other strategic projects and services. This allows governments to achieve a greater number of goals in a relatively short period of time with high efficiency, which boosts the economic growth of the country.

Moreover, the Public Private Partnership contracts are based on service availability, which means that the private sector is not to be paid unless the service is being provided to the users according to the contract specifications. In other words, the Public Private Partnership mechanism ensures that the private sector is not being paid

for an incomplete or insufficient service. Hence, the private sector is keen to provide the service on time and according to the contract specifications in order to collect the expected revenues as planned. This minimizes the probability of time delays and cost overruns in PPP projects tremendously. Furthermore, Public Private Partnership contracts can be of great benefit to the end users of a service. In order to maximize its revenues, the private sector usually tries to provide the service earlier in the concession period in order to increase the operation period, thereby increasing revenue.

1 . 3 Problem Statement

Despite all of the above benefits, PPP projects are very challenging in terms of attracting investors to enter the bidding process. This is due to several factors; one of which is the private sector's fear of the long-term nature of PPP projects, which makes it extremely difficult to anticipate contingencies along the projects' lifecycles. Due to the lengthy contract durations, the principles and bases upon which the original PPP contract was made may no longer apply; they may be simply altered or totally changed as the project evolves. A different set of conditions and situations may appear later in the project, making the need for a contract re-equilibrium inevitable, and with re-equilibrium comes renegotiation. During the renegotiation stage, conflicts may arise between the different stakeholders of the project. These lengthy renegotiations become full of conflicts that, in some cases, may lead to contract terminations and major losses for several parties. However, those conflicts can be avoided through a pre-agreed mechanism. Tools are needed to ease the lengthy renegotiation process. This thesis provides a tool that facilitates a renegotiation process in which the interests of all parties are considered in the final decision. This tool will help in attracting the private sector to enter PPP contracts and ensure project continuity and stability of transactions.

1 . 4 Thesis Objective

Since the PPP contract renegotiation process seems to be an inevitability, the goal of this research is to enhance and to support this process in order to make PPP contracts more favorable to investors.

Typically, there are four re-equilibrium scenarios that appear in a PPP contract: increasing the service charges, increasing the concession period, paying a lump sum amount to the private sector, or a combination of any of the above. The aim of those scenarios is to maintain the contractual internal rate of return of the private sector fixed. In order to enhance and to support the renegotiation process and to achieve the thesis goal, the research objective is to develop a tool that provides a clear method of selection from the common four re-equilibrium scenarios. This tool is a Decision Support System model which ensures that the decision is unbiased and robust. In other words, it increases transparency and stability of transactions by providing a pre-agreed mechanism which enhances mutual trust between the PPP parties.

The decision to choose from among the above scenarios is affected by many factors that exist in both the private and the public sectors. In order to achieve the thesis objective and ensure that the optimum decision is taken, a Decision Support System (DSS) is developed. This DSS model contains eight modules: a User-Interface Module, a Risk Allocation Module, a PPP Valuation Module, a Financial Model Re-equilibrium Module, a Scenarios Development Module, a Scenarios Selection Module, a Reports Module, and a Sensitivity Analysis Module. The User-Interface Module serves to help non-expert users interact easily with the tool, and the Risk Allocation Module reflects the contractual allocations of the different projects risks in order to determine the portions of the risks that will be considered in the renegotiation process. The PPP Valuation Module and the Financial Model Re-equilibrium Module provide a basis for the Scenarios Development Module calculations, which the latter develops the different re-equilibrium scenarios. The Scenarios Selection Module uses the weighted sum model to calculate the weights and the ranks of a number of factors influencing the stakeholders' decisions. The results of the DSS model are presented through the Reports Module and the Sensitivity Analysis Module.

1 . 5 Thesis Organization

This thesis is organized into six chapters. Chapter One is the introduction to Public Private Partnerships and their importance. It also includes the problem statement and the thesis goal and objective.

Chapter Two is a literature review of the concept of Public Private Partnerships (PPP), the different forms of PPP, the advantages and disadvantages of PPP, the different payment mechanisms, the PPP concession period, and the different PPP risks.

Chapter Three covers the current practice and the contract renegotiation. It includes the PPP lifecycle and the components of the PPP financial model. It also includes the renegotiation process and its frequency and outcomes. It also discusses the tools to facilitate the renegotiation process, such as Decision Support Systems (DSS), and examples of their applications in the PPP field.

Chapter Four presents the methodology of the research and an introduction of the framework proposed. It also explains the inputs and outputs of the eight modules of the prototype Decision Support System model.

Chapter Five evaluates the results and provides an analysis of the data obtained from the Decision Support System of PPP contracts renegotiation of PPP. It also incorporates an analysis of a case study of a wastewater treatment plant in Egypt, and the verification and validation of the suggested framework.

Finally, Chapter Six is the summary and conclusion of the research findings. It includes the contributions and the limitations of the research.

CHAPTER 2 : LITERATURE REVIEW

2 . 1 Evolution of the Public Private Partnership (PPP)

The Canadian Council describes Public Private Partnership (PPP) as "a cooperative venture between the public and private sectors, built on the expertise of each partner, that best meets clearly defined public needs through the appropriate allocation of resources, risks and rewards" (The Canadian Council, 2006). Public Private Partnership is, as its name denotes, a partnership between the public sector, which is usually represented in the government, and the private sector, which usually consists of a consortium of construction and operation companies and investors. In this context, the government awards a public project to the private sector in which the agreement between the government and the private sector is called a "Concession Agreement." The government is usually referred to as the "Off-taker" while the private sector is called the "Concessionaire" (Kriegler, 2006). The contractual period of the agreement is also called the "Concession Period," during which the Concessionaire has to fulfill his obligations under the contract. The PPP agreement may include one or more of the following components: design, build, finance, operate, maintain, own, transfer, lease, develop, buy, or refurbish (Delmon, 2010).

The first PPP project was in 1782 in France, where a water distribution project was awarded to Perrier (Grimsey & Lewis, 2002). Further cooperation between the public and the private sectors can be traced to the 1970s, represented in privatizations of many projects, especially in Europe, which continued to rise until the late 1980s (Hood, 1991). However, the term "PPP" was not used until the 1990s (Davies & Eustice, 2005). The use of PPPs began to rise in Europe, specifically in the United Kingdom, where the term "PPP" was first used in 1997. The most successful PPP programs today are found in the United Kingdom, where the value of the PPP projects until 2008 was almost 63 billion British Pounds (Demirag *et al*, 2010). Furthermore, PPPs continued to be used in Portugal, the Netherlands, Ireland, and many other European countries. PPPs may also be traced to the 1980s in the United States (Agyemang, 2011). As for South America, PPPs were highly evolving in Brazil and Mexico. Moreover, Africa and Asia also started using PPPs, mainly in South Africa in 2001 and in Japan (Broadbent & Laughlin, 2004).

Alhomadi, in his PhD dissertation entitled "Public-Private Partnership Implementations in Saudi Arabia Infrastructure," published in 2012, also suggested a framework to enhance PPP practices in the Kingdom of Saudi Arabia by trying to reach market maturity and avoid political and legal barriers (Alhomadi, 2012).

It has been noticed that PPPs emerge in developed countries in earlier stages than in developing countries (Guan-Wei, 2010). This proves that the claim that PPPs are only suitable for developing countries due to the lack of funds is not accurate. Actually, PPPs can be very costly if not studied thoroughly. According to the United Nations, the reason is that the government incurs costs, such as administrative and transaction costs, in order to prepare bids, negotiate the contract terms, manage the PPP contract along the life of the project, and provide monitoring (The United Nations, 2011). In addition, the cost of borrowing for the private sector is much higher than for the public sector.

Moreover, Viegas, in his paper entitled "Questioning the Need for Full Amortization in PPP Contracts for Transport Infrastructure," claims that, in most cases, PPP contracts have a relatively short concession period to reach full amortization, which also leads to an increase of transaction costs (Viegas, 2010). To summarize, the public sector should only choose the PPP option when the value for money is proven to be higher; for instance, if the private sector provides better control and monitoring, more advanced operation, or a higher level of know-how.

2 . 2 Forms of PPP

As mentioned above, PPP arrangement may include one or more of the components in Table 1. PPP contracts include one or more of the following components: design, build, finance, operate, maintain, own, transfer, lease, develop, buy, or refurbish. The combinations of those trades usually vary depending on the level of involvement of the private sector, the ownership status of an asset, and the source of financing. For instance, if the difference between BOT contracts and BOO contracts is the ownership of the asset (Kwak *et al*, 2009).

Table 1: Components of PPP Arrangements

Form	Abbreviation	Form	Abbreviation	Form	Abbreviation
Design	**(D)**	Maintain	**(M)**	Develop	**(D)**
Build	**(B)**	Own	**(O)**	Buy	**(B)**
Finance	**(F)**	Transfer	**(T)**	Refurbish	**(R)**
Operate	**(O)**	Lease	**(L)**		

PPP is a relatively new delivery method which is still developing and evolving. The five most common types of PPP are Operation-Maintenance (OM), Design-Build-Operate (DBO), Design-Build-Finance-Operate (DBFO), Build-Operate-Transfer (BOT), and Build-Own-Operate (BOO). Figure 1 explains the level of involvement of the private sector for those common types of PPP where the BOO represents the highest level of involvement of the private sector and the OM represent the lowest.

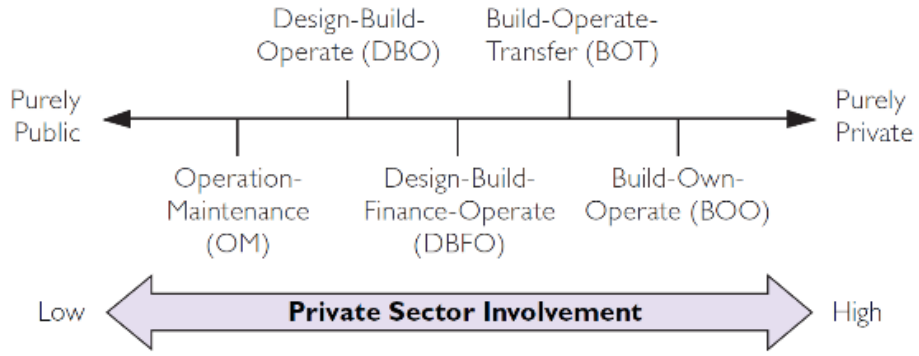


Figure 1: Private Sector Involvement (Kwak *et al*, 2009)

The Build Operate Transfer (BOT) is the most common among the above types; it is also referred to as Build-Transfer-Operate (BTO), Design-Build-Operate-Transfer (DBOT), Build-Refurbish-Operate-Transfer (BROT), Build-Lease-Transfer (BLT), and Turnkey (The United Nations, 2011). Build Operate Transfer (BOT) and its other forms mean that "the private sector is responsible for finance, design, construction, operation, and maintenance" (Kwak *et al*, 2009). It also means that the ownership rights belong to the public sector as the private sector transfers ownership at the end of the

project. Another type is Build Own Operate Transfer (BOOT), which during the project the ownership of the asset belongs to the private sector; however, at the end of the contract, the ownership is transferred to the public sector which can also be another name for the BOT contracts.

On the other hand, Broadbent in his paper entitled "PPPs: Nature, Development and unanswered Questions", claims that the ownership of the asset during the execution of a BOT contracts belong to the private sector as well (Broadbent & Laughlin, 2004). Unlike BOT, Build-Own-Operate (BOO) is a PPP type in which the ownership of the asset is transferred to the private sector.

In addition, Menendez, in his report entitled "Constrains and Opportunities for PPP Transport Projects," states that during Design-Build-Finance-Operate (DBFO) and Design-Build-Operate (DBO) contracts, the ownership of the asset remains with the public sector, which increases the level of involvement of the public sector (Menendez, 1998).

Public Finance Initiative (PFI) is another type of PPP, wherein the private sector finances the delivery of an improved specific service for the government, and ownership remains with the public sector, as well. In his paper entitled "Contract Issues and Financing in PPP/PFI," Palmer conducts a comparison between Design-Build-Finance-Operate (DBFO) and Design-Build-Operate (DBO) contracts. The paper defines the criteria based upon which the public sector decides whether to use DBO or DBFO contracts. The criteria depend on both the nature of the project and the availability of funds in the public treasury of a country. Because of the continuous evolution of new technologies and changing customer needs, a quick response is required. Palmer recommends in such cases to avoid using the DBFO contracts, as the financing component of this contract requires additional agreements and protocols with a financing party, such as a bank. This additional link in the PPP chain would require additional approvals in order to adjust any part of the PPP process to adhere to technological changes. It would be more efficient to have fewer approvals in such cases. Moreover, Palmer states that the DBO is better than the DBFO approach provided that the government has sufficient funds to bear the project costs (Palmer, 2000).

The various types of PPPs can constitute either an opportunity or a risk for both the public and the private sectors, as each type has advantages and disadvantages that

may be reversed depending on the nature of the PPP project. For example, opting for a Build-Own-Operate (BOO) approach for a strategic project such as a nuclear plant could have numerous disadvantages, as the public sector would hand the ownership of such an important facility to the private sector. Hence, advantages and disadvantages of a PPP should be studied thoroughly in order to ensure its feasibility for a certain project.

2 . 3 Advantages and Disadvantages of PPP

Almost all of the other PPP advantages lead to the same conclusion: a better value for money (VFM). According to Skanska in his report entitled "European Commission Second International Workshop on PPPs," the Net Present Value (NPV) of a public project consists of the whole life cost of procuring services, the cost of finance, and the cost of risks retained by the public sector, as shown in Figure 2 (Skanska, 2004). When going for the PPP option, the public sector reduces the whole life cost of procuring services and the cost of risks retained by the public sector; however, it increases the cost of finance.

According to Guan-Wei in his PhD dissertation entitled "The Bids-Evaluation Model Development and Application for PPP Transport Projects: A Project Risk Modeling Framework," in order to make a PPP more beneficial, a balance should be obtained to ensure that the summation of all the benefits and drawbacks achieves, in the end, a positive value for the public sector: the value for money (Guan-Wei, 2010).

Herpen, in his paper entitled "Public Private Partnerships, the Advantages and Disadvantages Examined," states that the value for money is achieved due to several factors. First, instead of the public sector bearing all the risks, the PPP approach allows the public sector to transfer many risks to the private sector; moreover, PPP contracts are output-based contracts, meaning that the private sector shall only be paid when providing the service as per the specifications required. In addition, the private sector is obliged to provide the public sector with the whole life cost of the project in advance, despite the long-term nature of the PPP project. Due to all of the above, PPPs promote cost efficiencies and provide improved service (Herpen, 2002).

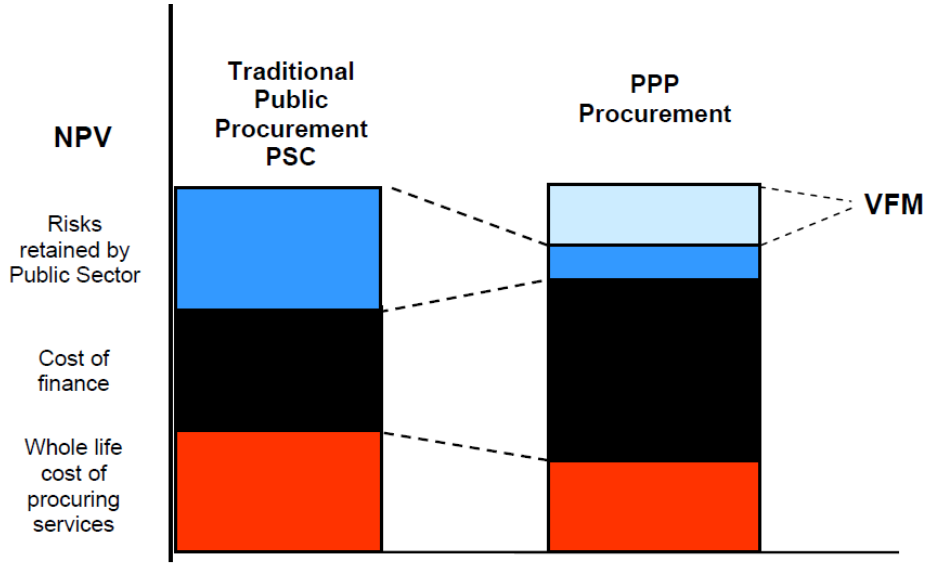


Figure 2: Value for Money (VFM) of PPP (Skanska, 2004)

Archer and Cameron, in their paper entitled "Making Public Private Partnerships Work," published results of a survey conducted by the National Audit Office (NAO) of the United Kingdom. The survey included 37 PPP projects. Cost overruns and time delays were estimated. The results indicated that almost 75 percent of conventional procured projects suffer from cost overruns while less than 25 percent of PPP projects suffer from cost overruns. The study also found that almost 24 percent of PPP projects suffer from time delays. The conclusion showed that PPPs are more efficient in terms of time and cost than conventional procurement methods (Archer & Cameron, 2003).

In its report entitled "An Owner's Guide to Project Delivery Methods," The Construction Management Association of America states that one of the main advantages of PPPs are that they delay the need of the public sector to use the funds in the public treasury. In other words, they allow the public sector to use the capital in the public treasury for other projects and minimize the need for raising taxes to meet the demands of infrastructure projects. However, the government should be very careful when planning for future spending, considering the operation costs of PPP projects after they are transferred to the government. Another advantage of PPPs are their quick responses to customers' needs, which are usually more efficient in the case of the user-fees payment method. PPPs also provide an incentive and high potential for early

delivery of the service, as the private sector wants to maximize the operation period in order to obtain higher profits. Many governments nowadays encourage the PPP option, creating an atmosphere of mutual cooperation and a better work environment for the private sector investors, which is another main advantage. The PPP option provides a non-depleting source of resources to meet the public demand for new services and infrastructure projects (The Construction Management Association of America, 2012).

The value for money (VFM) can be a great advantage of PPPs, as shown above; however, if not studied thoroughly, it can be also a major disadvantage if the conventional procurement methods become more efficient. PPPs have many additional costs that the public sector must bear, such as tendering, administration and transaction costs. Moreover, poor drafting of contract terms can lead to renegotiation, resulting in the private sector being overpaid for the service. Again, the cost of borrowing for the private sector is much higher than for the Public Sector, which also should be weighed against the other gains of PPPs.

Katz, in his paper entitled "Financing Infrastructure Projects: Public Private Partnerships (PPPs)," states that due to the length of PPP contracts, such contracts are usually prone to renegotiation as a result of various unexpected contingencies that might occur along the project lifecycle. In addition, it is very difficult to control the performance of the private sector and its quick response to growing demand, especially when the private sector is paid by the government rather than the user fees method. This may lead to political issues due to the dissatisfaction of the service users. A PPP contract may lose efficiency with time due to the fact that the project cannot be re-tendered, which diminishes competition and the incentive to provide a better service (Katz, 2006).

In his report entitled "Granting Renegotiation Infrastructure Concessions: Doing It Right", Guasch states that the aim of PPPs is to encourage better private sector quality and performance for the benefit of users. In the long run, the private sector records efficiency gains that should be passed to the users in the form of lower tariffs. However, it has been shown in different studies that these efficiency gains have a weak correlation with tariffs and usually reflect on a minor portion of them. According to Guasch, the efficiency gains are reflected only in 1 percent or less of the tariff value. In some cases, the government chooses to obtain those efficiency gains indirectly by increasing the taxes (Guasch L. , 2004).

In summary, the idea of a PPP is to combine the expertise and resources of the public and the private sectors in order to reach efficiency and value for money (VFM), yet the above disadvantages along with insufficient feasibility studies and poor decisions can turn a PPP from an advantageous method of delivering services to the public sector into leading to undesired results.

2 . 4 PPP Payment Mechanisms

Payments in PPP contracts are made based on the service availability, or what is called "verifiable outcomes," and are not paid against the cost of materials or the inputs of the process like other conventional contracts. In PPP project types where the private sector performs the construction agreement, it will not be paid until the service becomes available. Sometimes third parties are used to measure the output for the purpose of the payment. The public sector has to be very careful to define clear tools to measure the performance of PPP projects, especially if the output service is not as easy to quantify or verify. Surveys may be conducted to measure the performance of a project (Noble, 2006).

2 . 4 . 1 User Charges

This mechanism is used when the private sector is bearing the demand risk and, therefore, is collecting the payments or revenues from the users directly, as in the case of highways, bridges, or tunnel tolls. In determining the appropriate user charges, the public sector should apply tariffs in a manner that ensures the project will earn sufficient revenues to guarantee the bankability of the project. Sometimes it is necessary for the public sector to provide some help to the private sector to maintain the bankability of the project, such as providing a share of the capital expenditures (Capex) or grants. Another method is to provide revenue support, which is a way to support the private sector in cases of low demand during certain periods. Other governments may help with the debt guarantees in case of a major drop in demand that prevents the private sector from paying the debt at some stage (Noble, 2006).

In his paper "Contractual Structures and Risk Allocation and Mitigation in the Context of Public Private Partnerships in the Health Sector," Stemmer concluded that

the public sector has to be very careful when providing subvention, as fixed subventions are not recommended. In some cases, subventions decrease the performance of the private sector as it will transfer some of the demand risks back to the public sector. Hence, subventions should always be linked to the performance of the private sector. In some cases, the public sector may try to limit private sector profits when it is proven that the revenues are exceeding a certain boundary. One of the techniques of limiting the revenues is sharing surplus revenue, especially if the public sector is providing subventions. Another technique is capping revenues, but this may limit the private sector from enhancing the service and attracting more users (Stemmer, 2008).

2 . 4 . 2 Usage Payment

The payment in this case is provided by the public sector itself to the private sector for projects where it is known that the demand is not high enough to cover the debt and provide sufficient revenues to the private sector. In order to do that, a measurement tool has to be agreed upon between the two parties to measure the performance. If performance measures are not linked to the payment, the demand risk will be transferred to the public sector, which is not desirable and this makes it difficult to ensure that the private sector has an incentive to maintain the quality of the service until the end of the operation period. If the payments are made by users directly, this may be shown as a measure of the quality of the service itself. Therefore, if the payment is made by the government, the government has to take all necessary precautions to ensure that the service is delivered in a proper way, as mentioned above (Noble, 2006).

2 . 4 . 3 Availability Payment

The contract should mention clearly the definition of the service availability in order for the public sector to start paying the private sector for the service. Deductions are made in case of service unavailability. In addition, in some contracts it is stated that if within a certain period the private sector is able to rectify the service availability, minor or no deductions shall be applied. On the contrary, a provision in the contract is added for bonuses in case the private sector exceeds or enhances the performance level agreed upon with the public sector.

Sharma, in his PhD dissertation entitled "Design of Availability Payment Mechanism for Public Private Partnerships," developed a model that helps with designing availability payment for PPP contracts. In such contracts, the public sector usually defines an upper limit to the availability payment. Sharma's model calculates this upper limit, which guarantees that the public sector achieves its cost saving target and, at the same time, assures the re-equilibrium of the financial state of the private sector. The model also considers the different uncertainties and the financial state of the private sector (Sharma, 2012).

2 . 4 . 4 Monitoring and Control of Unplanned Payments in PPP Projects

In order to apply the above, the private sector has to introduce a quality management system to the project while the public sector shall review and monitor this system in order to ensure the service availability and performance. As this is the case in many countries, government officials may not be qualified or motivated enough to apply such monitoring systems; hence, it is recommended to use an external organization to perform the monitoring tasks for the public sector. This external organization shall be paid by the public sector to avoid any conflict of interest that could arise if it is paid by the private sector.

Spagnolo *et al*, in the report entitled "Contract Design in Public-Private Partnerships," states that in some projects, it is allowed for part of the facility to be rented to a third party, which will constitute secondary revenue for the private sector. If this has been accounted for in the bid price, then the private sector will earn such revenue. However, if this is not the case, then the revenue shall be shared between the public and the private sectors. Another source of unplanned revenue are price variations to protect the private sector from bearing the risk of cost overruns, which prevent the price from maximizing as a result of a huge mark up to account for such contingency. In any case, the service charge should always be adjusted to ensure that it will cover the financial obligations of the private sector. The contract has to state which "price index" will be used when calculating the inflation changes; moreover, it should define the "proportion of the tariff" or the part of the unitary payment to be affected by the inflation changes. On the other hand, the public sector may require a provision in the contract to protect itself when market prices decrease. (Spagnolo *et al*, 2007).

2 . 5 PPP Concession Period

As it is important to design the contract to be flexible enough to absorb changes and modifications in the project, as well as allow for an extension in the concession period to absorb the effects of such changes.

Meunier and Quinet, in their paper entitled "Tips and Pitfalls in PPP Transport Projects" stated that the contract duration should be designed very carefully in order to avoid unnecessary long concession periods, which constitute a greater risk for the private sector to forecast the future demand versus cost. In the case of a unitary payment mechanism, when determining the contract duration, it has to be connected with the amount of investment by the private sector and the unitary payments versus the residual value of the project assets. For example, if project assets will be given to the private sector after the completion of the project, then the duration of the contract should be relatively shorter in order to account for the residual value of the asset. In the case of a user charges payment mechanism, the contract duration is greatly connected with the amount of revenues expected along the project life. For contracts in which the cost of the projects depends on the condition of the assets and cannot be determined at the contract design stage, it is recommended to lengthen the contract duration to encourage the private sector to take on the project. However, in some countries there exist rules and regulations to limit the contract durations to certain number of years; for instance, in Chile, as well as Egypt, the concession period shall not exceed 30 years while in Italy it shall not exceed 50 years (Meunier & Quinet, 2010).

Albalate and Bel propose variable term contracts for PPP projects in their paper entitled "Regulating Concessions of Toll Motorways: An Empirical Study on Fixed vs. Variable Term Contracts." Albalate and Bel encourage the use of variable term contracts over the ordinary term contracts. Variable term contracts are contracts in which the concession period is not defined by a limited number of years but by certain conditions. The type that Albalate and Bel suggest is the Least Present Value of Revenue (LPVR) or the Least Present Value of Net Revenue (LPVNR). In those contracts, the concessionaire delivers the project back to the public sector after reaching a certain discounted value of revenue. This type of contract eliminates many disadvantages of the ordinary PPP contracts and tremendously minimizes the

probability of renegotiation. Despite the effectiveness of variable term contracts, they are rarely used in PPP projects nowadays (Albalate & Bel, 2009).

Bel *et al*, in their paper entitled "Public-Private Partnerships: Infrastructure, Transportation and Local Services," suggested that where the market is small with a low number of competitors, it is ideal to offer long contract durations in order to encourage a competitive atmosphere rather than internal agreements between the different competitors. On the other hand, if the market is unlikely to unify and there exists a spirit of competition between the different bidders, it is better to use short-term contracts, as these encourage originality and innovation, which usually lead to cost savings and quality enhancement. Another incentive that can be used is contract renewal based on the private sector performance. The shorter the contract duration, the greater the frequency of renewal, which constitutes a larger incentive for the private sector (Bel *et al*, 2013).

Vassallo, in his paper entitled "Traffic Risk Mitigation in Highway Concession Projects: The Experience of Chile," stated that the contract duration can be determined on the basis of the Least Present Value of Revenue (LPVR). In this case, when the LPVR is reached, the contract expires automatically. He concluded that some bidding options, such as the Minimum Income Guarantee (MIG) and the Revenue Distribution Mechanism (RDM) as well as the Least Present Value of Revenue (LPVR), decrease the probability of renegotiation (Vassallo, 2006).

In his PhD dissertation entitled "A Real Options Model for the Financial Valuation of Infrastructure Systems under Uncertainty," Kashani developed a model that estimates the value of the above measures. In his model, he was able to estimate a value for the Minimum Revenue Guarantee (MRG), or a price cap to be defined by the public sector. Kashani's measures took the demand risk into consideration and used Monte Carlo simulation with the aid of stochastic processes to develop his model (Kashani, 2012).

Shen *et al*, in their paper entitled "Alternative Concession Model for Build Operate Transfer Contract Projects," produced a model that can give an estimate of the optimum concession period in such contracts. Their model balances both the investor and the government interests, which makes this type of contract more efficient and appealing (Shen *et al*, 2002). Shen and Wu improved the model in their paper titled

"Risk Concession Model for Build/Operate/Transfer Contract Projects." In this model, they focused on different risks and their effects on the concession period. An investor has to account for the risks that may cause any delay or cost overrun to the project and increase the concession period to account for those risks. They used a hypothetical case to apply the project, which can be very misleading in terms of adjusting the variables to get the desired results. Because cash flows of a project cannot be a deterministic value, Shen *et al* used Monte Carlo simulation to model the effect of the different risks on the project cash flow (Shen & Wu, 2005).

In "The Cost of Contract Renegotiation: Evidence from the Local Public Sector," Gagnepain *et al* also stress the importance of increasing the concession period in order to make sure that the investor is getting fair returns on investment. This will minimize the probability of a contract renegotiation later in the project (Gagnepain *et al*, 2013).

Liou and Huang, in their paper entitled "Automated Approach to Negotiations of BOT Contracts with the Consideration of Project Risk," used the Monte Carlo simulation to produce a contractual-negotiation model. They also studied how the model would vary in case of high and low risk profiles. A conclusion was reached that a sponsor or an investor should be given a longer concession period in the case of a high risk profile project (Liou & Huang, 2008).

2 . 6 PPP Projects Risks

One of the major triggers of PPP renegotiation is the inability to predict and account for all the contingencies in the contract design stage; hence, PPP risks should be studied carefully. In their Procedure Manual, the Water Services Training Group in Ireland states that one of the main advantages of the Public Private Partnership approach is that it provides a better risk allocation approach for both the private sector and the government. Allocating risks to the party that is able to mitigate them is a good practice to help in attracting the private sector to engage in PPP projects. Transferring too many risks to the private sector may not be in favor of the PPP project and may cause the private sector to fail to meet the obligations of the contract. Moreover, some risks

cannot be transferred to the private sector, such as the political risks in the case that the service did not satisfy public needs (Water Services Training Group, 2012).

PPP risks have major effect on deciding whether or not to choose the PPP delivery method. Checherita, in her PhD dissertation entitled "A Macroeconomic Analysis of Investment under Public-Private Partnerships and its Policy Implications - the Case of Developing Countries," has developed a model to help in deciding whether to invest in a PPP project or not. The conclusion of the study was that some risks, such as exchange rates and public investment risks, have a great impact on the choice to invest in a PPP. Other factors affecting the decision were the degree of experience of the different parties, the economic condition of a country, and the degree of aid provided by the public sector (Checherita C. , 2009).

2 . 6 . 1 PPP Risk Management Process

2 . 6 . 1 . 1 PPP Risk Identification

In his paper entitled "Risks and Guarantees in BOT Tender", Tiong stated that, "Unpredictability is the kiss of death in BOT project financing" (Tiong, 1995). In order to minimize unpredictability, great concern should be given to the risk identification phase in risk management. In order for the risks to be identified, they have to be categorized either by project phases or by their type. In general, PPP project phases consists of bid phase, negotiation with preferred bidders, construction phase, operational phase, and transfer of asset phase. Risks can also be defined by their type, such as site risk, design, construction and commissioning risk, sponsor and financial risk, operating risk, market risk, network and interface risk, industrial relations risk, legislative and government policy risk, force majeure risk, asset ownership risk, etc.

Chan *et al* published a paper entitled "Potential Obstacles to Successful Implementation of Public-Private Partnerships in Beijing and the Hong Kong Special Administrative Region." In their paper, Chan *et al* identified the main risks affecting the PPP projects in Beijing and Hong Kong and compared them with the ones in the United Kingdom. They conducted a survey to identify the top risks in the PPP field. The results of the survey were that two of the major risks in both Beijing and Hong Kong are the long period of renegotiation and the delays due to political debate. One of

the top risks in Beijing was also the lack of experience and sufficient skills for managing PPPs, while in Hong Kong, it was the low number of concessions reaching the award phase (Chan *et al*, 2010).

2 . 6 . 1 . 2 Risk Assessment

Risks have to be assessed and studied carefully in order to allocate them to the suitable party and choose a suitable risk mitigation mechanism. The likelihood of the occurrence of a risk should be calculated carefully. This is not an absolute figure, as it is affected by many factors, one of which is the question of whether this risk is to be allocated to the public or the private sector. Another factor to consider is the effect of such risk if it materializes. In other words, some risks may have a high probability of occurrence, yet they have such a minor effect on the project that they can be neglected. Fischer *et al*, in their paper entitled "An Integrated Risk Management System (IRMS) for PPP Projects," stated that the risk management process is very complicated, especially in PPP projects. They conducted a questionnaire of 53 German PPP experts to evaluate the risk management status. The result showed that industry practitioners prefer to use qualitative techniques of risk assessment over more complicated techniques, such as simulation methods. Moreover, industry experts do not rely totally on the results of risk assessment due to the lack of transparency and accuracy (Fischer *et al*, 2010).

Tolani, in his PhD dissertation entitled, "An Examination of Risk Perceptions and Allocation Preferences in Public-Private Partnerships in Nigeria," conducted a questionnaire aiming to compare the comprehension of PPP risks by the private sector, the public sector and the bank. Tolani argued that the different parties of a PPP project perceive risks differently. However, the questionnaire results indicated that apart from poor workmanship risk, the three players had the same comprehension of the different PPP risks in Nigeria. The researcher conducted the same process in China and obtained the same result except for the corruption risk. This indicates that the private sector, the public sector and the bank have almost the same risk assessment of the different PPP risks (Tolani, 2013).

In their paper entitled "Evaluating the Risks of Public Private Partnerships for Infrastructure Projects," Grimsey and Lewis stress the need for assessing risks in PPP projects. Grimsey and Lewis developed a computer-aided model providing a framework for the process of evaluating the different risks from the perspective of the public sector, the private sector, and the lenders. They applied their framework to a case study of a wastewater treatment plant in Scotland and found that the objectives of the framework were achieved (Grimsey & Lewis, 2002).

On the other hand, from the lender's point of view, many risks are considered important. Demirag *et al*, in their paper entitled "Risks and Financing of PPP: Perspectives from the Financiers," study PPP risks from the perspective of the lender. They conducted a survey sent to 109 experts in PPP debt and equity, and almost 40 percent responded. The survey results showed that the lenders usually prefer that all risks are either insured or allocated. Moreover, the survey also proved that lenders usually go for an investment environment that they are aware of or worked in before, whether by working with the same institutions, the same type of projects, or in the same region. (Demirag *et al*, 2011).

2 . 6 . 1 . 3 Risk Allocation

The goal of risk allocation is to reach the optimum value of the project; in other words, the lowest contract price. If risks are allocated to the private sector while the public sector is the party who can control and predict such risks, then the private sector would have a very high contingency, resulting in an unnecessary increase in the bid price. This happens first by choosing the type of contract that would help in assigning the right risks to the party that is best suited to handle such risk. "Proactive contracting" is a term used by Tieva and Junnonen in their paper entitled "Proactive Contracting in Finnish PPP Projects," which means that the allocation criteria of PPP risks should be defined in clear terms in the PPP contract. The allocation criteria may include insurances, securities, or guarantees. An example of allocation of political risk and the necessity of obtaining governmental guarantees was used by Tieva and Junnonen (Tieva & Junnonen, 2009).

In the Partnership Victoria model, the government only pays the private sector for the output, which means that all risks that have to do with construction are allocated to the private sector. Given the above, governments should also take over the risks that they can handle the best in order to reach the optimal risk allocations. In the case of risks over which neither party has control, it is better to go with a shared approach in order to avoid high risk premiums if the full risk allocated to the private sector. In general, it should be allocated to the party which can best mitigate the rick. It is also recommended to relate the payment mechanism to the risk allocation, meaning that, "No service, No payment." In other words, payments should not start before the service is delivered to users, as this is an incentive for the private sector to complete the project according to the specifications of the government (Department of Treasury and Finance, 2001).

Ke *et al*, in their paper entitled "Preferred Risk Allocation in China's Public-Private Partnership," focused on China's Private Public Partnership projects, and how the different risks should be allocated to the different contractual parties. The research was conducted with the help of a two-round Delphi survey. Based on the survey results, 37 risks were defined, and only one risk should be totally allocated to the government: the risk of ''expropriation and nationalization." Twelve risks are mostly allocated to the public sector including, ''land acquisition" and ''approval and permit." Fourteen risks are shared equally between the public and the private sectors including ''ground/weather conditions" and ''force majeure" (Ke *et al*, 2010).

In "VFM and Risk Allocation Models in Construction PPP Projects" Li *et al* conducted a survey to gather results of both qualitative and quantitative risk allocation of PPP risks. In other words, it gathers information of the different types of PPP risks and the percentages of the risks allocated to the private sector, the public sector, or shared (Li *et al*, 2001).

Li *et al* published another paper entitled "The Allocation of Risk in PPP/PFI Construction Projects in the UK" in 2005. Li *et al* studied the Private Finance Initiative (PFI) which has the advantages of Private Public Partnership, yet it also transfers risk away from the public sector. A survey was conducted to define which risks should be allocated to the public sector and which to the investor. Risks were categorized into three categories: macro-level risks, such as macroeconomic risks; meso-level risks such

as construction and operation risks; and micro-level risks, such as coordination risks. Macro and micro-level risks are advised to be allocated to the public sector or shared with the private sector. While PPP/PFI projects usually contain meso-level risks, it is advised to allocate them to the private sector (Li *et al*, 2005).

Badran, in her thesis entitled "Risk Analysis and Contract Management for Public Private Partnership Projects in Egypt," also discussed the allocation of the different PPP risks in Egypt. Badran gathered 59 risks from the academic literature and conducted a survey to define the critical risk groups. She also developed a risk matrix with the different PPP risks and their recommended allocations (Badran, 2013).

Finally, it has been advocated that PPP risk allocation is not a straightforward decision. In their paper entitled "Perceived Risk Allocation in Public-Private-Partnered (PPP) Water Supply Projects in Indonesia," Wibowo and Mohamed conducted a survey aiming to gather experts' opinions about the allocation of the different risks of the water services-related PPP projects. The survey included 39 project risks that were grouped in six risk categories. Thirty-four experts who hold managerial positions in the water services-related companies responded to the questionnaire. The results were totally different from one questionnaire to the other, reflecting a large variance of who should bear certain risks. The risk transfer is one of the huge advantages of PPP; however, risk allocation requires further study in order to guarantee the success of PPP projects (Wibowo & Mohamed, 2008).

2 . 6 . 1 . 4 Risk Mitigation

The goal of risk mitigation is to reduce both the probability of a risk occurrence and the effect on different contractual parties if a risk materializes. Both the private and the public sectors have different mitigation mechanisms. The private sector mechanisms include passing the risks to a third party. As an example, the concessionaire usually passes the design and construction risks to a design and build contractor. An example of another famous mechanism is insurance. The public sector mechanisms are similar to those of the private sector. The public sector usually appoints different consultants or advisors in the different fields of the project, such as legal, financial, and technical consultants, (Delmon, 2010).

Li *et al* published another paper entitled "Risk Treatment Preferences for PPP/PFI Construction Projects in the UK" in 2004. In their paper, Li *et al* discuss the different risk mitigation techniques. They recommend the use of risk retention and risk transfer over the use of risk avoidance and risk reduction when dealing with PPP risks (Li *et al*, 2004).

2 . 6 . 1 . 5 Monitoring and Review

Monitoring and reviewing is the most important phase of risk management, as it ensures the effectiveness of the plan. It is significant to ensure that the risk management plan expresses all risks that can be identified in a certain project. Moreover, the process should not only guarantee that the mitigation plans are being followed and identify critical phases and deadlines, but also ensure its effectiveness and viability along the different phases of the project. In addition, the plan should continuously update the probabilities and impacts of each risk, and calculate its mitigation costs, as well. The reviewing process should also monitor the resources that should be available at certain times to deal with the risks (Noble, 2006).

2 . 6 . 2 Common Types of PPP Risks and Their Preferred Allocations

There are many types of risks, some of which are associated with a specific project and others which apply to almost any project. Both types should be considered when preparing the risk matrix for a PPP project.

2 . 6 . 2 . 1 Statutory Risk

Examples of statutory risks are land acquisition, permits, and compensations in the case of the land not being owned by the government. The public sector is the best party to control such risk, more so than the private sector, as in most cases, the public sector will carry out such tasks before the tender stage. In some countries, such as Latin America, the public sector cannot bear the statutory risks as it lacks the know-how and the technical capabilities to be competent to carry such risks. On the other hand, the private sector has no control over such risks; it will have to increase the contingency

allowance, which increases the unitary charges. In this case, it is optimum for the public sector to carry statutory risk. Li *et al* introduce the case study of YD2nd Tunnel in Shanghai, China in their paper "The Allocation of Risk in PPP/PFI Constructions Projects in the UK." During the mentioned project, the public sector chose to carry the statutory risk. Li *et al* recommend that the public sector carries the statutory risks, whether by using "in house" expertise or an external consultant, but bearing in mind that, at some point in time, the public sector should gain knowledge from such consultant in order to better handle the risks on its own (Li *et al* 2005).

2.6.2.2 Legislative Risk

Legislative risk is the risk that the government will change a law or a policy that will impact the project in a negative way. According to Dong, the government chooses to allocate this risk to the private sector. The private sector might deal with those changes in laws and minimize their effect on the project by passing the effect of such risk to the users through increasing the service charges. However, if the service is provided by the government itself, the private sector would opt to share the legislative risk with the public sector (Dong, 2010).

2.6.2.3 Output Specifications Risk

Iossa *et al*, in their report entitled "Best Practices on Contract Design in Public-Private Partnerships," stated that the output specifications are usually defined by the public sector during the pretender stage of the project. It is recommended that the output specifications risk be allocated to the public sector to serve as a motivation for the experts in the tender committee to spend time and effort to avoid any mistakes that might occur in the output specifications and appear later during the design stage. However, this might not be sufficient motivation for the public sector officials as, simply, the public sector officials may lack the financial and technical capabilities. In addition, PPP projects last for a long period of time, and mistakes are more likely to be discovered at a later stage, at which point the government employee responsible for them may have changed jobs already. Hence, the public sector should appoint consultants or an external advisory committee to produce the specifications of the

output requirements in order to be held accountable and carry such risks in case of an error discovered in a later stage of the project (Iossa *et al*, 2007).

2 . 6 . 2 . 4 Design, Planning and Construction Risk

In most of the cases, government interference during the design and the construction stage is minimal. The design, planning, and construction risk includes the design stage, the planning stage, the construction stage, the commissioning stage, and the operation stage. All of the above should be allocated to the private sector to work as a motivation to perform its obligations and duties under the contract agreement. The private sector should plan for any event that might result in a cost or a time over-run, or in mistakes in the design. Moreover, it should plan for any potential risks that would result in unavailability or inadequacy of the service provided. In some circumstances, the risk sharing mechanism between the public and the private sectors is used, especially when dealing with renovation projects, as the government in this case would be the party who can evaluate the conditions of the existing assets and predict the probability of occurrence of relevant risks (Stemmer, 2008).

2 . 6 . 2 . 5 Demand Risk

In their paper entitled "Private Concession Contracts for Toll Roads in Spain: Analysis and Recommendations," Baeza and Vassallo state that the demand risk is one of the main reasons for renegotiation. Demand risks can be allocated to the private sector, the public sector, or shared between the two of them depending on the nature of the demand in different PPP projects. For projects in which the users pay for the service, the demand risk is best allocated to the private sector, as it is the sector that can best quantify such risk. For projects wherein the public sector pays the private sector a unitary charge, the demand risk is best allocated to the public sector, as it is the one in control of the demand, such as in the case of prisons. Finally, in projects where the private sector depends on cash forecasts and cannot predict accurately the expected demand, such as infrastructure projects such as a road or a bridge, it is better to reach a risk sharing mechanism between the public and the private sectors (Baeza & Vassallo, 2010).

2 . 6 . 2 . 6 Price Risk

The price risk is the risk that the value of the service or the service charges will change from the base charge assumed at the beginning of the project. This can occur due to reasons such as an economic crisis, a change in government practices, new competition or substitutes entering the market, competitors lowering their prices, new preferences of the target market, or simply the service becomes outdated. The Office for Official Publications of the European Communities, in their report entitled "Long Term Contracts between Government Unites and Nongovernment Partners," states that the allocation of such risk varies depending on the nature of the project and whether the private sector deals with the users directly or through the government. In general, it is expected that the public sector is the best party able to quantify that risk, and it may, in an indirect way, change some of the public needs themselves. However, it is also recommended to introduce a risk sharing technique to involve the private sector in the equation, as it is the best party to assess the different ways to satisfy the public's needs as they arise. In order to mitigate this risk, a precise forecast should be developed to predict the demand and the market conditions of a certain service (Office for Official Publications of the European Communities, 2004).

2 . 6 . 2 . 7 Financial Risk

One type of financial risk is the possibility that a project will suffer a lack of funds at some period in time due to insufficient debt or equity. Other financial risks are a change in the prices of project elements prices, as well as the risk that the bidders have lowered their prices due to a competitive market to the extent that the private sector will not be able to fulfill its duties under the contract.

It is recommended to allocate the financial risk to the private sector, as it is the best party to deal with financial risks. This is a motivation for the private sector to avoid importing many foreign resources, and it serves on the domestic level to mitigate such risk as investors will try to use local suppliers. The public sector may also apply tariffs to the exchange rates in order to encourage the private sector to go to the local market instead. In the case of developing countries where importing cannot be avoided, the exchange rate risk should be allocated to the public sector. Moreover, the government usually prefers to allocate tax risks and the like to the private sector. However, unlike

several other references, Iossa *et al* maintain that the risks that have to do with changes in the price of project parameters, including for example a change in the interest rate, are shared between the public and the private sectors, but the public sector carries the larger share of the risk. The government can also mitigate the risk of the private sector underbidding the project by closely monitoring the bidding process and the market conditions at that time. In other words, the government should make sure that the short-listed bidders are able to fulfill the contract and not merely choose the lowest bidder without ensuring that the bid is the actual fair value of the project (Iossa *et al*, 2007).

2 . 6 . 2 . 8 Investment Risk

Pantelias, in his PhD dissertation entitled "A Methodological Framework for Probabilistic Evaluation of Financial Viability of Transportation Infrastructure Under Public Private Partnerships," defined the investment or sponsor risk as the risk that the private sector or its subcontractors fail to fulfill their duties and obligations in the contract; moreover, the government is unable to interfere and force the private sector to fulfill these obligations. This risk can be a result of a change in ownership in the private sector. In order to mitigate this risk, the government should ensure that the contract contains provisions to obtain the government consent before any change in the ownership of the private sector. The government should ensure that the new owner will be able to fulfill the contractual obligations. In this case, it is preferred that this risk be allocated to the public sector, as the private sector cannot regulate this type of risk (Pantelias, 2009).

2 . 6 . 2 . 9 Residual Value Risk

The residual value risk includes any damage of the facilities, a technology change that will result in the asset being obsolete, or simply the appearance of a substitute or competition. It is crucial for the public sector to ensure that the asset will be in good shape at the end of the concession period, which is why the public sector should put a provision in the contract to ensure that part of the payment to the private sector is retained against the condition of the asset at the end of this period. This risk

shall be allocated to the private sector as a motivation to ensure the quality of the asset at the end of the concession period (Engel *et al*, 2009).

2 . 6 . 2 . 10 Macroeconomic Risk

Checherita and Gifford, in their paper entitled "Risk Sharing in Public-Private Partnerships: General Considerations and an Evaluation of the U.S. Practice in Road Transportation," list the different PPP related risks and their preferred allocation. One of the risks introduced is the macroeconomic risk. An example of macroeconomic risk is the financial crisis of 2008. Macroeconomic risk is a risk that occurs on a wide scale and affects the economy globally. It can come in many forms, such as a crisis in the exchange rates or a severe financial crisis. Macroeconomic risk is better allocated to an insurer, or at least to the public sector, as it cannot be controlled by the private sector. Macroeconomic shocks and financial crises affect a concession contract enormously, as most of the operator's obligations and investment are in foreign currency while it collects its revenues in local currency (Checherita & Gifford, 2007).

2 . 6 . 2 . 11 Operation Risk

Operation risk is the risk of failing to deliver the service as per the contract due to a fault in a certain element in the operation process, or simply due to cost over-runs. The public sector prefers to allocate this risk to the private sector, as the level of intervention of the government is preferred to be kept minimal at this stage. In order to mitigate this risk, the government should carefully draft clear service output requirements. The private sector should forecast future plans for the service, and predict the change in the different operation requirements, if any. Those future plans should be mentioned in the contract to give the private sector flexibility to adjust the operation process in order to upgrade the existing process to meet those new requirements (Garg, 2012).

However, Iossa and Martimort, in their paper entitled "Risk Allocation and the Costs and Benefits of Public-Private Partnerships," stated that when the operation risk is very high, it better not to use the PPP option and combine the design with the execution of the service. In other words, in the case of a complex project, the

government would not be able to anticipate the project costs and operation contingencies in advance; hence, transferring the operation risk to the private sector is not the optimum solution (Iossa & Martimort, 2012).

2 . 6 . 2 . 12 Network Risk

PPP projects are usually large projects that deal with many parties to deliver the service. The private sector does not only deal with the public sector or the financiers, but also with many other parties, building a network. This network can include more than one PPP project, as well as some other parties that support the PPP projects. The network risk is the risk that any part of this network may not function properly, thus affecting the service delivery. For example, in the case of a water treatment plant, the private sector would collaborate with a water company to provide water for the treatment process. The failure of this water company to deliver water to the treatment plant will affect the service and, as a result, is a network risk. This risk should be allocated to the public sector, as the public sector is the only party that can coordinate with all the parties in the network. In order to mitigate this risk, during the pretender stage, the public sector should study carefully the relationships and dependencies between the different parties of the network; moreover, the government should make sure that the needs of the new project will be met (Hegazy & Wassef, 2001).

Jenkin, in his PhD dissertation entitled "Multiple-Case Examinations of Complex Decisions to Form Networked Public-Private Partnerships," was able to determine the factors affecting the decisions of PPP officials. Those factors should help in eliminating the network risk. The factors included economic and political factors that should be studied carefully to suit both the public and the private sectors. Moreover, the level of know-how required by the specifications of the service delivered by the PPP is another factor. Low turnover rates, risks allocation, and parties' reputations should also be considered in order to mitigate the network risk (Jenkins, 2012).

2 . 6 . 2 . 13 Interface Risk

The network risk deals with the broader network that the PPP project is part of, but the interface risk is about the inner network within the PPP project itself. The

interface risk is the risk that the process of delivering the service will in some way prevent the core service from being delivered to the users. An example is the sterilization process in a hospital where the time needed to accomplish this process will affect the delivery of the service to the hospital users. Such risk should be allocated to the private sector in order to ensure that the private sector will coordinate between the different players and make sure that the service is being delivered as per the contract (Archer & Cameron, 2003).

2 . 6 . 2 . 14 Force Majeure Risk

Force majeure risk is any event that would prevent the private sector from fulfilling its obligations in the contract, provided that this event is out of control of both the private and the public sectors. The public sector would prefer that this risk be allocated to the private sector. The private sector is asked to provide insurance for such risk as a way to mitigate it; however, if the cost of such insurance is very high or unreasonable, the risk is allocated to the public sector instead (Kashani, 2012).

CHAPTER 3 : CURRENT PRACTICE IN CONTRACT RENEGOTIATION

3 . 1 Current Practice

3 . 1 . 1 PPP Life Cycle

The lifecycle of PPP projects consists of seven phases. The PPP lifecycle starts with identification of the project of interest. Then, the client or the government should prepare a feasibility study, followed by the pre-qualification stage, and finally bidding the project. Then, both the client and the service provider start the negotiation stage, which leads to contract signing, after which the contract management stage continues until the end of the project lifecycle. The PPP project lifecycle is shown in Figure 3, which is prepared by the Public Private Partnership Central Unit in Egypt (Public Private Partnership Central Unit, 2009).

Figure 3: PPP Project Life Cycle (Public Private Partnership Central Unit, 2009)

Phase one of the PPP project lifecycle is the project initiation and screening, which answers the question of whether to proceed with the PPP delivery method or not. Phase two provides a detailed business case. This includes defining the exact scope and output specifications of the PPP project. It also includes a detailed technical, financial, economic, legal, and environmental feasibility studies. Phase three is concerned with the PPP affordability and risk assessment, which is done through developing a value for money (VFM) analysis and the Public Sector Comparator (PSC). In his paper entitled "Public Sector Comparator for Highway PPP Projects," Kerali defines the Public Sector Comparator (PSC) as a detailed study of calculating the PPP lifecycle cost in case the public sector decides to pursue conventional procurement methods, providing that it will deliver the same output specifications and quality of the private sector. The Public Sector Comparator (PSC) should account for the costs incurred by the private sector, such as the opportunity cost of public assets in the project; moreover, it should be adjusted for the interest rate, taking into consideration the inflation and any subsidies as well (Kerali, 2009).

If the PSC proves that the PPP option is more efficient, the project moves to phase four. Phase four is the tendering and procurement of the PPP project. This phase starts with issuing the Expression of Interest (EOI), followed by issuing the Information Memorandum and the pre-qualification documents. After receiving the forms from interested bidders, the bidding documents are prepared and sent to bidders in order to receive their final proposal. Another difference between PPP and conventional procurement methods is the bidder company. PPP requires the formation of a new entity called the Special Purpose Vehicle (SPV), which usually consists of a consortium of several companies (generally financial, construction, and operation companies). The SPV is formed for the purpose of conducting a single PPP project only. Moreover, in some rare cases, the public sector can be part of the consortium in exchange for shares.

Phase five is the most important of all phases: the bidder selection. There are many methods for the bidder selection phase; however, the most common technique is the two-envelope method. In this method, the bidders submit two sealed envelopes: a technical bid and a financial bid. The technical bid is to be opened at the beginning to exclude unqualified bidders, followed by the financial bids of the qualified bidders only. After comparing the financial models submitted by the different bidders to the Public Sector Comparator (PSC), the winning bidder is selected and notified.

Phase six is the contract signature and financial closure, which includes the implementation of Conditions Precedent. Phase seven is the post-award, monitoring which continues till the end of the project lifecycle. During the execution of the PPP project, the concessionaire usually does not receive any operation payments until the construction phase is completed and the facility is ready to be operated. The payment can be in a form of service charges paid by the government, fees paid by the users of the service, or a combination of both. In general, the concessionaire usually subcontracts a construction company, to which it passes the construction and output risks. In some cases, the concessionaire chooses to allocate to the construction contractor more tightened conditions, such as shortening the concession period or increasing the penalties. According to Kriegler, the form of agreement between the concessionaire and the construction contractor is usually a Design Build Agreement, Figure 4 (Kriegler, 2006).

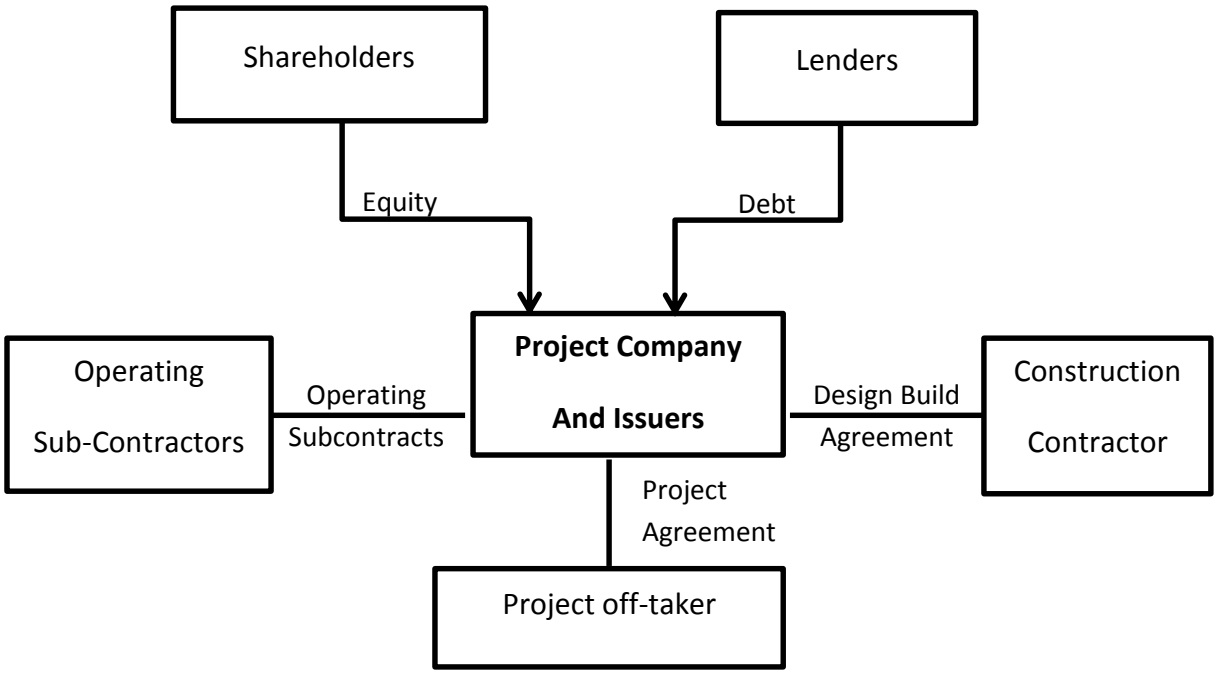


Figure 4: PPP Agreement Structure (Kriegler, 2006)

The concessionaire, or the private sector, is the key stone among the different parties involved in a PPP project. Figure 4 shows the relationship between the private

sector consortium and the government. It also shows the different components of the consortium, as it includes fund sources such as debt sources, usually represented in the bank, and equity sources, represented in the different investors. In addition, the consortium should include a design and construction contractor. The type of contract in this case is usually a design and build contract, as stated above. The consortium should also include the operator, which usually starts acting before the end of the construction phase and extends beyond the concession period and all the way up to the handover of the facility back to the government (Department of Treasury and Finance, 2001).

3 . 1 . 2 The PPP Financial Model

The financial bid of the PPP project is different from conventional projects, as it includes detailed calculations comprising all costs and revenues associated with the PPP project. The financial model is usually done on a spreadsheet, such as Microsoft Excel. According to the Public Private Partnership Handbook issued by the Asian Development Bank, the private sector financial model's main purpose is to calculate all the direct and indirect costs, contingencies, and profits in order to come up with the service fees. The model includes assumptions, inputs, and outputs. Assumptions include inflation rates, taxes, etc.; moreover, the modeler should input the capital expenditure (Capex), the operating expense (Opex), equity and debt service data, revenues based on forecasted demands or production rates, etc. The model also includes calculations of the different financial statements of the SPV, including income statement, cash-flow statement, profit and loss account, and the balance sheet. The model also provides a group of financial indicators such as the Internal Rate of Return (IRR), Return on Equity (ROE), Annual Debt Service Coverage Ratio (ADSCR), and Loan Life Debt Service Cover Ratio (LLCR) (Public Private Partnership Handbook, 2008).

According to Turhani and Turhani in their paper entitled “Financial Model of a PPP Project,” the importance of the bidders’ financial models is that they are compared to shadow bid models prepared by the public sector to ensure the viability of the bids. Further, the lenders usually require the private sector to submit the financial model in order to ensure that the private sector will be able to meet the loan payment deadlines. Moreover, the financial model is a very handy tool during the lifecycle of the project,

as it is the only way to adjust the service fees to reflect changes in the contract, variation orders, or refinance gains, if it is included in the contract conditions. It also can be used while monitoring the project budget and to provide financial statements along the lifecycle of the project (Turhani & Turhani, 2012).

3 . 2 Contract Renegotiation

3 . 2 . 1 Triggers of Renegotiation

Guasch and Straub, in their paper entitled "Renegotiation of Infrastructure Concessions: An Overview," stated that due to the length of PPP projects, renegotiation is inevitable during the concession period; therefore, the renegotiation process should be defined clearly and accounted for before awarding the PPP contract. Moreover, renegotiation triggers should be defined carefully and drafted in the contract in order to avoid unnecessary costs of unjustified renegotiation claims. The government can misuse its power; on the other hand, the private sector may ask to renegotiate the contract and obtain a better deal that may not be in favor of the users and may allow monopoly behavior by the private sector. Hence, good contract design and regulatory framework is necessary to regulate the incidence of renegotiating any concession contract (Guasch & Straub, 2006).

Guasch and Straub published another article, entitled "Corruption and Concession Renegotiations: Evidence from the Water and Transport Sectors in Latin America," in 2009. In their paper, Guasch and Straub discuss more than 300 PPP contracts in Latin America, and are able to prove that the level of corruption in the countries had a high impact on the number of contracts renegotiated. They summarized the different factors that increase or decrease the probability of renegotiation. The factors increasing the probability of renegotiation are corruption, many investment obligations, very competitive environment, allocating most risks to the private sector, lack of regulation enforcement, financial crisis, indulgent award requirements, and awarding the project close to election dates. The factors decreasing the probability of renegotiation are strong enforcement of the contract terms, gaining experience by increasing the number of PPP projects in a country, and minimizing the income guarantees (Guasch & Straub, 2009).

Moreover, Garg, in his PhD dissertation entitled "Working the PPP: Coordination of Public-Private Partnerships," also proves that the degree of experience of the different parties' representatives greatly affects the level of coordination among the different parties. This hugely influences the contract renegotiation possibilities, as well. While designing the contract, the contract terms should try as much as possible to account for any potential changes in the project. This ensures the flexibility of the contract and makes it easier to renegotiate the contract in a later stage when the change occurs. In cases where changes cannot be determined, a concept similar to cost plus contracts can be used, or a provision may be added in the contract against such change, provided that such cost plus value shall be reviewed by a committee of experts to ensure that the private sector will not take advantage of this cost plus method and that the costs are at the market prices (Garg, 2012).

In their paper entitled "Multidimensionality and Renegotiation: Evidence from Transport-Sector Public-Private-Partnership Transactions in Latin America," Estache *et al* state that the likelihood of renegotiation depends on many variables that exist along the lifecycle of PPPs, as early as the bidding stage. Renegotiation can be a result of internal project factors, such as unforeseen risks, or external factors, such as changes in the government policy. Renegotiation usually reflects an incomplete contract (Estache *et al*, 2009).

According to De Brux in his paper entitled "The Dark and Bright Sides of Renegotiation: An Application to Transport," the incompleteness of PPP contracts costs the public sector the burden of resorting to renegotiation. The complexity of renegotiation is proportional to the size and complexity of the project and the length of the concession period, as well. The more complex, bigger, and longer the project is, the highest the probability of going through contract renegotiation (De Brux, 2010).

In their paper entitled "Balancing Contractual and Relational Approaches for PPP Success and Sustainability," Kumaraswamy, Anvuur, and Rahman study inflexible contracts as one of the triggers of the PPP contract renegotiation. They propose a system that combines both the traditional contracting protocols and what is called relational contracting (RC), which is more flexible in terms of dealing with unforeseen conditions and the risk that arises suddenly during the execution of the project (Kumaraswamy *et al*, 2005).

Silva, in his paper entitled "Toll Roads: Recent Trends in Private Participation," conducted a literature review to explain some lessons learned from some cases of failure in Latin America. One of the cases was a toll road program that failed for several reasons; the main among them is that the contract was not flexible enough to mitigate all the construction and the operation risks. In other words, the contract gave more care to the construction risks than the operation risks (Silva, 2000).

According to Garvin in his paper entitled "Governance of PPP Projects through Contract Provisions," one of the most important factors in the renegotiation process is the mutual trust between the different parties, which leads eventually to sustainability. The key aspect of this approach is sharing benefits and risks among the different parties of the PPP through the contract agreement; however, some problems and unforeseen risks may occur during the construction and the operation that have not been included within the contract clauses. Garvin has studied different incentives mechanisms through some contract clauses in order to make those clauses flexible to absorb any risks arising after the commencement of the project and minimize the need for renegotiation (Garvin, 2009).

Dong, in his PhD dissertation entitled "Essays in Advanced Risk Management and Quantitative Strategies in Infrastructure Finance," used the concept of contract flexibility, as well. In his dissertation, he incorporated the critical success factors (CSFs) of PPP projects into a tool to help achieve economic efficiency of PPP projects by using the concept of contract flexibility (Dong, 2010). Finally, clear and flexible contract provisions, choosing a suitable payment mechanism, and providing transparency along the project execution are good practices to encourage investors to pursue the PPP path and minimize the probability of renegotiation.

According to the European Investment Bank (EIB), renegotiations that lead to major changes in PPP contracts are banned by the European Union Laws; in addition, it recommends that contracts are drafted in a way that minimizes the need for larger renegotiation operations. Moreover, the EIB proposes using a "facilitator" to moderate the renegotiation process in a fair and neutral way in order to guarantee its efficiency. The bank states that the renegotiation process has many benefits for regaining the equilibrium of the contract; however, most recorded renegotiation requests aim only for unjustified gains, which should be forbidden (European Investment Bank, 2011).

Roach also recommends, in his PhD dissertation entitled "Law and Politics in Public Private Partnerships: Transparency, Conflict of Interest, and Renegotiation in Concession Arrangements," establishing an "independent auditor" within the public sector to be responsible for all the PPP projects in the state or government. Roach suggests that the independent auditor be formed by five members who have knowledge and experience in the PPP field. The advantage of such an institution is to avoid conflicts between the different governmental institutions involved in the PPP process that may lead to the failure of PPP projects. Roach states that the auditor will prevent any initiations of conflicts of interest and will help in the process of renegotiation in general (Roach , 2011).

Other than the above recommendations, the contract designer of a PPP project should apply some adjustments in order to ensure a well-defined path for the renegotiation process to avoid unfavorable solutions, such as termination. Dewatripont and Legros, in their paper entitled "Public-Private Partnerships: Contract Design and Risk Transfer," recommend that PPP contracts have a clear method of output indicators. They also suggest a clear procedure to revise the different cost items and evaluate the investments and assets of the project. Moreover, PPP contracts should include a clear method of conflict resolution and early termination (Dewatripont & Legros, 2009).

Chan and Yu, in their paper entitled "Contract Strategy for Design Management in the Design and Build System," discussed the design and build projects with large scales similar to PPP projects. Although the public sector procures the private sector to do the design and construction work, the coordination between the designer and the contractor is still a concern for the public sector. The paper focuses on the different responsibilities in the design phase and how the design is coordinated between the design consultant and the contractor. In addition, the researchers performed a survey to determine the obligations of each party in the design stage and the ability of existing contract terms to reflect these obligations. Chan and Yu introduce a set of rules to be considered when drafting the contracts in order to avoid renegotiation (Chan & Yu, 2005).

3 . 2 . 2 Frequency of Renegotiation

Renegotiation arises from a major change that is usually included within the terms and conditions of the concession contract, such as a change in law, a change in payment, a change in the concession period, or a change in technical standards. Changes in tariffs due to inflation or periodic changes as per the contract are not considered to be renegotiations.

In their paper entitled "Concessions of Infrastructure in Latin America: Government-Led Renegotiation," Guasch, Laffont and Straub present statistics belonging from Latin America that renegotiation occurs in 74 percent of water and sanitation concession contracts versus 55 percent in transportation concession contracts; moreover, they are able to calculate an average of the time of renegotiation from the contract award date, which was estimated to be 1.6 years in case of water and sanitary projects versus 3.1 years in case of transportations projects. The above results show a high frequency of renegotiation in concessions contracts, which raise the question of the validity of the concession model and its efficiency. If bidders become aware of their ability to easily renegotiate the concession, they would be inclined to gain the concession at any price, then renegotiate the terms to obtain a better deal that erases the benefits of a concession contract. Hence, Guasch *et al* recommend fixing a renegotiation fee to be paid by the private sector in order to avoid unnecessary renegotiation claims; however, such fees shall be refunded to the private sector in case the renegotiation was in favor of the private sector (Guasch *et al*, 2007).

Moreover, contract renegotiation is more likely to occur in contracts awarded through competitive bidding, while it is less likely to occur in bilateral negotiation concession contracts, as bidders may be forced to lower their prices to unrealistic margins to stay in competition. According to Marques and Berg in their paper entitled "Revisiting the Strengths and Limitations of Regulatory Contracts in Infrastructure Industries," contracts which follow a price cap regime are subjected to renegotiation more than contracts following the rate of return regime. In 60 percent of the cases, the private sector is the initiator of the renegotiation. Table 2 explains the percentages of renegotiated contracts with the combined effect of the type of regulation and the initiator of the renegotiation. In case of the Price Cap Regime, the operator feels at risk;

hence, this justifies the 83 percent of operators initiating the renegotiation process (Marques & Berg, 2010).

Table 2: Percentage of Renegotiated Contracts (Marques & Berg, 2010)

Initiator of Renegotiation	Both Government and Operator	Government	Operator
Price Cap	11%	6%	83%
Rate of Return	39%	34%	26%
Hybrid Regime	30%	26%	44%

3 . 2 . 3 PPP Contract Renegotiation and the Re-equilibrium Model

Due to the long term nature of PPP projects, unforeseen conditions have a very high probability of occurrence; hence, PPP contracts usually contain provisions for contract renegotiation in order to enhance transparency and flexibility in the contract. The private sector should have a very strong financial monitor and control policy in order to identify the events that may lead to unbalancing the contract equilibrium.

The agreed upon financial model of a PPP project is used as a basis to create a re-equilibrium model. The financial model provides a way for the different parties in the PPP project to have common ground when forced to make some modifications to the service fees. The importance of the re-equilibrium model comes from its transparency, which makes it clear for all parties which parts have changed, as well as the effect of such parts on the rest of the model.

The private sector, the public sector, or both may call for contract renegotiation upon realizing a change in the financial model equilibrium. In PPP contracts, the party responsible for preparing the re-equilibrium sheet whenever a risk materializes and defining responsibilities of events is called the Independent Financial Expert, which is a third party. Whenever a risk arises, the Independent Financial Expert calculates the impact of such risk on the different elements of the base financial model. The change can be in the assumptions or the inputs of the base financial model components. Then, the Independent Financial Expert develops the re-equilibrium sheet, which usually has a number of options to keep the financial model balanced and ensure that the private sector is getting the contractual internal rate of return (IRR). The common three

scenarios that the re-equilibrium sheet has are: increasing the service charges, increasing the concession period, paying a lump sum amount to the private sector, or a combination of any of the above in order to maintain the original IRR constant.

3 . 2 . 4 Results of Renegotiation

The output of the renegotiation process is usually a change to the financial model, which reflects a number of possibilities, such as a change to the service charge rate, a change to one or more of the different cost items, a change to the concession period, etc.

Ho, in his paper entitled "Model for Financial Renegotiation in Public Private Partnership Projects and Its Policy Implications: Game Theoretic View," develops a dynamic game model, which means that the decision makers in the model make their decisions in sequence; in other words, the government knows the decision of the private sector before making their new decision, and vice versa. A game theory model is a term describing "the study of mathematical models of conflict and cooperation between intelligent rational decision-makers" (Myerson, 1991). The aim of Ho's model is to help the public sector in developing new policies and regulations to avoid the opportunistic behavior of the private sector bidders by comparing the political cost of re-tendering the project versus the political cost of renegotiation (Ho, 2006).

When discussing the results of the renegotiation process, the question shall always be whether to accept or reject the renegotiation claim. Ho, in his paper entitled "Government Policy on PPP Financial Issues: Bid Compensation and Financial Renegotiation," has developed a model to answer this question. Ho recommends avoiding renegotiation as much as possible, as it usually favors the private sector and may harm the competitive nature of the bidding process. Ho develops a game-theoretical model for the financial renegotiation process (Ho, 2009).

In the below table, Guasch, Laffont, and Straub demonstrate the percentage of negotiated contracts with a certain renegotiation outcome. As shown in Table 3, 69 percent of the renegotiated contracts in the selected sample agreed to delay the targets of the investment obligations of the private sector (Guasch *et al*, 2007).

Table 3: Renegotiation Outcomes (Guasch L., 2004)

Renegotiation Outcome	% Renegotiated Contracts
Delays on investment obligations targets	69%
Acceleration of investment obligations	18%
Tariff Increases	62%
Tariff Decreases	19%
Increase in the number of cost component which increase tariff	59%
Extension in the Concession Period	38%
Increase Annual fees paid by the Operator	17%
Decrease Annual fees paid by the Operator	31%

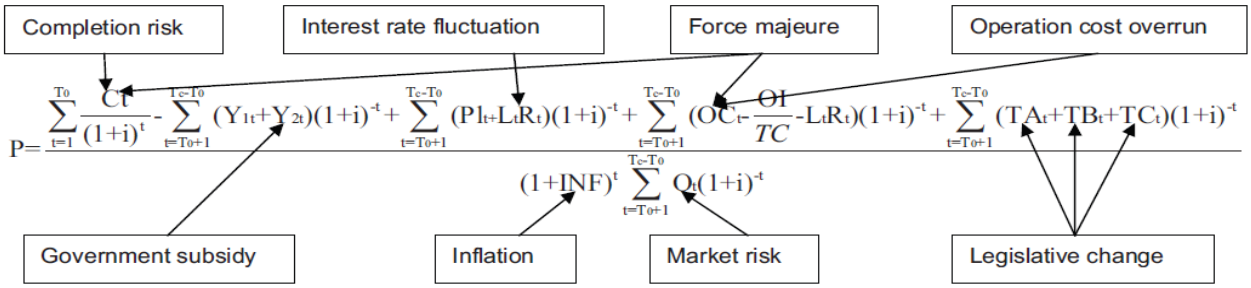
Xu *et al* developed a pricing model to calculate the price of PPP contracts both before and after renegotiation in their paper entitled, "Developing a Concession Pricing Model for PPP Highway Projects." They generated a simplified equation to calculate the concession price present value based on the in and out cash flows, considering the construction and operation costs, the loan repayment, taxes, and revenues. Equation 1

$$P = \frac{P_t}{(1+INF)^t} \qquad P_t = \frac{\sum_{t=1}^{T_0} \frac{C_t}{(1+i)^t} - \sum_{t=T_{0+1}}^{T_c} (Y_{1t} + Y_{2t}Pl_t - L_tR_t - C_{0t} - TA_t - TB_t - TC_t)(1+i)^{-t}}{\sum_{t=T_{0+1}}^{T_c} Q_t(1+i)^{-t}}$$

Concession price P ,
Concession price in the tth year P_t,
Daily average traffic flow in the tth year Q_t,
Other operation income in the tth year (i.e. advertisement income etc) $Y1_t$,
Government subsidy in the tth year $Y2_t$,
Project capital fund in the tth year C_t,
Payment of loan principle in the tth year Pl_t,
Loan balance in the tth year L_t,
Interest in the tth year R_t,
Operation cost in the tth year C_{ot},
Business tax in the tth year TA_t
Sales tax extra charges in the tth year TB_t
Income tax in the tth year TC_t
TC is the Concession Term,
T0 is construction period,
Inflation rate INF

Equation 1: PPP Pricing Equation (Xu *et al*, 2012)

shows the steps of calculating the concession price by considering the financial elements and price parameters of PPP. Xu *et al* developed a price adjustment mechanism in order to account for unforeseen risks and fluctuation in inflation and interest rates in the original pricing equation. Equation 2 shows the different PPP risks and their effect on the pricing equation (Xu *et al*, 2012).



$$P=\frac{\sum_{t=1}^{T_0}\frac{C_t}{(1+i)^t}-\sum_{t=T_0+1}^{T_c-T_0}(Y_{1t}+Y_{2t})(1+i)^{-t}+\sum_{t=T_0+1}^{T_c-T_0}(Pl_t+L_tR_t)(1+i)^{-t}+\sum_{t=T_0+1}^{T_c-T_0}(OC_t-\frac{OI}{TC}-L_tR_t)(1+i)^{-t}+\sum_{t=T_0+1}^{T_c-T_0}(TA_t+TB_t+TC_t)(1+i)^{-t}}{(1+INF)^t\sum_{t=T_0+1}^{T_c-T_0}Q_t(1+i)^{-t}}$$

Equation 2: The Effect of PPP Risks on the Pricing Equation (Xu *et al*, 2012)

3 . 3 Tools to Facilitate the Renegotiation Process

3 . 3 . 1 Decision Support Systems (DSS)

Decision Support Systems (DSS) are tools to choose from a set of alternatives. DSS can be very helpful in assisting the choice among the different re-equilibrium scenarios of the PPP financial model. Such tools can facilitate the PPP contract renegotiation process. In their paper entitled "Developing a Theory of Construction Problem Solving," Li and Love conclude that Decision Support Systems can be developed to deal with complex decisions (Li & Love, 1998).

In their paper entitled "Management Information Systems," Sousa and Oz state that Decision Support Systems (DSS) usually contain three modules: "Data Management Module," "Model Management Module," and "Dialog Module;" moreover, in some cases, it also contains "Sensitivity Analysis Module." The Data Management Module is where the database is; in other words, it contains all the relevant data that will be used in the decision making process. The Model Management Module can be a fixed or dynamic module, in which the output can depend on fixed data, or it can change with the change of data. Another name of the Dialog Module is the user interface, where this is the part of the model with which the user will be dealing. The

Sensitivity Analysis module is the module measuring the effect of certain inputs on the outputs of the model (Sousa & Oz, 2014). Decision Support Systems (DSS) are systems developed to imitate experts; they can be used in many applications, such as making choices, consulting, teaching, training, diagnosing, repairing, predicting, and monitoring and control (Turban & Watson, 1994).

In this research, the alternatives to be chosen from are the outputs of the renegotiation process, which are increasing the service charges, increasing the concession period, or paying a lump sum amount to the private sector. The limitation of the decision is to maintain the contractual internal rate of return (IRR) constant. The factors affecting such a decision are different and vary according to whether they are associated with the private sector or the public sector. As stated in the problem statement section, the public and the private sectors usually have different interests when it comes to renegotiation. The private sector is seeking profits, while the public sector is seeking public demands. Hence, DSS will serve in making sure that the interests of both parties are considered in the decision making process.

3 . 3 . 2 Applications of DSS in PPP

Ghavamifar, in his PhD dissertation entitled "A Decision Support System for Project Delivery Method Selection in the Transit Industry," developed a Decision Support System that helped the public sector in the selection process of a suitable delivery method for the transit projects. Ghavamifar included many parameters in his model, such as financial issues, including the value for money (VFM) aspect and the public sector comparator (PSC) in case of PPP delivery method. By choosing the most suitable delivery method, projects were more likely to attain their goals in efficient ways. One of the main advantages of Ghavamifar's model is that it was a tool which provides a fair comparison between PPP and conventional delivery methods despite the many differences between them (Ghavamifar, 2009).

Gross, in her PhD dissertation entitled "Aligning Public-Private Partnership Contracts with Public Objectives for Transportation Infrastructure," developed Decision Support Systems for determining the key features of PPP contracts, such as the length of the concession period, the payment mechanism, and the risk mitigation

techniques. Gross studied a database of eighteen PPP projects in the United States and other countries by using a new method called "Qualitative Comparative Analysis (QCA)" in order to assess qualitative data quantitatively. The criteria of selection included reaching a specific unit rate, minimizing government subsidies, and increasing revenues (Gross, 2010).

Kassab, in his PhD dissertation entitled "Integrated Decision Support System for Infrastructure Privatization under Uncertainty Using Conflict Resolution," developed a Decision Support System to choose a suitable PPP type for an infrastructure project. PPPs have many types that can suit the different parties' interests. This model helps in reducing conflict by being able to choose a module that fits all parties, minimizing the probability of conflict. It also minimizes cost and time wasted in those conflicts. Moreover, Kassab's model is adjusted to suit environments with high levels of uncertainty (Kassab, 2006).

Finally, Jin, in his paper entitled "Neurofuzzy Decision Support System for Efficient Risk Allocation in Public-Private Partnership Infrastructure Projects," developed a Decision Support System with the aid of artificial intelligence tools to predict the optimum allocation of risks in infrastructure PPP projects. The model proved to give precise and effective results (Jin, 2010).

3 . 4 Originality of Research

This research develops a framework in order to support and facilitate the PPP contract renegotiation process. As shown in previous research, the contract renegotiation process is very frequent in the case of PPP projects. The tool developed consists of a Decision Support System in order to enable the model developed to deal with choosing a renegotiation re-equilibrium scenario suitable for both the public and the private sectors. This has never been attempted in previous research. The Decision Support System will not only provide a way to choose among the different re-equilibrium scenarios, but it will also provide a tool to calculate the different scenarios. The Decision Support System is a user-friendly tool which helps non-expert users through the decision making process. The model shall also provide the user with

strategic decision making reports and sensitivity analysis. This model is considered interdisciplinary research, as it combines civil engineering and management sciences.

CHAPTER 4 : RESEARCH METHODOLOGY

4 . 1 Framework Development

The purpose of this research is to facilitate the PPP renegotiation process, starting from specifying the events leading to renegotiation, moving to formulating the re-equilibrium scenarios, and finally choosing the optimum scenario to satisfy all parties. Stakeholders have different interests and concerns in the renegotiation process; hence, the proposed model will work on finding common ground between all parties in order to reach an optimum renegotiation outcome. This will ensure a fair approach and enhance mutual trust between the stakeholders, which will benefit the project's overall progress.

The following framework is to be of great benefit to decision makers in the public and the private sectors, yet the objective of the proposed framework is not to be a substitute for decision makers. During renegotiation, the only way to benefit the project is to make sure that all parties are compensated justly so that they can fulfill their obligations under the contract agreement; in other words, if the investors are not getting a sufficient rate of return, the project will not function properly, which will eventually harm the interests of the client.

In order to achieve the thesis objective, a framework is developed in order to facilitate the PPP contract renegotiation process. The framework consists of eight modules: a User-Interface Module, a Risk Allocation Module, a PPP Valuation Module, a Financial Model Re-equilibrium Module, a Scenarios Development Module, a Scenarios Selection Module, a Reports Module and a Sensitivity Analysis Module, Figure 5. The user-interface module interacts with all the other seven modules as it provides inputs and receives outputs from all of them. The risk allocation module presents the risk matrix of the project and the risks allocated to the private sector, the public sector, or shared between them. It also shows the impact of the risks on the different cost parameters. The PPP valuation module defines the present value of the concession, while the financial model re-equilibrium module defines the adjusted present value due to an event or a group of events resulting in the destruction of the balance of the financial model equilibrium. Then, the scenarios development module

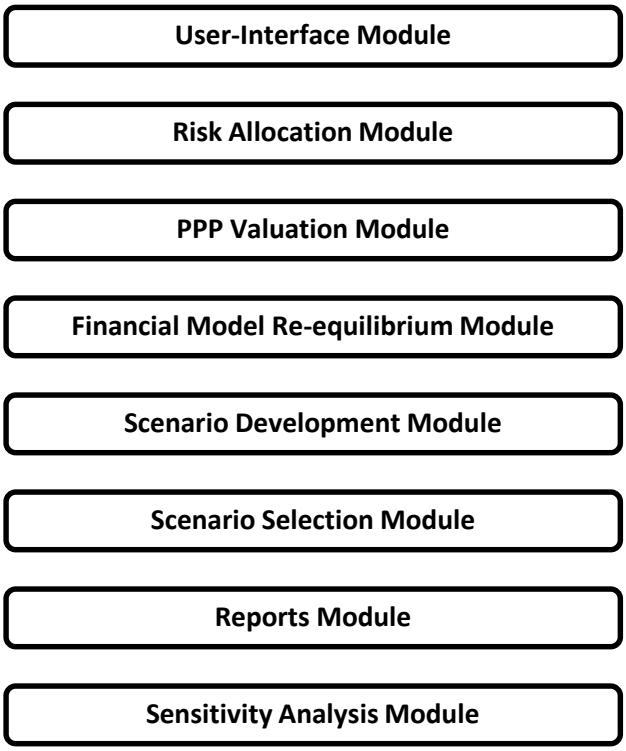


Figure 5: Proposed Framework Modules

calculates the different scenarios to return to the contract equilibrium. The scenarios selection module helps to provide a clear method of selection among the different scenarios. Finally, the reports module and the sensitivity analysis module provide the decision maker with a user friendly version of the results and analysis in order to help him in the decision making process.

4 . 2 Prototype DSS Model

A prototype Decision Support System model is developed to reflect the proposed framework. The model is constructed by using a number of computer-aided programs including Microsoft Excel 2013, Visual Basic for Applications (VBA) programming language, and the Precision Tree 5.5 for Excel add-in. Moreover, the Visual Basic for Applications (VBA) programming language helped in making the user-interface module simpler, more user-friendly, and more adaptive to the user's requirements. This model is considered to be a multi-user system in which both the public sector and the private sector interact with the user-interface consecutively.

Moreover, the Precision Tree 5.5 for Excel add-in tool provided a more vivid presentation of the process of selecting the best scenarios for the public sector, the private sector, and both of them. It also provided a number of reports and the sensitivities of the different inputs.

As stated in the previous section, the framework has eight modules: a user-interface module, a risk allocation module, a PPP valuation module, a financial model re-equilibrium module, a scenarios development module, a scenarios selection module, a reports module and a sensitivity analysis module. Each of the above modules has a number of sub-modules, as shown in Figure 6. The user-interface module has the

Figure 6: The Framework Sub-modules

project general information, risk matrix, risk allocation information, risk impact, initial payment information, updated payment information, scenario selection criteria, criteria importance, and criteria ranking. In addition, the risk allocation module has the risk allocation tables. Moreover, the PPP valuation module has the initial payment distribution and the PPP value calculations. The scenarios development module has the re-equilibrium scenarios calculations, while the scenarios selection module has the scenario selection criteria, the criteria weights calculations, the weighted sum model, the best scenario calculations, the private sector decision tree, and the expected monetary value (EMV), the public sector decision tree and the expected monetary value, as well as the combined decision tree and the expected monetary value. Finally, the reports module has the risk allocation charts, the PPP initial value, the PPP updated value, the re-equilibrium scenarios, the private sector best scenario, public sector best scenario, the combined best scenario, the probability chart report, the cumulative chart report, the statistical summary report, the decision table report, the optimal tree report, and the policy suggestion report, and the sensitivity analysis module has the selection criteria sensitivity analysis.

4 . 2 . 1 The User-Interface Module

The user-interface module networks with all the other modules; the relationship between the user-interface module and the other modules is shown in Figure 7. This module's function is to provide inputs to the risk allocation module, the PPP valuation module, the financial model re-equilibrium module, the scenarios development module, and the scenarios selection module based on an interactive dialogue among those different modules and the user-interface module. Then, it receives the results and analysis from the reports module and the sensitivity analysis module. There exists a continuous interaction between this module and the other modules along the framework. The input process is dynamic, as it depends on sending and receiving information along the modules of the prototype model. A set of inputs is entered, and, based on the obtained results from a specific module, the following set of inputs become ready to be entered.

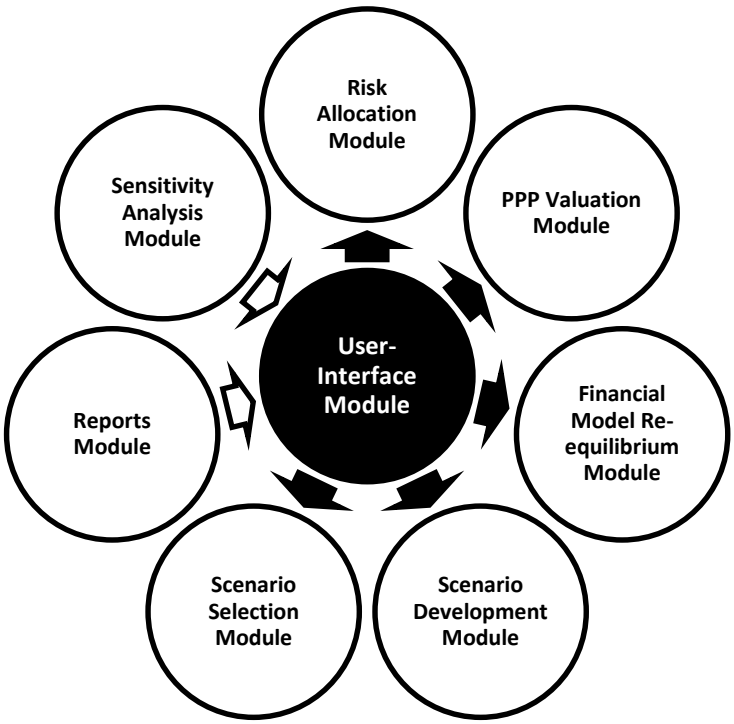


Figure 7: Modules Interrelation

The first set of inputs includes the project name, the PPP contract type, the payment mechanism, the payment amount, and the payment intervals. It also contains some information with regard to the risk allocation module about the risks profile of the project, including all possible risks, their allocations, and their expected impacts on the project valuation process. The framework provides both options of having a standardized risk sheet and an inputted one. The risk sheet contains the PPP risks, and their preferred allocations and expected impacts on the valuation process.

Then, the user is asked to enter the second set of inputs: some information regarding the PPP valuation module, such as the initial payment distribution of the project, like the capital expenditure distribution along the lifecycle of the project, and other costs and revenues as well. The third set of inputs are for the financial model re-equilibrium module, such as the main reasons for the re-equilibrium of the contract and the corresponding risks and their allocation. It also includes the updated payment distributions.

The above inputs are used in the scenarios development module in order to obtain the three common re-equilibrium scenarios: increasing the service charges,

increasing the concession period, or paying a lump sum amount to the private sector. Then, the user-interface module presents those three scenarios in order to choose a combination for a fourth scenario (i.e., the fourth scenario shall be an increase in the concession period and a payment of a lump sum amount to the private sector). The scenarios development module then uses those inputs to provide the final four scenarios, moving to the scenarios selection module to pick the best scenario that would maximize the satisfaction of both parties.

This comes by another set of inputs representing the criteria of scenarios selection, their weights, and importance with respect to the four scenarios, and the ranking of the sub-criteria, based upon which the public sector and the private sector choose their best scenarios. Finally, the results are analyzed and reported via the reports module and the sensitivity analysis module back to the user-interface module.

4 . 2 . 2 The Risk Allocation Module

The risk allocation process is a very important process in construction projects, and it is even more important when dealing with long-term PPP projects. The significance of risk allocation is clear during the renegotiation process. As stated in the literature, the government shall only compensate the private sector for the portions of the risks that are allocated to the public sector; hence, a clear definition of risk allocation should exist in the PPP contract and be included in this proposed framework.

Figure 8 shows the relationship between the risk allocation module and the other related modules. As shown in the figure, the inputs of the risk allocation module come from the user-interface module, while the outputs of the risk allocation module are heading for the PPP valuation module, the financial model re-equilibrium module, and the reports module.

In the proposed framework, there are two options for obtaining the risk allocation percentages of the public sector and the private sector. The first option is the user-interface module via inputting the actual values of the risks allocation stated in the PPP contract, which is the ideal choice.

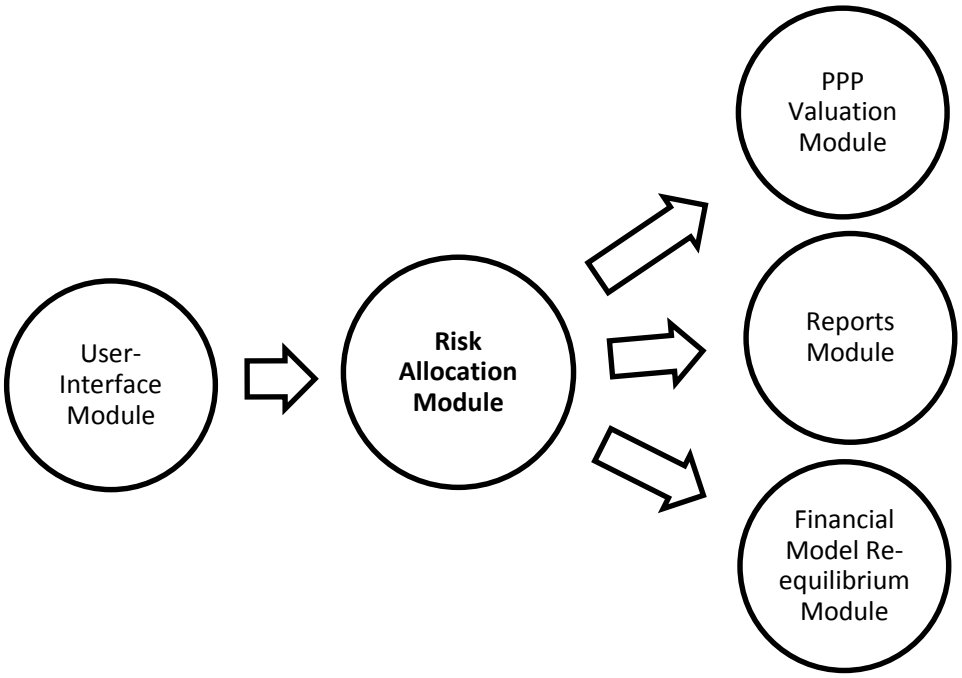


Figure 8: The Risk Allocation Module Interrelation with the Other Modules

On the other hand, the risk allocation percentages can be obtained from a redefined risk allocation matrix, which is based on a survey conducted by Badran in her thesis entitled "Risk Analysis and Contract Management for Public Private Partnership Projects in Egypt." The predefined risk allocation percentages are shown in Table 4 (Badran, 2013). The risks were categorized into three groups: country risks, sector risks, and project risks. This is not the optimal choice, as it will not reflect the exact risk allocation percentages in the PPP contract; however, this option can be used when doing a quick check, or when the re-equilibrium value is already agreed upon and there is no need to look into the responsibilities and risk allocations in detail. In general, Table 4 presents the three main categories and the different PPP risks with their percentage allocations and the party to which it is allocated.

The risk allocation module also includes a section that studies the effect of certain risk occurrences on the different parts of the PPP valuation process. This will not only affect the PPP valuation process, but will also affect the financial model re-equilibrium module. Risks are the main triggers of renegotiation, which means that the events leading to renegotiation should be studied thoroughly and assigned to their corresponding risks in order to define the bearer of such risk. The financial model re-

equilibrium module shall only account for a portion of the risks that are allocated to the public sector. Finally, the results are reported via the reports module.

Table 4: Qualitative and Quantitative PPP Risks Allocation (Badran, 2013)

#	Risk Factor	Private (%)	Public (%)	Both (%)	Risk Allocation
	Country Risks:				
1	Interest Rate Fluctuation	32	12	56	Both
2	Inflation	24	20	56	Both
3	Foreign exchange fluctuation	36	16	48	Project Dependent
4	Public Credit	20	28	52	Both
5	Political Risk	28	8	64	Both
6	Nationalization/expropriation	56	16	28	Private
7	Government corruption	60	12	28	Private
	Sector Risks:				
8	Price Change	40	8	52	Both
9	Revenue Risk	36	24	40	Project Dependent
10	Market competition	36	12	52	Both
11	Supply and demand	24	16	60	Both
12	Change in Market demand	12	24	64	Both
13	Legislation changes	32	20	48	Project Dependent
14	Change in tax regulation	36	20	44	Project Dependent
15	Government policy	24	16	60	Both
16	Political/Public opposition	12	24	64	Both
17	Swings in Public Opinion	20	16	64	Both
18	Regulatory/Contractual Risk	44	8	48	Project Dependent
19	Government Intervention	40	16	44	Project Dependent
20	Poor public decision making process	36	24	40	Project Dependent
21	Inadequate law and supervision system	36	32	32	Project Dependent
22	Lack of supporting infrastructure	12	20	68	Both
	Project Risks:				
23	Operation cost overrun	76	0	24	Private
24	Inability of concessionaire	36	8	56	Both
25	Subjective Project evaluation method	24	12	64	Both
26	Insufficient project finance supervision	44	4	52	Both

27	Performance Security Risk	56	4	40	Private
28	Permits Risks	20	8	72	Both
29	Delay in project approvals/permits	20	16	64	Both
30	Dispute resolution	28	0	72	Both
31	Imperfect contract documents	20	16	64	Both
32	Deficiency of design	32	12	56	Both
33	Quality Assurance	36	8	56	Both
34	Quality Control	32	8	60	Both
35	Latent Defect Risk	52	0	48	Private
36	Project/operation changes	52	8	40	Private
37	Inability of concessionaire	32	8	60	Both
38	Provision of transformers, substations or backup power	38	8	56	Both
39	Construction Risk	76	0	24	Private
40	Organization risk	64	0	36	Private
41	Coordination risks	44	4	52	Both
42	Land acquisition	22	32	56	Both
43	Physical Obstacles that cannot be avoided	28	20	52	Both
44	Maintenance Risks	60	12	28	Private
45	Access and delivery of site	32	20	48	Project Dependent
46	Connection of Public utilities to boundaries of site	20	36	44	Project Dependent
47	Connection to boundary of Site of telephone lines and natural gas provision	24	44	32	Project Dependent
48	Labor unavailability	72	4	24	Private
49	Material shortage	72	4	24	Private
50	Third party delay/violation	56	0	44	Private
51	Planning risks	52	12	36	Private
52	Supervision, organization and control for inspection of Construction works	68	4	28	Private
53	Technological Risks	60	12	28	Private
54	Completion risk	48	4	48	Project Dependent
55	Sustainability Risk	24	32	44	Project Dependent
56	Antiquities Risks	20	36	44	Project Dependent
57	Unforeseen Weather conditions	56	4	40	Private
58	Unforeseen geotechnical conditions	52	8	40	Private
59	Force majeure	20	0	80	Both

4 . 2 . 3 The PPP Valuation Module

The PPP valuation process is a very long and tedious process. In general, PPP project valuation is done through a financial model that incorporates all direct and indirect costs of the project; it also includes the revenues and contingencies. The purpose of the financial model is to come up with the service charge and the internal rate of return (IRR) of the project. The financial model also provides different forms of financial statements, such as the income statement, the cash-flow statement, and the balance sheet. Moreover, it calculates some financial ratios to help in evaluating the financial standing of the SPV. The financial model is quite important as it is considered the basis of any adjustments through the lifecycle of the PPP contract.

Xu *et al* developed a pricing equation that is used in the valuation process in their paper entitled "Developing a Concession Pricing Model for PPP Highway Projects." Equation 1 is developed by Xu *et al* to calculate the PPP highway project price (Xu *et al*, 2012). In this framework, Equation 1 is edited to suit all types of PPP projects. Some symbols are changed for the ease of notation as shown in Equation 3. The PPP price at a certain point in time is the summation all the cash in and cash out flows of the project. The equation considers only the items that will have as significant effect on the PPP value and ignores minor items.

The cash in items are the operation income (OI) and the government subsidies (GS), while the cash out items are the capital expenditure (Capex), the loan principle (LP), the loan interest, which is the loan balance (LB) multiplied by the loan interest (Li), the operation cost (Opex), and taxes (T). All the above costs and revenues are discounted at a fixed interest rate (i) to get the present value of the PPP concession at time (t). The value of the PPP concession can be determined at any time along the construction period (T0) or the concession period (TC).

In this framework, a benchmark is taken at the beginning of the construction period to calculate the PPP value. The above terms are adjusted to account for inflation as per the PPP contract terms. Finally, the internal rate of return (IRR) is calculated for the free cash flow by equating Equation 3 to zero and solving for the interest rate, which will be the IRR.

$$P = \sum_{t=1}^{T_0} Capex_t\,(1+i)^{-t} - \sum_{t=T_0+1}^{T_c}(OI_t+GS_t)(1+i)^{-t} + \sum_{t=T_0+1}^{T_c}(LP_t+LB_tLi_t)(1+i)^{-t}$$

$$+ \sum_{t=T_0+1}^{T_c} Opex_t\,(1+i)^{-t} + \sum_{t=T_0+1}^{T_c} T_t(1+i)^{-t}$$

Where:

Construction Period	T_0
Concession Period	T_C
Capital Fund at time t	$Capex_t$
Operation Income at time t	OI_t
Government Subsidy at time t	GS_t
Loan Principle at time t	LP_t
Loan Balance at time t	LB_t
Loan Interest at time t	Li_t
Operation Cost at time t	$Opex_t$
Taxes at time t	T_t
Interest Rate	i

Equation 3: PPP Valuation Equation

Figure 9 shows the relationship between the PPP valuation module and the other modules. The inputs of the PPP valuation module are taken from the user-interface module and the risk allocation module. The outputs of the PPP valuation module are used in the scenarios development module and the reports module.

The inputs coming from the user-interface module are the start and end dates of the project, the concession period, the contractual construction period, the interest rate that will be used to discount the different cash flows, the base inflation rate used in the contract, as well as the initial distribution along the lifecycle of the project of the capital expenditure distribution (Capex), the operation income distribution (OI), the government subsidies distribution (GS), the loan principle distribution (LP), the loan balance distribution (LB), the loan interest (Li), the operation cost distribution (Opex), taxes distribution (T) and the output quantity distribution (Q). The above distributions should be identical to the ones in the base financial model of the PPP concession to reflect the same internal rate of return in the contract. Moreover, the risk allocation module will also affect the PPP valuation module by affecting the cost of contingency added to the above equation.

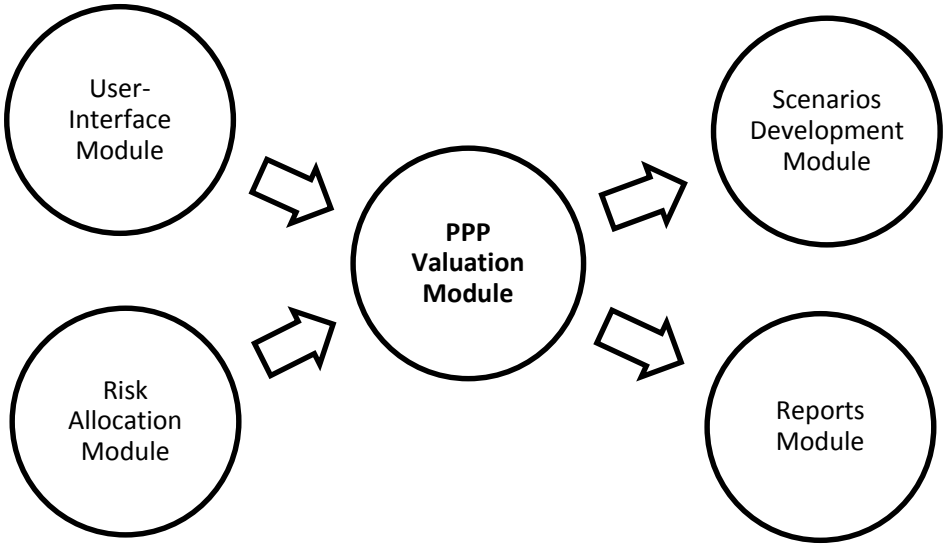


Figure 9: The PPP Valuation Module Interrelation with the Other Modules

The scenarios development module uses the base concession value in its calculations of the different re-equilibrium scenarios, as will be explained later in this chapter. Finally, the PPP valuation module results will be reported via the reports module.

4 . 2 . 4 The Financial Model Re-equilibrium Module

During the lifecycle of a PPP, which tends to be very lengthy compared to conventional procurement methods, many events may arise that result in the need for re-equilibrium or contract renegotiation, such as variation orders, unforeseen risks, or refinancing gains. The only way to reflect those changes on the PPP value is by constructing a re-equilibrium model similar to the financial model but adding the cost and time impact of those events.

Figure 10 shows the financial model re-equilibrium module's relationship with the rest of the framework modules. The financial model re-equilibrium module is similar to the PPP valuation module as it gets its inputs from the user-interface module and the risk allocation module, and the outputs go to the scenarios development module

and the reports module, as well. However, the inputs of the PPP valuation module are different than the ones for the financial model re-equilibrium module. For instance, the concession period (TC) is not an input, as it cannot be changed before agreeing on choosing the scenario that corresponds to adjusting the concession period. Moreover, the interest rate (i) remains constant in order to compare the present value obtained from the PPP valuation model to the present value obtained from the financial model re-equilibrium module.

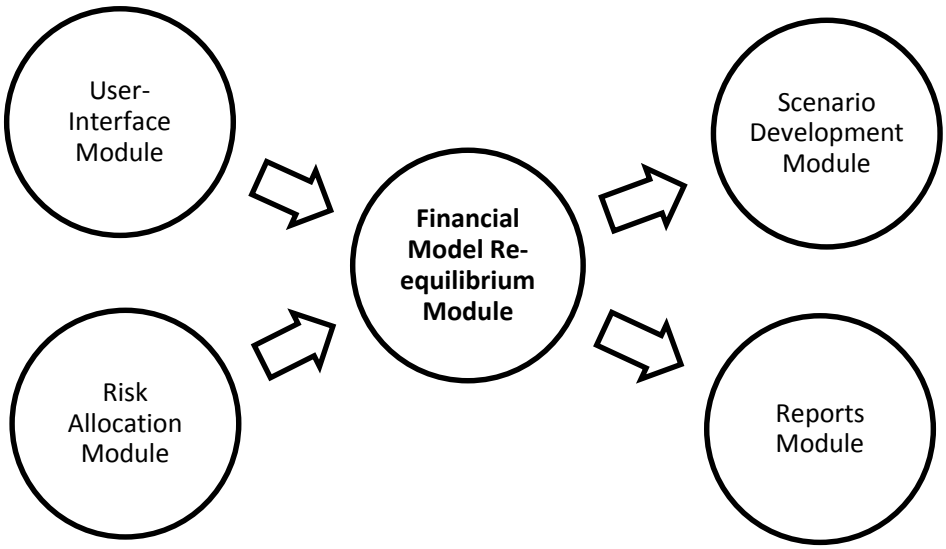


Figure 10: The Financial Model Re-equilibrium Module Interrelation with the Other Modules

The inputs coming from the user-interface module are the actual start and actual end dates of the project, the re-equilibrium date (RD) that the scenarios are calculated with reference to, the actual construction period (T0), the actual inflation rate, and the updated distribution along the lifecycle of the project of the capital expenditure distribution (Capex), the operation income distribution (OI), the government subsidies distribution (GS), the loan principle distribution (LP), the loan balance distribution (LB), the loan interest (Li), the operation cost distribution (Opex), taxes distribution (T), and the output quantity distribution (Q). However, this updated distribution shall reflect the impact of the events that led to renegotiation of the contract. This is the role of the risk allocation module, as it is important to note that the updated distributions shall only include the portion of the risks allocated to the public sector, for the public

sector has already waived the other risk portions to the private sector as per the PPP concession contract. Equation 3 shall be used again but with the updated values rather than the base values to determine the updated concession value. Then, Equation 3 is equated to zero in order to obtain the updated rate of return (IRR) that reflects those changes. Finally, the outputs of the financial model re-equilibrium module are used in the scenarios development module and reported in the reports module, as will be explained later in the chapter.

4 . 2 . 5 The Scenarios Development Module

In order to gain the financial model re-equilibrium back, certain actions should be taken. The commonly used re-equilibrium scenarios in PPP are paying a lump sum amount to the private sector, increasing the service charges, increasing the concession period, or a combination of the one or more of the above. The sole aim of the renegotiation process is to maintain the investors' initial IRR constant. Figure 11 illustrates the relationship between the scenarios development module and the other modules. The scenarios development module inputs come from the user-interface module, the PPP valuation module, and the financial model re-equilibrium module, while the outputs go to the scenarios selection module and the reports module.

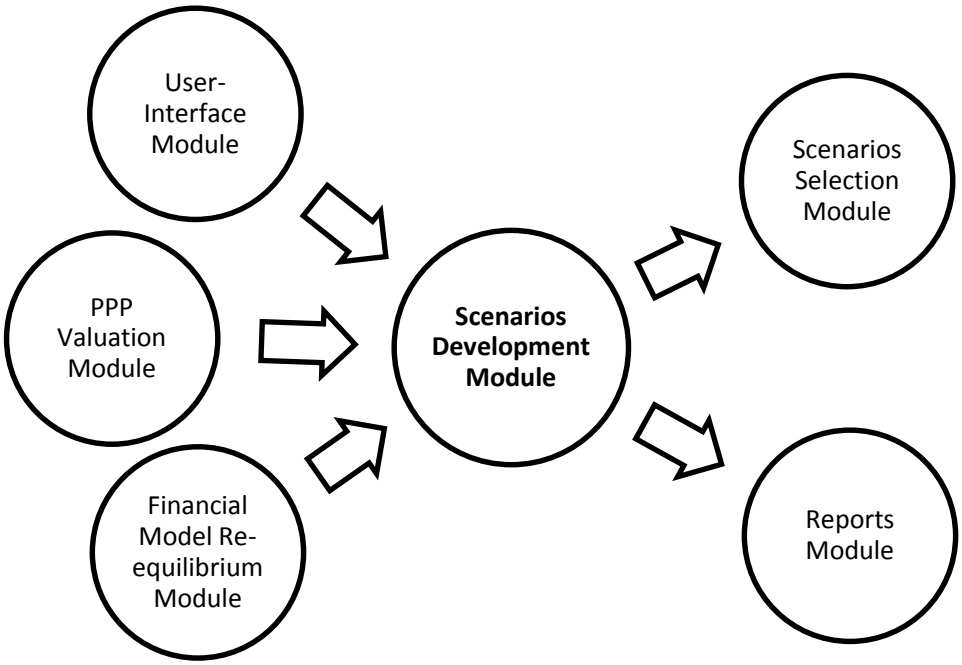


Figure 11: The Scenarios Development Module Interrelation with the Other Modules

The inputs coming from the PPP valuation module and the financial model re-equilibrium module are the present value of the PPP concession value and the PPP updated concession value at the start date of the PPP project, respectively. The difference between the present value of the PPP concession value and the PPP updated concession value is the re-equilibrium payment that is the basis for the different scenarios development process.

In case of positive re-equilibrium payment, it means that the public sector shall compensate the private sector. The opposite is also true. In case of a negative re-equilibrium payment, it means that the private sector shall compensate the public sector. Furthermore, in the case of a negative re-equilibrium payment, three scenarios of the four scenarios shall actually not be applicable: paying a lump sum amount to the public sector; decreasing the concession period; and the fourth scenario which is the combination between the other scenarios. This is because the payment of a lump sum amount from the private sector to the public sector shall distort the private sector cash flow. Decreasing the concession period is not allowed due to the obligations the private sector may have towards third parties until the end of the concession period. Moreover, in PPP projects where the private sector is directly paid by the service users, the fourth scenario which is decreasing the PPP payment may also not be applicable. For example, in the case of transportation projects, the private sector cannot decrease the toll, as it will create a market distortion.

The re-equilibrium date (RD) is considered the base date of the calculations of the different scenarios. The first re-equilibrium scenario is to pay a lump sum amount to the private sector. The re-equilibrium date (RD) is considered the date upon which the lump sum payment shall be made. Hence, in order to calculate the required lump sum payment, the future value of the difference between the present value of the PPP concession value and the PPP updated concession value is obtained at the re-equilibrium date using Equation 4, where, in this case, (FV) is the lump sum payment, (PV) is the difference between the present value of the PPP concession value and the PPP updated concession value at the beginning of the project, (i) is the fixed discount rate, and (N) is the number of periods between the start date of the project and the re-equilibrium date.

$$FV = PV \times (1 + i)^N$$

Equation 4: Future Value given Present Value

The second re-equilibrium scenario is to increase the service charges. This scenario depends on the nature of the payment in the contract. The user-interface module supplies this module with the payment mechanism used (user charges, usage payments, or availability payments), the amount of the periodic payment, and the frequency of payment (i.e., annually, semi-annually, quarterly, etc.). The adjusted value of the service charge is obtained using Equation 5, where the (A) is the adjusted amount, (PV) is the lump sum payment at the re-equilibrium date obtained in the first scenario, (i) in this case is the fixed discount rate divided by the number of periods in one year in order to get the effective discount rate, and (N) is the number of periods, which equals the number of periods from the re-equilibrium date until the end date of the project. Finally, the adjusted amount is then added to the original payment amount to be the adjusted periodic payment, which is to be paid starting from the re-equilibrium date until the end of the concession period.

$$A = PV \times \frac{i(1 + i)^N}{(1 + i)^N - 1}$$

Equation 5: Annuity given Present Value

The third re-equilibrium scenario is to increase the concession period. This is done through a number of steps. The first step is to calculate the future value of the difference between the present value of the PPP concession value and the PPP updated concession value at the end date of the project using Equation 4, where, in this case, (FV) is the required payment at the end date of the project, (PV) is the difference between the present value of the PPP concession value and the PPP updated concession value at the start date of the project, (i) is the fixed discount rate, and (N) is the number of years of the concession period. The second step is to get the required number of periods after the concession period for this amount to be paid with an extension of the service payment. This is done by using Equation 5, where the (A) is the project initial

service charge, (PV) is future value calculated in the previous step, (i) in this case is the fixed discount rate divided by the number of payments in one year in order to get the effective discount rate, and (N) is the additional number of periods required to reach re-equilibrium after the end date of the project. Finally, the additional number of periods are added to the original concession period in order to obtain the adjusted concession period.

The fourth scenario is a combination of any two of the above scenarios. The user-interface module provides the exact combination required for the fourth scenario after getting the reports for the three scenarios. This is to allow the framework to avoid breaking the maximum values required of the above scenarios. For instance, there can be a maximum number of years that the concession period cannot exceed. In order to add this limitation to the framework, the user-interface module shall provide the scenarios development module with a combination for the fourth scenario, which includes the increase of concession period scenario. This input shall be limited to fix the concession period to a value between the original concession period and a maximum value defined by the user-interface module. This process serves to exclude the unwanted or unfeasible re-equilibrium scenarios. Finally, the outputs of this module, which are the three scenarios report and the final scenarios report, will be used in the scenarios selection module and the reports module.

4 . 2 . 6 The Scenarios Selection Module

In the scenarios development module, four re-equilibrium scenarios are originated: paying a lump sum amount to the private sector, increasing the service charges, increasing the concession period, or a combination of one or more of the above. The scenarios selection module is the module in which the choice between the four re-equilibrium scenarios is made. Figure 12 shows the relationship between the scenarios selection module and the other modules. The inputs of the scenarios selection module are from the user-interface module and the scenarios development module. The outputs of the module go to the reports module and the sensitivity analysis module. The goal of the scenarios selection module is to account for the interests of the stakeholders of the

PPP project, mainly the public sector and the private sector, when selecting the renegotiation outcome scenario.

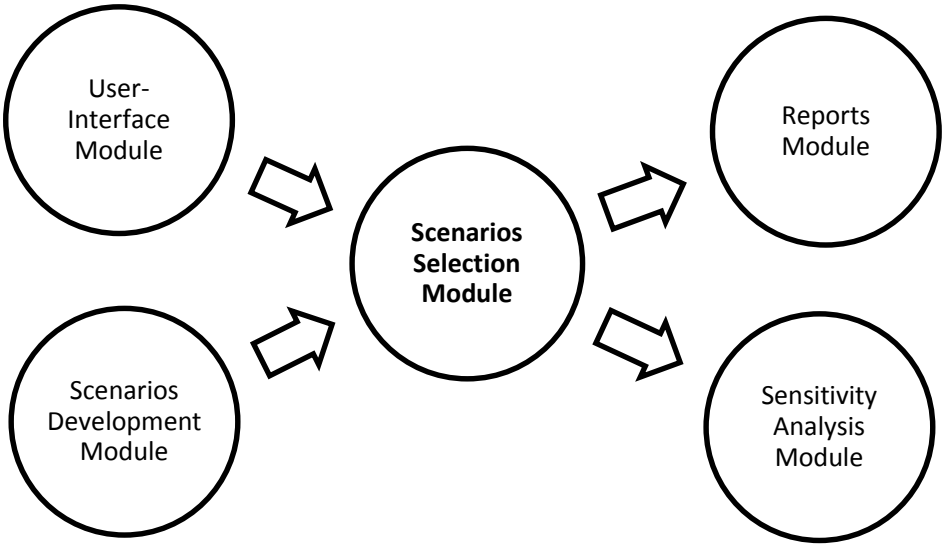


Figure 12: The Scenarios Selection Module Interrelation with the Other Modules

The scenarios development module provides the scenarios selection module with the final four re-equilibrium scenarios, while the user-interface module supplies this module with the criteria and their corresponding sub-criteria, based on which the selection is to be made. In order to evaluate each scenario, a score shall be given to each scenario. The scenario score is calculated using the weighted sum model. This model suggests that each scenario to have a set of criteria which have a relative importance to each other. The scenario score shall equal the summation of the weight of importance for each criteria multiplied by its value as shown in Equation 6. (x) is the number of alternatives of scenarios, (i) is the number of main criteria, (j) is the number of sub-criteria of a certain main criteria, (W) is the weights and (R) is the rankings.

$$\text{Scenario Score } (SS_x) = \sum_{j=1}^{m} W_{C_i} W_{S_j} R_{S_j} \qquad \begin{array}{l} x = \{1,2,3,4\} \\ i = 1,2,3,\ldots,n \\ j = 1,2,3,\ldots,m \end{array}$$

Equation 6: Scenario Score

After inputting the criteria, the user-interface provides the scenarios selection module with the importance of each criteria with respect to the rest of the criteria for each of the four scenarios. Moreover, it also supply the scenarios selection module with the importance of sub-criteria with respect to the rest of the sub-criteria of the same category for each of the four scenarios. Then, the scenarios selection module determines the weights of the criteria and sub-criteria with respect to the different re-equilibrium scenarios. The approach is to draw matrices for the main criteria and each of the sub-criteria categories in which the top row is the criteria or the sub-criteria and the rest of the matrix is a mirror image. Decision matrices were invented by Stuart Pugh (Pugh, 1991). An example of the decision matrix is shown in Figure 13. The importance of the criteria with relative to the other criteria is taken from the user-interface module and inserted in the respective position in the matrix. In order to obtain the weight of each criteria, the number of occurrences of each criteria is counted, and the weights are calculated by dividing the number of occurrences of each criteria over the total number of occurrences of all of them. It is important to note that the total number of weights of the criteria or a certain sub-criteria of one category should equal to one.

	Criteria 1	Criteria 2	Criteria 3	Criteria 4
Criteria 1		Criteria 2	Criteria 1	Criteria 4
Criteria 2			Criteria 3	Criteria 2
Criteria 3				Criteria 4
Criteria 4				

Figure 13: Scenario Selection Criteria Decision Matrix (Pugh, 1991)

The above exercise is done for the criteria and the sub-criteria for each one of the four scenarios, as the weights may differ when dealing with making a lump sum payment or just extending the concession period. After obtaining the weights of the criteria, rankings are taken via the user-interface module. Separate rankings are required from both the public sector and the private sector in order to reflect their interests and preferences. Using the weighted sum model, eight scenario scores are calculated: four for the four re-equilibrium scenarios from the perspective of the public sector, and the other four for the four re-equilibrium scenarios from the perspective of the private sector. The outputs of this step are the best scenarios or the scenarios with the highest scores from the public sector perspective and the public sector perspective. Then,

averages of the private sector rankings and the public sector rankings are taken to calculate the four re-equilibrium scenarios scores from the perspective of both parties. The scenario with the highest score is marked to be the best scenario from the perspective of both prospective.

4 . 2 . 7 The Reports Module

The reports module is the module in which all the results of the previous modules are combined and processed in order to be directed to the user-interface module. The reports module allows the decision maker to look at the broader picture rather than looking at detailed calculations. Figure 14 illustrates the relationship between the reports module and the other modules of the framework.

The reports module provides risk allocation charts showing the portions of the risks allocated to the public sector, the portions of the risks allocated to the private sector, and the portions of the risks shared between the both. The reports module also provides the user-interface module with a report showing the original PPP concession value versus the PPP updated concession value. In addition, the reports module presents the four re-equilibrium scenarios: paying a lump sum amount to the private sector

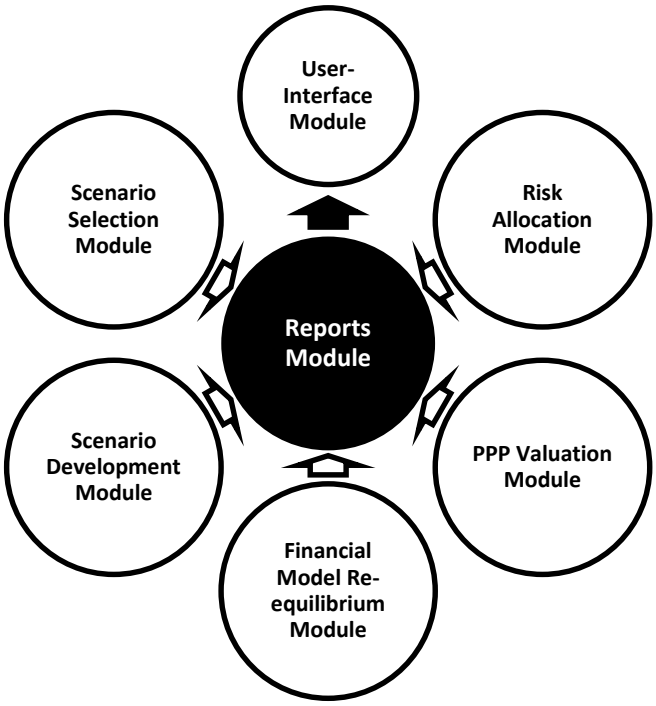


Figure 14: The Reports Module Interrelation with the Other Modules

scenario, increasing the service charges scenario, increasing the concession period scenario, and a combination of any two of the above scenarios. Then, the reports module presents the best scenario from the perspective of the public sector, followed by the best scenario from the perspective of the private sector, and finally the best scenario from the perspective of both.

The following reports are three decision tree reports, each presenting the expected monetary value (EMV), which is another way of calculating the scenario score. The trees start with a decision node, with the four alternatives of scenarios branching from it. Each scenario has branches presenting the criteria, and each criteria branches into the sub-criteria. The branches have the weights, and the rankings are assigned at the end of the tree branches.

The reports module then develops the risk profile graphs as it shows the risks and opportunities of choosing one scenario over the other. The first graph is the probability chart, which shows the effect of changing the weights of the criteria and sub-criteria on the scenario scores, reflecting the probability of choosing a certain scenario over the other. The second graph is the cumulative graph, which presents the ranges of values that the scenario can yield versus the corresponding probabilities or weights. A statistical summary report is then formulated to provide some statistics about all the ranges of possible outcomes of the decision tree.

The following reports are called the policy suggestion reports, which help the decision maker look at the broader picture when making his decision. The decision table report provides the "benefit of correct choice," which is basically the difference between the value of the highest scenario score and the lowest one. This helps in showing whether the scenario scores are close or not. The policy suggestion reports also include an optimal tree report that shows the path of the optimal decision only.

4 . 2 . 8 The Sensitivity Analysis Module

Figure 15 shows the relationship between the sensitivity analysis module and the framework modules. The sensitivity analysis module inputs come from the scenarios selection module, and it presents its outputs to the user-interface module directly. The sensitivity analysis is another form of the risk profile graphs of the reports

module. It shows the effect of changing certain inputs on the final output of the module. The sensitivity analysis is performed to study the effect of changing the criteria rankings on the scenario scores.

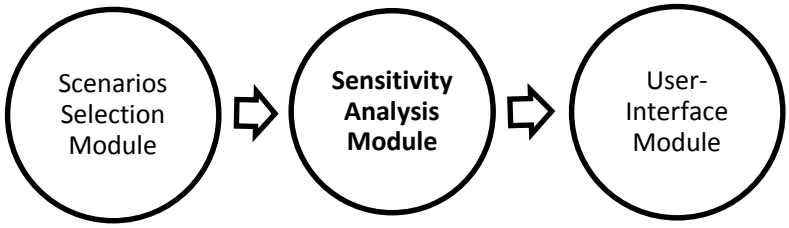


Figure 15: The Sensitivity Analysis Module Interrelation with the Other Modules

As stated above, the inputs of the sensitivity analysis module are the ranks presented in the scenarios selection module. The criteria rankings can be any integer number between one and five. The sensitivity analysis is done by changing the value of the rankings of the sub-criteria from one to five, and the output is observed. This is done for the sub-criteria that have the highest rankings; moreover, it is performed individually for each sub-criteria, then a double-sensitivity analysis is executed to measure the effect of changing two sub-criteria at the same time. A strategy graph is also provided to measure the sensitivity of changing the rankings of a sub-criteria on all the alternatives or the scenarios to determine the area of decision within the desired output. A tornado graph and a spider graph are used to present the results of the sensitivity analysis.

CHAPTER 5 : RESULTS ANALYSIS, VERIFICATION AND VALIDATION

5 . 1 The Waste Water Treatment Plant (Case Study)

In this research, a case study of a wastewater treatment plant in Egypt is applied to the prototype model in order to validate the proposed framework. The case study of concern is a design, build, finance, operate, maintain, renew, and transfer of ownership PPP contract (DBFOMRT). It has many forms of PPP agreements, which makes it very suitable to be used as a validation for the suggested framework.

The concession period is set to be 20 years, divided into two years of construction and 18 years of operation. The plant is to produce 250,000 cubic meters of treated domestic wastewater per day as per the required specifications in the contract. The Service Provider is to receive periodic availability payments in exchange for the sewage treatment, which is the payment mechanism of this PPP contract. The location of the wastewater treatment plant, the SPV name, the consultants' and advisors' names are concealed due to confidentiality. The Owner or the Grantor of the wastewater treatment plant is the Ministry of Housing, Utilities, and Urban Development (MHUUD), while the tender documents were issued by the New Urban Communities Authority (NUCA) with the assistance of the PPP Central Unit of the Ministry of Finance.

In Egypt, the PPP Central Unit is part of the Ministry of Finance and deals with all PPP projects in Egypt. The goal of the unit is to assist the different ministries during the tender process and along the lifecycle of the PPP projects in order to promote the PPP initiative in Egypt. The unit is also engaged in developing PPP project proposals, forming the financial and legal documents of the projects, announcing new PPP projects to the private sector, reviewing the bids, and providing feedbacks and solutions to any obstacles facing the PPP projects. In other words, the PPP Central Unit is the unit forming the standard practice for the PPP projects.

The pre-qualification documents of the project were issued in December 2007, and five bidders were qualified for the bid. The final tender documents were issued in February 2009. The tender was based on a competitive bidding process including a technical bid and a financial bid. The project is tendered under Law no. 89 for 1998,

which is the Law on Organizing Tenders and Bids for Public Procurement and its Executive Regulations, issued by virtue of Decree no. 1367 for 1998 by the Ministry of Finance. The contract was issued in June 2009, before the PPP law was issued. In August 2010, the People's Assembly of Egypt approved Law no. 67 for Partnerships with the Private Sector in Infrastructure Projects and Public Utilities. The Executive Regulations of the law were issued through Prime Ministerial Decree no. 238 for the year 2011.

One of the Conditions Precedent for the Contract to come into effect is to submit a financial model that has all the calculations and computations of the financial bid. The components of the financial model is explained in detail in Chapter Three of this research. Typically, the financial model should include detailed calculations of all the costs, including direct and indirect costs and contingencies, and the revenues of the PPP project. The outputs of the model usually includes the different financial statements and the financial indicators.

The Independent Financial Expert is a third party that reviews the base financial model and prepares any amendments based on that model when an event arises that harms the Return on Equity value as per Contract Clause 34.4: Mechanisms of Compensation for Contract Re-equilibrium. This Clause states that the method of calculating the re-equilibrium value shall be to keep the internal rate of return of the Service Provider, or the SPV constant. Then, the re-equilibrium scenarios are defined in Contract Clause 34.5: Forms of Compensation, including adjusting the PPP payment, paying a lump sum amount, or a combination of the above.

In the wastewater treatment plant contract, it is stated that the Independent Financial Expert is the one to determine the form of compensation; however, in case of dispute, the issue shall be referred to the Partnership Committee. According to Contract Clause 24, the Partnership Committee consists of five representatives who belong to the New Urban Communities Authority (NUCA), the Construction Authority for Portable Water and Wastewater, the Ministry of Housing, Utilities, and Urban Development (MHUUD), the PPP Central Unit, and the Egyptian Water, Wastewater Regulatory, and Customer Protection Authority (EWRA), as well as another five representatives belonging to the Service Provider (SPV.) The Partnership Committee is not a third party, as it consists of both involved parties, which seems not to be the best

way to deal with disputes. The PPP contract renegotiation process needs to be supported and enhanced in order to avoid disputes. To achieve this, the suggested framework provides guidance through the PPP contract renegotiation process by defining the exact events leading to the renegotiation of the PPP contract and the party responsible for each event. The framework also helps in formulating the re-equilibrium scenarios; moreover, it defines the optimal scenario to suit all parties. The framework results are unbiased and robust, therefore enhancing transparency and mutual trust between the parties.

5 . 2 Results Analysis

In this case study, a call for a contract re-equilibrium was raised by the Service Provider in April 2013 due to a delay in the operation start date. The public sector, represented by the New Urban Communities Authority (NUCA), was responsible for the delay in delivering the influent water, which was the wastewater to be treated by the plant. Moreover, NUCA was also delayed in providing the effluent pumping station. The above case was presented to the Independent Financial Expert (IFA) of the project. The same case will be applied to Decision Support System model in order to validate the suggested model and compare the results obtained with the outputs of the IFA.

5 . 2 . 1 The User-Interface Module

The user-interface module interacts with the user dynamically along the different stages of the Decision Support System model, as it is linked to almost all of the other modules. It provides the inputs for some modules while receiving the output from the others to present them to the user. The welcome screen of the model consists of the model name “PPP Contract Renegotiation DSS” and its version, as shown in Figure 16. By clicking into anywhere in the screen, the user is directed to the second user-interface page, shown in Figure 17, to start inputting the data that will be used in the following modules.

Figure 16: DSS User-interface no.1

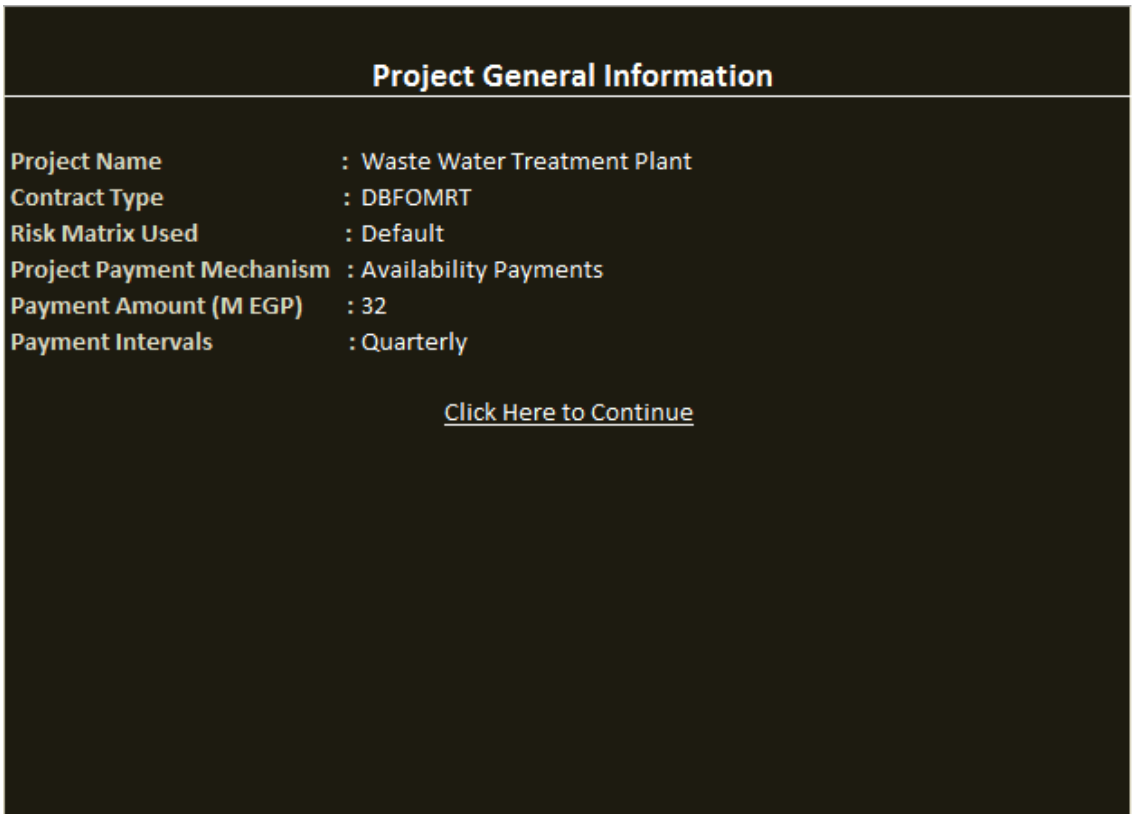


Figure 17: DSS User-interface no.2

The first set of data required are the project name, the PPP contract type, the risk matrix used, the payment mechanism, the payment amount, and the payment intervals. The project name of the case study is the wastewater treatment plant; the actual name is concealed due to confidentiality. The contract type is a design, build, finance, operate, maintain, renew, and transfer of ownership PPP contract (DBFOMRT). The payment mechanism is availability payments in which service availability is the key condition for the payment. The service availability definition in the case study contract is to be able to deliver quarter of a million cubic meters of treated wastewater per day. The payment value is 32 million Egyptian Pounds (EGP) to be paid quarterly by the government to the private sector. As for the "risk matrix used" field, the user selects from a dropdown menu whether to use a default risk matrix or input a risk matrix as per the contract of the wastewater treatment plant, as shown in Figure 18. When the "user input" option is selected, a hyperlink appears on the right, marked with

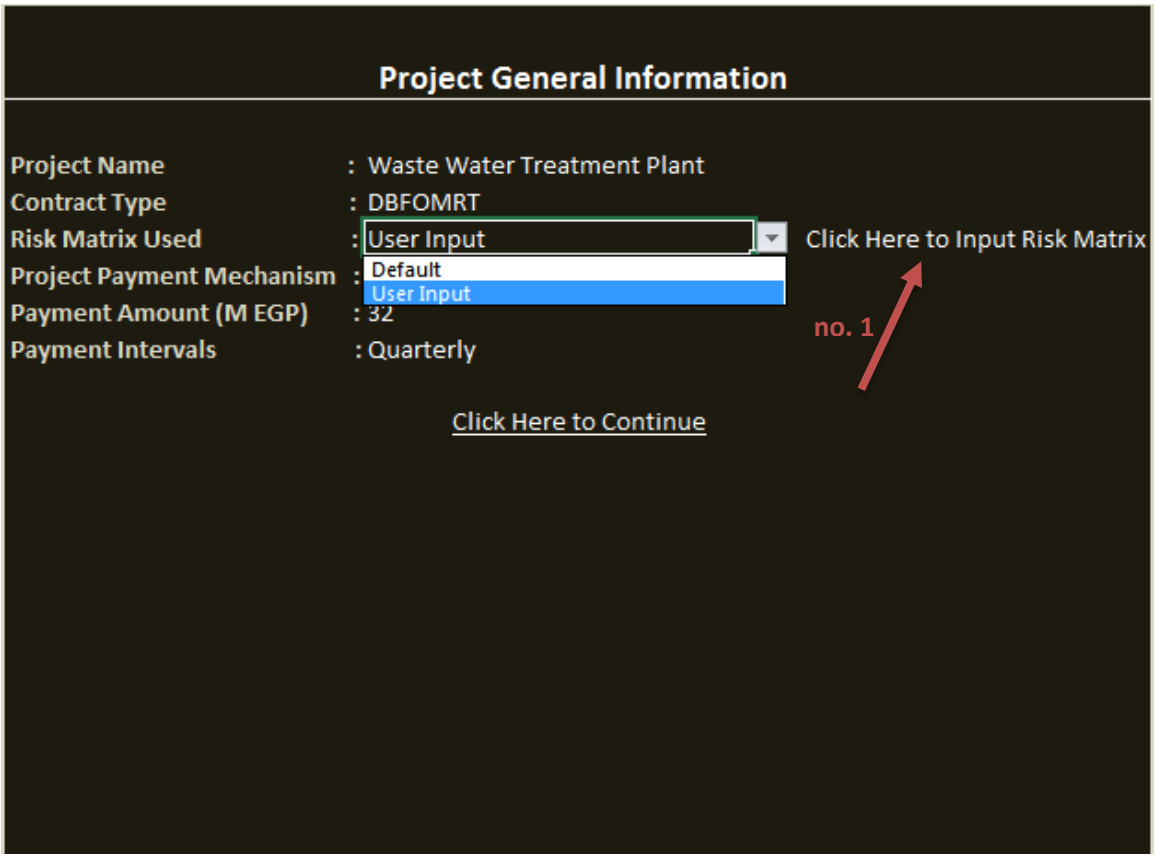


Figure 18: DSS User-Interface no.2'

arrow no.1, which directs the user to the risk allocation module in order to input some information with regard to the risks profile of the project, including all possible risks, their allocations, and their expected impact on the project valuation process. However, the default risk matrix is selected for the purpose of this case study, which is deduced from the literature review. The rest of the user-interface module shall be explained along with the following modules, for the model is to be explained in the right sequence.

5 . 2 . 2 The Risk Allocation Module

The risk allocation process in general is very important through the lifecycle of any PPP project, especially during the renegotiation of the PPP contract. Risk allocations and their impacts on Equation 3 are used in the different calculations in the model. They affect the valuation process of the PPP project, and at the same time, they are important for determining which risks should be accounted for when calculating the re-equilibrium value.

The user input risk table and the default risk table have the same formatting with respect to the table columns and their headings. However, the default risk table has already been filled with data extracted from the literature review to be ready for use in case of quick access to the other modules in the model. On the other hand, the user input risk table is to be filled with the exact percentages of allocations as per the contract. The user input risk matrix is more accurate and recommended to be used when possible. Figure 19 shows the default risk table used in the Decision Support System prototype model. As shown in the figure, the first column contains a set of standardized risks, and the following column contains their typical allocations to the public sector, the private sector, or shared among them. The following three columns show the exact percentages of the risks allocations carried by the different parties or shared. This portion of the table is extracted from the literature review (Badran, 2013). The risks are then divided into three main risk categories: country-related risks, sector-related risks, and project-related risks. An example of a country risk is macroeconomic risk, while an example of sector risk is market risk. The project risks are risks related to the nature of the project itself, such as permits risk.

Risk	Allocation	Risk Allocation Public	Risk Allocation Private	Risk Allocation Shared	Risk Allocation Total	Impact T_o	Impact T_c	Impact $Capex_t$	Impact OI_t	Impact GS_t	Impact LP_t	Impact LB_t	Impact Li_t	Impact $Opex_t$	Impact T_t	Impact Q_t	Impact inf
Country Risks:																	
Interest Rate Fluctuation	Both	32%	12%	56%	100%	☐	☐	☐	☐	☐	☐	☑	☑	☐	☐	☐	☐
Inflation	Both	24%	20%	56%	100%	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑
Foreign exchange fluctuation	Project Dependent	36%	16%	48%	100%	☐	☐	☑	☐	☐	☐	☐	☐	☑	☐	☐	☐
Public Credit	Both	20%	28%	52%	100%	☐	☐	☐	☐	☑	☐	☐	☐	☐	☑	☐	☐
Political Risk	Both	28%	8%	64%	100%	☐	☐	☐	☐	☑	☐	☐	☐	☐	☑	☐	☐
Nationalization/expropriation	Private	56%	16%	28%	100%	☐	☐	☑	☐	☐	☐	☐	☐	☐	☑	☐	☐
Government corruption	Private	60%	12%	28%	100%	☐	☐	☑	☐	☐	☐	☐	☐	☑	☑	☐	☐
Sector Risks:																	
Price Change	Both	40%	8%	52%	100%	☐	☐	☑	☑	☐	☐	☐	☐	☑	☐	☐	☐
Revenue Risk	Project Dependent	36%	24%	40%	100%	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐
Market competition	Both	36%	12%	52%	100%	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐
Supply and demand	Both	24%	16%	60%	100%	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐
Change in Market demand	Both	12%	24%	64%	100%	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐
Legislation changes	Project Dependent	32%	20%	48%	100%	☐	☐	☑	☑	☑	☐	☐	☐	☑	☑	☐	☐
Change in tax regulation	Project Dependent	36%	20%	44%	100%	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐
Government policy	Both	24%	16%	60%	100%	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☑
Political/Public opposition	Both	12%	24%	64%	100%	☑	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐
Swings in Public Opinion	Both	20%	16%	64%	100%	☐	☐	☐	☑	☑	☐	☐	☐	☐	☐	☐	☐
Regulatory/Contractual Risk	Project Dependent	44%	8%	48%	100%	☐	☐	☐	☐	☐	☑	☑	☑	☑	☐	☐	☐
Government Intervention	Project Dependent	40%	16%	44%	100%	☑	☐	☑	☑	☑	☐	☐	☐	☐	☐	☐	☐
Poor public decision making process	Project Dependent	36%	24%	40%	100%	☐	☑	☑	☑	☑	☐	☐	☐	☐	☐	☐	☐
Inadequate law and supervision system	Project Dependent	36%	32%	32%	100%	☐	☐	☐	☑	☐	☐	☐	☐	☐	☑	☑	☐
Lack of supporting infrastructure	Both	12%	20%	68%	100%	☐	☑	☑	☑	☐	☐	☐	☐	☐	☐	☐	☐
Project Risks:																	
Operation cost overrun	Private	76%	0%	24%	100%	☐	☐	☐	☑	☐	☐	☐	☐	☑	☐	☐	☐
Inability of concessionaire	Both	36%	8%	56%	100%	☐	☐	☑	☑	☐	☑	☑	☑	☑	☐	☐	☐
Subjective Project evaluation method	Both	24%	12%	64%	100%	☐	☐	☐	☐	☐	☑	☑	☑	☐	☐	☐	☐
Insufficient project finance supervision	Both	44%	4%	52%	100%	☐	☐	☑	☐	☐	☑	☑	☑	☐	☐	☐	☐
Performance Security Risk	Private	56%	4%	40%	100%	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐
Permits Risks	Both	20%	8%	72%	100%	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Delay in project approvals/permits	Both	20%	16%	64%	100%	☐	☑	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐
Dispute resolution	Both	28%	0%	72%	100%	☑	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Imperfect contract documents	Both	20%	16%	64%	100%	☐	☑	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐
Deficiency of design	Both	32%	12%	56%	100%	☐	☑	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐
Quality Assurance	Both	36%	8%	56%	100%	☐	☑	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐
Quality Control	Both	32%	8%	60%	100%	☐	☑	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐
Latent Defect Risk	Private	52%	0%	48%	100%	☐	☑	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐
Project/operation changes	Private	52%	8%	40%	100%	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☑	☐
Inability of concessionaire	Both	32%	8%	60%	100%	☐	☐	☐	☐	☐	☑	☑	☑	☐	☐	☑	☐
Transformers, substations or backup power	Both	38%	8%	56%	102%	☐	☑	☑	☐	☐	☐	☐	☐	☑	☐	☐	☐
Construction Risk	Private	76%	0%	24%	100%	☐	☑	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐
Organization risk	Private	64%	0%	36%	100%	☐	☑	☑	☐	☐	☑	☑	☑	☑	☐	☑	☐
Coordination risks	Both	44%	4%	52%	100%	☐	☐	☐	☑	☐	☐	☐	☐	☑	☐	☑	☐
Land acquisition	Both	22%	32%	56%	110%	☐	☑	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐
Physical Obstacles that cannot be avoided	Both	28%	20%	52%	100%	☐	☑	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐
Maintenance Risks	Private	60%	12%	28%	100%	☐	☐	☐	☑	☐	☐	☐	☐	☑	☐	☑	☐
Access and delivery of site	Project Dependent	32%	20%	48%	100%	☐	☑	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐
Connection of Public utilities to site boundaries	Project Dependent	20%	36%	44%	100%	☐	☑	☑	☑	☐	☐	☐	☐	☑	☐	☑	☐
Connection to boundary of Site	Project Dependent	24%	44%	32%	100%	☐	☐	☐	☑	☐	☐	☐	☐	☑	☐	☑	☐
Labor unavailability	Private	72%	4%	24%	100%	☐	☑	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐
Material shortage	Private	72%	4%	24%	100%	☐	☑	☑	☑	☐	☐	☐	☐	☑	☐	☐	☐
Third party delay/violation	Private	56%	0%	44%	100%	☐	☑	☑	☑	☐	☐	☐	☐	☑	☐	☐	☐
Planning risks	Private	52%	12%	36%	100%	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Inspection of Construction works	Private	68%	4%	28%	100%	☐	☑	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐
Technological Risks	Private	60%	12%	28%	100%	☐	☑	☑	☑	☐	☐	☐	☐	☑	☐	☐	☐
Completion risk	Project Dependent	48%	4%	48%	100%	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Sustainability Risk	Project Dependent	24%	32%	44%	100%	☐	☐	☐	☑	☐	☐	☐	☐	☑	☐	☐	☐
Antiquities Risks	Project Dependent	20%	36%	44%	100%	☐	☑	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐
Unforeseen Weather conditions	Private	56%	4%	40%	100%	☐	☑	☑	☑	☐	☐	☐	☐	☑	☐	☐	☐
Unforeseen geotechnical conditions	Private	52%	8%	40%	100%	☐	☑	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐
Force majeure	Both	20%	0%	80%	100%	☐	☑	☑	☑	☐	☐	☐	☐	☑	☐	☑	☐

Figure 19: Risks Default Table

Go Back to Input Sheet

The column headings in the right half of the table start with “Impact.” This part of the risk table identifies which terms of the PPP valuation equation are affected when a risk materializes. This is important in order to study which part of the equation is going to be adjusted when calculating the re-equilibrium value of the contract if renegotiation is required, as will be shown later. Finally, for the purpose of the case study, the default risk table is used in the model as the exact allocation percentages are concealed due to confidentiality.

5 . 2 . 3 The PPP Valuation Module

After preparing the risk table, the user is referred to the third screen of user-interface module by clicking the button at the bottom of Figure 19. The following screen is shown in Figure 20. This screen is for inputting the project payment information. In

Initial Payment Information

Project Start Date	SD	:	1-Jan-10
Project End Date	ED	:	31-Dec-29
Re-equilibrium Date	RD	:	1-Apr-13
Construction Period (Yrs)	T_0	:	2
Concession Period (Yrs)	T_C	:	20
Interest Rate %	i	:	10%
PPI	inf	:	108%
Capital Fund at time t (M EGP)	$Capex_t$	:	
Operation Income at time t (M EGP)	OI_t	:	
Government Subsidy at time t (M EGP)	GS_t	:	
Loan Principle at time t (M EGP)	LP_t	:	
Loan Balance at time t (M EGP)	LB_t	:	
Loan Interest at time t %	Li_t	:	
Operation Cost at time t (M EGP)	$Opex_t$	:	
Taxes at time t (M EGP)	T_t	:	
Output Quantity at time t (M Unit)	Q_t	:	

Input Payment Distribution

Click Here to Continue

Figure 20: DSS User-interface no.3

other words, it summarizes the financial model submitted to the government, which is part of the wastewater treatment plant contract. It has all the base values for the cash in

and cash out of the project. As shown in the figure, the wastewater treatment plant milestones are inputted by the user, including the project start date, the project end date, the construction period, and the concession period. The user is also asked to enter the re-equilibrium date, which is the effective date or a benchmark from which the re-equilibrium scenario is calculated. For instance, if the increase in the availability payment scenario is chosen, the adjusted availability payment is assumed to be paid starting from the re-equilibrium date until the end date of the project. The interest rate is the rate at which the cash flows are to be discounted to obtain the concession value at the project start date. The producer price index (PPI) is used to adjust the cash flows to account for the effect of inflation, and it is fixed to equal 108 percent as per the case study contract.

The user then clicks the "Input Payment Distribution" to the right of Figure 20 in order to move on to the cash flow table and enter the values for the payment distribution as stated in the base financial model and the concession contract. The table used for the entry of the initial payments in and out cash flows is shown in Figure 21. The first column contains the equation parameters in order to insert the cash flows corresponding to each category. The header of the second column is set to the project start and continues by adding one month to each column until reaching the project end date. The table in Figure 21 is trimmed for illustration purposes.

As stated before, this table is the summary of the base financial model in the concession contract. The complete schedule of payments is included in Appendix A. The first item in the table is the capital fund which is the investment costs paid by the private sector. The investment cost has two sources: debt and equity. In this case study, the equity constitutes 30 percent of the total investment cost, while the debt constitutes 70 percent. The investment cost is paid during the construction period over the first two years of the concession period, as per the financial model. The schedule of payments from January 2010 until December 2011 is included in Appendix A. The investment cost includes the engineering, procurement and construction (EPC) contract value of the wastewater treatment plant, which is a subcontract. It also includes the contingency, the advisors' fees, the bid bond commission, the performance bond commission, general and administrative charges during the construction period, and any other pre-operation expense.

Payment Distribution

		Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10		Jun-29	Jul-29	Aug-29	Sep-29	Oct-29	Nov-29	Dec-29
Capital Fund at time t (M EGP)	$Capex_t$	124.81	8.07	11.22	14.71	17.80	20.35								
Loan Payments (M EGP)				100.88			37.00								
Operation Income at time t (M EGP)	OI_t								54.66			54.66			54.66
Government Subsidy at time t (M EGP)	GS_t								5.35			5.35			5.35
Loan Principle at time t (M EGP)	LP_t							...							
Loan Interest at time t (M EGP)									0.07						0.07
Loan Interest at time t %	Li_t								10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
Operation Cost at time t (M EGP)	$Opex_t$								38.09			38.09			38.09
Taxes at time t (M EGP)	T_t														20.79
Output Quantity at time t (M Unit)	Q_t								7.50	7.50	7.50	7.50	7.50	7.50	7.50

Go Back to Input Sheet

Figure 21: Initial Payment Distribution

#	Corresponding Risks	Risk Allocation	Risk Allocation Public	Risk Allocation Private	Risk Allocation Shared	Risk Allocation Total	Impact T_0	Impact T_C	Impact $Capex_t$	Impact OI_t	Impact GS_t	Impact LP_t	Impact LB_t	Impact Li_t	Impact $Opex_t$	Impact T_t	Impact Q_t	Impact inf
1	Connection of Public utilities to site boundaries	Project Dependent	20%	36%	44%	100%	0	1	1	1	0	0	0	0	1	0	1	0
2	Connection of Public utilities to site boundaries	Project Dependent	20%	36%	44%	100%	0	1	1	1	0	0	0	0	1	0	1	0
3	Connection of Public utilities to site boundaries	Project Dependent	20%	36%	44%	100%	0	1	1	1	0	0	0	0	1	0	1	0

Figure 22: Risk Factor Filtration

The second line in the table is the loan payments, which shows the profile of the debt portion of the capital expenditure. It is paid on a quarterly basis for the same period of the capital expenditure from January 2010 until December 2011.

The third item is the operation income, which includes the availability payment paid by the public sector during the operation period from January 2012 until December 2029. The operation income includes capacity charges, fixed operation charges, variable operation charges, sludge revenues, and interest income on the debt service reserve account (DSRA).

The fourth item is the government subsidy, which in this case study is the electricity charges. The following items are the loan principle payments and the loan interest payments. The loan terms in this project are 15 years with a two-year grace period. The operation expenses include the operation and maintenance costs of the wastewater treatment and the sludge treatment. They also include the general and administrative charges during the operation period.

The last two rows of the table are the taxes and the quantity of output produced, which is, in this case study, the amount of treated wastewater in cubic meters. Finally, the user is referred back to the user interface sheets by clicking on the button at the bottom of Figure 21.

5 . 2 . 4 The Financial Model Re-equilibrium Module

After inputting the initial payment information, the user is directed to the following screen of the user-interface module in order to enter the events that led to the contract renegotiation. Figure 23 shows the following user-interface screen. In this screen, the user is asked to enter the reasons for re-equilibrium. The user is also asked to select the corresponding risk factor to which the event belongs.

In the wastewater treatment plant case study, the events that led to renegotiation of the contract were delays in the operation start date, a delay by the New Urban Communities Authority (NUCA) to deliver the influent water (the wastewater to be treated by the plant), and a delay by NUCA to provide the effluent pumping station. All the above risks belong to the risk category of connection of public utilities to site

boundaries. The user may prefer to enter three events all at the same time or separately, yet the model shall give the same results in all cases.

In the background, those risk categories are filtered to consider the share of risk belonging to the public sector only. The filtration process is shown in Figure 22, where the model recalls the exact percentages of allocations belonging to a certain risk

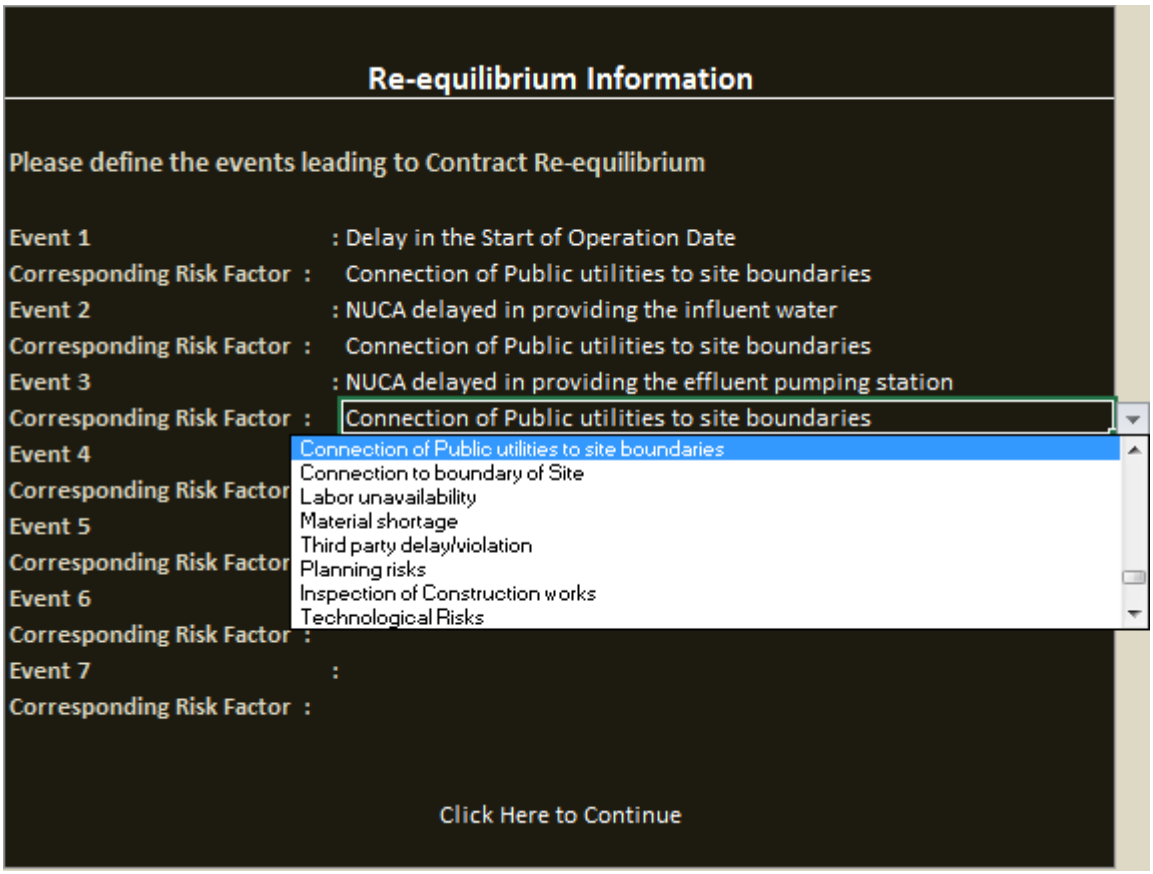


Figure 23: DSS User-interface no.4

category and which part of the equation will be impacted. This part is not shown to the user, as the user will be directed to the following user-interface screen shown in Figure 24. The message at the beginning of the screen is a variable, which changes to inform the user of the events that will be considered in the renegotiation process. The user is asked to re-enter the same information that is required in the PPP valuation module, but after reflecting the impacts of those filtered events on the payments values. The user is

directed to a screen similar to the previous module shown in Figure 25 to enter the updated distribution of the payments cash flows.

The detailed cash flow is shown in Appendix A. One of the major changes between the base cash flow and the updated cash flow is the missing operation income, missing government subsidy, and missing output in the period from January 2012 until March 2013, as the new operation start date is April 1, 2013. All cash flows are discounted up to January 2010, which is considered the benchmark or time zero.

Re-equilibrium Information

Please adjust the below to reflect impact of Event 1& Event 2& Event 3 reflecting the percentage of risk allocated to the public sector only:

Project Start Date	SD	:	1-Jan-10
Project End Date	ED	:	31-Dec-29
Construction Period (Yrs)	T_0	:	2
Inflation Rate %	inf	:	10%
Capital Fund at time t (M EGP)	$Capex_t$	:	
Operation Income at time t (M EGP)	OI_t	:	
Government Subsidy at time t (M EGP)	GS_t	:	
Loan Principle at time t (M EGP)	LP_t	:	
Loan Balance at time t (M EGP)	LB_t	:	Input Updated Payment Distribution
Loan Interest at time t %	Li_t	:	
Operation Cost at time t (M EGP)	$Opex_t$	:	
Taxes at time t (M EGP)	T_t	:	
Output Quantity at time t (M Unit)	Q_t	:	

Click Here to view preliminary re-equilibrium scenarios

Figure 24: DSS User-interface no.5

The discount rate (i) used is entered by the user in the screen shown in Figure 20. Figure 26 shows a summary of the present values of the payment distribution items for both the initial values and the updated ones. Using Equation 3, the value of the concession at time zero for the base value is almost 37 million Egyptian Pounds, while the updated value is almost negative 161 million Egyptian Pounds. The difference between the two values is considered to be the re-equilibrium value at time zero, which is almost 198 million Egyptian Pounds.

Updated Payment Distribution

		Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10		Jun-29	Jul-29	Aug-29	Sep-29	Oct-29	Nov-29	Dec-29
Capital Fund at time t (M EGP)	$Capex_t$	124.81	8.07	11.22	14.71	17.80	20.35								
Loan Payments (M EGP)				100.88			37.00								
Operation Income at time t (M EGP)	OI_t								54.66			54.66			54.66
Government Subsidy at time t (M EGP)	GS_t								5.35			5.35			5.35
Loan Principle at time t (M EGP)	LP_t							...							
Loan Interest at time t (M EGP)									0.07						0.07
Loan Interest at time t %	Li_t								10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
Operation Cost at time t (M EGP)	$Opex_t$								38.09			38.09			38.09
Taxes at time t (M EGP)	T_t														20.79
Output Quantity at time t (M Unit)	Q_t								7.50	7.50	7.50	7.50	7.50	7.50	7.50

Go Back to Input Sheet

Figure 25: Updated Payment Distribution

Contract Payment Information - Present Values	
Base IRR	19.95%
Capital Fund (M EGP)	788.51
Loan Payments (M EGP)	551.50
Operation Income (M EGP)	2,978.61
Government Subsidy (M EGP)	194.38
Loan Principle (M EGP)	515.21
Loan Interest (M EGP)	494.22
Operation Cost (M EGP)	1,707.63
Taxes (M EGP)	181.39
Output Quantity (M Unit)	1,620.00

Re-equilibrium Information - Present Values	
Updated IRR	0.00%
Capital Fund (M EGP)	788.51
Loan Payments (M EGP)	551.50
Operation Income (M EGP)	2,787.46
Government Subsidy (M EGP)	187.20
Loan Principle (M EGP)	515.21
Loan Interest (M EGP)	494.22
Operation Cost (M EGP)	1,707.63
Taxes (M EGP)	181.39
Output Quantity (M Unit)	1,507.50

Calculating the Concession Value at (t = 0) :

	Base	Updated	Re-equilibrium
Concession Value at t = 0	37.52	(160.81)	198.33

Figure 26: PPP Concession Value and Re-equilibrium Value at t = 0

5 . 2 . 5 The Scenarios Development Module

As stated in previous sections, the common three scenarios used to regain the financial model equilibrium are paying a lump sum amount to the private sector, increasing the service charges, or increasing the concession period. The re-equilibrium value calculated in the previous module is to be used as the basis for calculating the values of the above three scenarios as well as an additional fourth scenario, which is a combination of any two of the above scenarios. All the calculations are done in the background, as the user will only get to see the final results of the scenarios. Figure 27 shows the scenarios development tables.

Calculating Re-equilibrium Scenarios:

Scenario 1: Lump Sum Payment at re-equilibrium time

	Base	Updated	Lump Sum Payment
Concession Price	37.52	(160.81)	270.34

Scenario 2: Adjusted Payment

	Base	Required to Re-equilibrium	Adjusted
User Charges	-	-	-
Usage Payments	-	-	-
Availability Payments	32.00	8.36	40.36

Scenario 3: Adjusted Concession Period

	Base	Required to Re-equilibrium	Adjusted
Concession Period	20	N/A	N/A

Scenario 4: Combination of the above

	Quarterly Payment	Concession Extension
Limitation	-	30.00
Remaining Value	-	10.00
Adjusted	34.50	30.00

Figure 27: Re-equilibrium Scenarios Calculations

The first scenario is paying a lump sum amount to the private sector. The value of the lump sum payment is assumed to be paid at the re-equilibrium date, which is April 2013. Hence, the lump sum payment is calculated using Equation 4 where (i) is the discount rate ten percent, (N) is the number of periods from time zero (January 2010) until the re-equilibrium date (April 2013), (PV) is the re-equilibrium payment at time = 0, and finally the (FV) calculated is the lump sum value to be paid by the public sector to the private sector, which is almost 270 million Egyptian Pounds.

The second re-equilibrium scenario is adjusting the availability payment paid to the private sector. The model shall automatically select the payment mechanism used in the contract and calculate the additional payment required to reach re-equilibrium. The case study payment mechanism is availability payments, where the payment value is almost 32 million Egyptian Pounds paid quarterly to the private sector.

The amount of the added payment is calculated via Equation 5 where the (A) is the adjusted amount, (PV) is the lump sum payment at the re-equilibrium date obtained in the first scenario, (i) in this case is the fixed discount rate of 10 percent divided by the number of periods in one year, which is four, in order to get the effective discount rate, and (N) is the number of periods from the re-equilibrium date until the end date of the project, which is four multiple of the difference in years between April 2013 and December 2029.

The adjusted amount is then added to the original payment amount as shown in the scenario two calculations of Figure 27. Finally, the adjusted payment is almost 40 million Egyptian Pounds, paid quarterly starting from the re-equilibrium date until the end of the concession period.

Moreover, the third option to return the contract equilibrium is adjusting the concession period. This is calculated by first by using Equation 4 to get the future value of the re-equilibrium value at the end of the project in December 2029. (FV) in this case is the required payment at the end date of the project, (PV) is the difference between the present value of the PPP concession value and the PPP updated concession value at the start date of the project, or simply the re-equilibrium value, (i) is the fixed discount rate of 10 percent, and (N) is the number of years of the concession period, 20 years.

This value is to be considered the present value in Equation 5. The (A) is the 32 million Egyptian Pounds; the (i) is the effective discount rate per quarter. The equation is solved to get (N), which constitutes the number of periods remaining to be able to regain the financial model re-equilibrium. The maximum concession period for PPP contracts in Egypt is 30 years, as regulated by the Egyptian Law of PPP. However, in this case study, after adding the (N) obtained to the original concession period, the adjusted concession period exceeded 30 years, violating the law and making scenario three inapplicable.

All the previous calculations are done in the background, as after the user enters the updated payment distribution in Figure 24, the user will be directed straight to the preliminary three re-equilibrium scenarios in Figure 29. The user will then be directed to Figure 28 in order to enter the elements of the fourth scenario. The user chooses a combination from the above three scenarios in order to calculate their values. In the case study, the Independent Financial Expert chose the fourth scenario to be a combination of adjusting the quarterly payments and extending the concession period. The user is also asked to enter a limitation to one of the two items selected. In this case study, the concession period is to be set to the maximum which is 30 years, as per Egyptian Law.

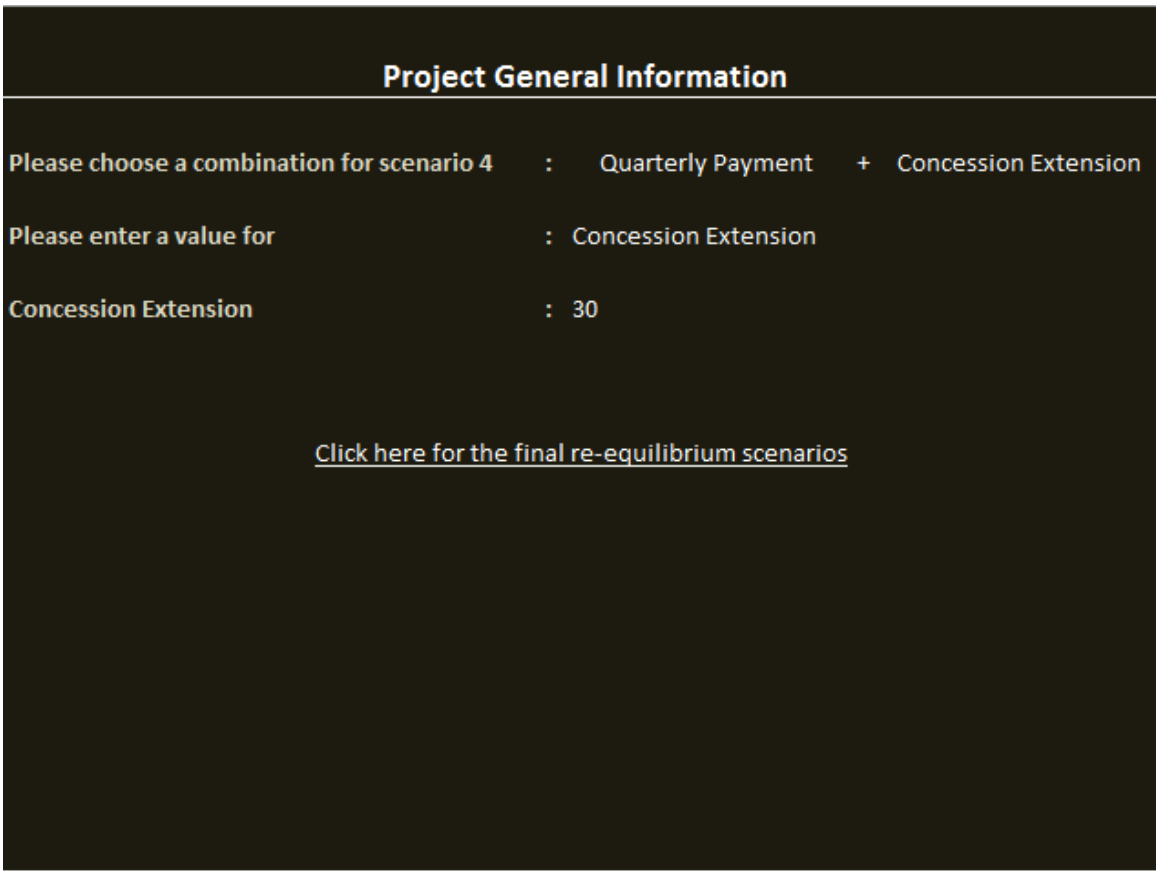


Figure 28: DSS User-interface no.6

The calculations of the fourth scenario are shown in Figure 27. The first row is the limitation which is what the user defines in the user-interface screen. The limitation shall always be a figure greater than the contractual value. Without entering a limitation,

there would be an infinite number of combinations for scenario four. The second row is the remaining value which is the difference between the limitation and the base value. In other words, it is the value that shall be transferred into the other form of the combination.

In the case study, the combination chosen for the fourth scenario is to adjust the concession period and the capacity charge. The limitation for the concession period has been set to 30 years. The remaining value is 10 years. An adjusted quarterly payment is to be paid starting from the re-equilibrium date until the end of the 30-year adjusted concession period. In order to calculate the amount to be added to the base quarterly payment, the following steps should be followed.

A new re-equilibrium payment should be calculated to deduct the value of the payments to be paid in the additional 10 years of the concession period. This is done using Equation 5 where the (A) is the 32 million Egyptian Pounds payments paid in the additional 10 years, (i) in this case is 10 percent fixed discount rate divided by four periods in order to get the effective discount rate, and (N) is the number of periods in the additional 10 years, which is 40, as the payments are paid quarterly. The (PV) obtained is discounted until the project start date.

The (PV) is to be plugged into Equation 4 as the future value, (i) is the fixed discount rate of 10 percent, and (N) is 20. The (PV) obtained from Equation 4 shall be deducted from the re-equilibrium value at time zero to obtain the new re-equilibrium value, which shall be plugged into Equation 4 to obtain the (FV) at the re-equilibrium date, then Equation 5 shall be used to obtain (A), which is the adjustment that shall be added to the base capacity charge of the project. The adjusted payment in this case is almost 35 million Egyptian Pounds. The final set of scenarios are presented to the user, as shown in Figure 30.

Finally, the four re-equilibrium scenarios, obtained from the model, are very close to the ones obtained by the Independent Financial Expert. One of the scenario's value is almost identical to the IFE value, and the others do not exceed the IFC values by more than five percent. This is considered an acceptable range to validate the developed model.

Re-equilibrium Scenarios

Scenarios	Scenarios Description	Concession Value at time 0 (M EGP)	IRR %	Lump Sum Payment (M EGP)	Payment (M EGP)	Concession Period # of years
Base Scenario	Contract Information	37.52	19.95%	-	32.00	20.00
Updated Scenario	Updated Information	(160.81)	0.00%	-	32.00	20.00
Re-equilibrium Scenario 1	Lump Sum Payment at RD	37.52	19.95%	270.34	32.00	20.00
Re-equilibrium Scenario 2	Adjusted Payment	37.52	19.95%	-	40.36	20.00
Re-equilibrium Scenario 3	Adjusted Concession Period	37.52	19.95%	-	32.00	N/A

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Figure 29: The Preliminary Re-equilibrium Scenarios

Re-equilibrium Scenarios

Scenarios	Scenarios Description	Concession Value at time 0 (M EGP)	IRR %	Lump Sum Payment (M EGP)	Payment (M EGP)	Concession Period # of years
Base Scenario	Contract Information	37.52	19.95%	-	32.00	20.00
Updated Scenario	Updated Information	(160.81)	0.00%	-	32.00	20.00
Re-equilibrium Scenario 1	Lump Sum Payment at RD	37.52	19.95%	270.34	32.00	20.00
Re-equilibrium Scenario 2	Adjusted Payment	37.52	19.95%	-	40.36	20.00
Re-equilibrium Scenario 3	Adjusted Concession Period	37.52	19.95%	-	32.00	N/A
Re-equilibrium Scenario 4	Combination of the above	37.52	19.95%	-	34.50	30.00

Input Re-equilibrium Criteria

Figure 30: The Final Re-equilibrium Scenarios

5 . 2 . 6 The Scenarios Selection Module

The purpose of the scenarios selection module is to be able to identify the best scenario from the four re-equilibrium scenarios: paying a lump sum amount to the private sector, increasing the service charge, adjusting the concession period, and a fourth scenario with a combination of any two of the above scenarios. The aim is to maximize the satisfaction of both parties. In order to achieve this goal, a set of criteria should be defined in order to evaluate this degree of satisfaction.

After the user is directed to the final set of scenarios developed in the previous module, shown in Figure 30, the user shall click the button at the bottom to enter the re-equilibrium criteria. The user-interface module presents the screen in Figure 31 for the user to enter the criteria in the first row of the table. The user may also enter sub-criteria for each one of the criteria. The criteria main categories are economic, political, financial, project related, contractual, and policy. The economic criteria has to do with the economic situation of the country where the project is located. The sub-criteria for this category include inflation, general conditions of the country, stability of the exchange rates, and how the IRR is affected by all of the above. This is followed by the political criteria. The sub-criteria include long-term stability of the country, the current political situation, and the justice system in general. In addition, the financial criteria has to do with the party's financial standing. It includes any current financial obligations required to be paid by the party, additional financial obligations, liquidity, the ratio between debt and equity, and the transparency of financial data. On the other hand, the project-related criteria is specific to the project nature, which includes original concession period, preferable concession period, and the level of complexity of the project. Moreover, the contractual criteria includes existence of regulator, risk sharing agreement, and how clear the termination clauses and re-equilibrium clauses are. Finally, the policy criteria is the general manner in which a certain party usually reacts to a certain situation. It includes the long-term business strategy, the likelihood of repeated business with a certain partner who is able to recognize the claim, and the experience of other partners. After the user enters the re-equilibrium criteria, the user shall enter scenario one priorities by clicking on the button in Figure 31. The user is then directed to the screen in Figure 32.

Scenario Selection Criteria:

Economic	Political	Financial	Project Related	Contractual	Policy
Inflation	Long-term Stability	Current Financial Obligations	Original Concession Period	Existence of Regulator	Business Strategy
General Conditions	Current Political Situation	Additional Financial Requirements	Preferred Concession Period	Risk Sharing Agreement	Likelihood of Repeated Business
Exchange Rates	Justice System	Liquidity	Complexity of the Project	Termination Clauses	Who Recognized the Claim
Effect on IRR		Ratio Debt vs. Equity		Re-equilibrium Clauses	Experienced Parties
		Transparency			

Click to Input S1 Priorities

Figure 32: Re-equilibrium Criteria

Scenario 1	Lump Sum Payment at RD

Criteria Priorities:

Criteria
Economic
Political
Financial
Project Related
Contractual
Policy

Criteria 1	Criteria 2	Which is more important?
Political	Economic	Political
Financial	Economic	Financial / Economic
Financial	Political	Financial
Project Related	Economic	Economic
Project Related	Political	Project Related
Project Related	Financia	Project Related / Political
Contractual	Economi	
Contractual	Political	Political
Contractual	Financial	Financial
Contractual	Project Related	Project Related
Policy	Economic	Economic
Policy	Political	Political
Policy	Financial	Financial
Policy	Project Related	Policy / Project Related
Policy	Contractual	Policy

Economic
Inflation
General Conditions
Exchange Rates
Effect on IRR

Subcriteria 1	Subcriteria 2	Which is more important?
General Conditions	Inflation	General Conditions
Exchange Rates	Inflation	Inflation
Exchange Rates	General Conditions	Exchange Rates / General Conditions
Effect on IRR	Inflation	Inflation
Effect on IRR	General Conditions	General Conditions
Effect on IRR	Exchange Rates	Exchange Rates

Figure 31: Criteria and Sub-criteria Priorities

The weights of each criteria and sub-criteria changes depending on its relation to a certain scenario, as explained in the methodology; hence, the user shall be directed to four screens, each one representing the weights for a specific scenario. The detailed priority tables are in Appendix A; however, Figure 32 shows a sample of the priorities of the criteria and the economic sub-criteria for scenario one. The user is asked to select from a dropdown menu which is more important among combinations of two criteria with respect to the selected scenario. The user has the right to select both criteria if he believes that they are equally important. In the background of the model, this information shall be transferred to form the decision matrix shown in Figure 33. The decision matrix is a mirror matrix with the top row identical to the first column, then the priorities are entered in the respective cells. The weights of the criteria or the sub-criteria are calculated in the tables, shown also in Figure 33, by counting the number of occurrences of the criteria or the sub-criteria in the decision matrix and dividing it by the total number of occurrences of all the criteria or the sub-criteria to get a percentage. The weights for the economic, political, financial, project-related, contractual and policy with respect to scenario one are shown in Figure 33.

After the user selects all the priorities for the four scenarios, the weights are ready to be used in the weighted sum model. As stated before, there exist separate weights for the criteria and the sub-criteria for each one of the four scenarios. However, the user is to enter only one rank for all the four. The user will be directed to the screen where he enters a ranking for the sub-criteria. A sample of the ranking sheet is shown in Figure 34. There exist two separate sheets for the private sector and the public sector. The sheet structure is shown in Figure 34, where the first column is the sub-criteria. In order to decide whether this sub-criteria is in favor of the party or not, the user looks at the risk allocations in order to see the broader picture. The following column is related risk, where the user chooses the risk that affects his decision from a dropdown menu. The risk allocation will automatically appear for the user to choose the suitable rank for a certain sub-criteria. The ranks are very suitable, suitable, neutral, unsuitable, and very unsuitable. The user selects the ranks from a dropdown menu. For the purpose of this case study, the weights and ranks are advised by governmental officials and private sector representatives.

Criteria

Criteria	Economic	Political	Financial	Project Related	Contractual	Policy
Economic		Political	Financial / Economic	Economic	Contractual	Economic
Political			Financial	Project Related	Political	Political
Financial				Project Related	Financial	Financial
Project Related					Project Related	Policy / Project Related
Contractual						Policy
Policy						

Criteria	# of Occurrence	Weight
Economic	3	18%
Political	3	18%
Financial	4	24%
Project Related	4	24%
Contractual	1	6%
Policy	2	12%

Economic

Economic	Inflation	General Conditions	Exchange Rates	Effect on IRR
Inflation		General Conditions	Inflation	Inflation
General Conditions			Exchange Rates / General Conditions	General Conditions
Exchange Rates				Exchange Rates
Effect on IRR				

Economic	# of Occurrence	Weight
Inflation	2	29%
General Conditions	3	43%
Exchange Rates	2	29%
Effect on IRR	0	0%

Figure 33: Criteria and Sub-criteria Decision Matrix

Criteria	Related Risk	Risk Allocation	Rank	Rank #
Economic				
Inflation	Inflation	Primarily to Private Sector	Suitable	4
General Conditions	Influential economic events	rimarily to Private Sector	Suitable	4
Exchange Rates		Solely to Private Sector	Very Suitable	5
Effect on IRR		Solely to Private Sector		1
Long-term Stability		Public Sector	Very Unsuitable	1
Current Political Situation	Poor political decision-making process	Public Sector	Very Unsuitable	1
Justice System	Legislation change	Shared	Very Suitable	5
Financial				
Current Financial Obligations	Lack of commitment from public/private partner	Shared	Suitable	4
Additional Financial Requirements	Financial market	Solely to Private Sector	Suitable	4
Liquidity	Availability of finance	Solely to Private Sector	Neutral	3
Ratio Debt vs. Equity	High financing cost	Solely to Private Sector	Suitable	4
Transparency	Level of public support	Strongly Depending	Very Suitable	5
Project Related				
Original Concession Period	Construction time delay	Solely to Private Sector	Suitable	4
Preferred Concession Period	Construction time delay	Solely to Private Sector	Neutral	3
Complexity of the Project	Quality of workmanship	Solely to Private Sector	Neutral	3
Contractual				
Existence of Regulator	Industrial regulatory change	Solely to Private Sector	Very Unsuitable	1
Risk Sharing Agreement	Responsibilities and risk distribution	Shared	Suitable	4
Termination Clauses	Force majeure	Shared	Suitable	4
Re-equilibrium Clauses	Contract variation	Strongly Depending	Suitable	4
Policy				
Business Strategy	Financial attraction of project	Primarily to Private Sector	Very Suitable	5
Likelihood of Repeated Business	Residual risk	Primarily to Private Sector	Neutral	3
Who Recognized the Claim	Level of public support	Strongly Depending	Neutral	3
Experienced Parties	Lack of experiences in PPP arrangement	Strongly Depending	Very Suitable	5

Influential economic events
Financial attraction of project
Level of demanding project
Different working methods
Industrial regulatory change
High financing cost
Interest rate
Organization and coordination risk

Very Suitable
Suitable
Neutral
Unsuitable
Very Unsuitable

Input Public Sector Ranking

Figure 34: Sub-criteria Ranking

After both the private sector and the public sector enter the ranks, twelve scenario scores are calculated: four from the public sector perspective, four from the private sector perspective, and four from the perspective of both. Using the weighted sum model presented in Equation 6, where (x) is the number of alternatives scenarios, which is twelve scenarios, (i) is the number of main criteria, which is six, (j) is the number of sub-criteria of a certain main criteria, which varies depending on the criteria, (W) is the weights, and (R) is the rankings. Figure 35 shows the calculations of the

Weighted Sum Model

Criteria	Scenario 1 Weights	Scenario 2 Weights	Scenario 3 Weights	Scenario 4 Weights	Private Sector Ranks	Public Sector Ranks	Combined Ranks
Economic	18%	19%	19%	21%			
Inflation	29%	29%	14%	29%	4	5	4.5
General Conditions	43%	43%	43%	43%	4	2	3
Exchange Rates	29%	29%	29%	29%	5	2	3.5
Effect on IRR	0%	0%	14%	0%	1	1	1
Political	18%	19%	19%	16%			
Long-term Stability	67%	33%	67%	50%	1	2	1.5
Current Political Situation	0%	0%	0%	25%	1	3	2
Justice System	33%	67%	33%	25%	5	2	3.5
Financial	24%	19%	19%	21%			
Current Financial Obligations	36%	18%	36%	27%	4	4	4
Additional Financial Requirements	27%	27%	27%	27%	4	4	4
Liquidity	18%	27%	9%	27%	3	3	3
Ratio Debt vs. Equity	9%	18%	18%	9%	4	2	3
Transparency	9%	9%	9%	9%	5	4	4.5
Project Related	24%	25%	19%	21%			
Original Concession Period	50%	50%	50%	50%	4	4	4
Preferred Concession Period	25%	25%	25%	25%	3	3	3
Complexity of the Project	25%	25%	25%	25%	3	4	3.5
Contractual	6%	6%	13%	5%			
Existence of Regulator	29%	29%	29%	29%	1	4	2.5
Risk Sharing Agreement	43%	29%	43%	29%	4	2	3
Termination Clauses	14%	14%	14%	29%	4	4	4
Re-equilibrium Clauses	14%	29%	14%	14%	4	1	2.5
Policy	12%	13%	13%	16%			
Business Strategy	13%	25%	13%	25%	5	5	5
Likelihood of Repeated Business	25%	25%	25%	25%	3	3	3
Who Recognized the Claim	38%	13%	38%	38%	3	5	4
Experienced Parties	25%	38%	25%	13%	5	5	5

	Scenario 1 Score	Scenario 2 Score	Scenario 3 Score	Scenario 4 Score	Best Scenario
Private Sector	3.54	3.81	3.43	3.52	Scenario 2 with Score 3.81
Public Sector	3.28	3.20	3.07	3.36	Scenario 4 with Score 3.36
Combined	3.41	3.51	3.25	3.44	Scenario 2 with Score 3.51

Figure 35: Scenario Scores Calculations

scenario scores in the bottom. The last column to the right, called the combined ranks, is the average of the private sector ranks and the public sector ranks. The scenarios with the highest scores are identified as the best scenarios for each party and the combined best scenario for both the public and the private sectors. After entering the ranks, the

user is directed to the results directly without going into the calculation details. The results are presented via the user-interface screen shown in Figure 36.

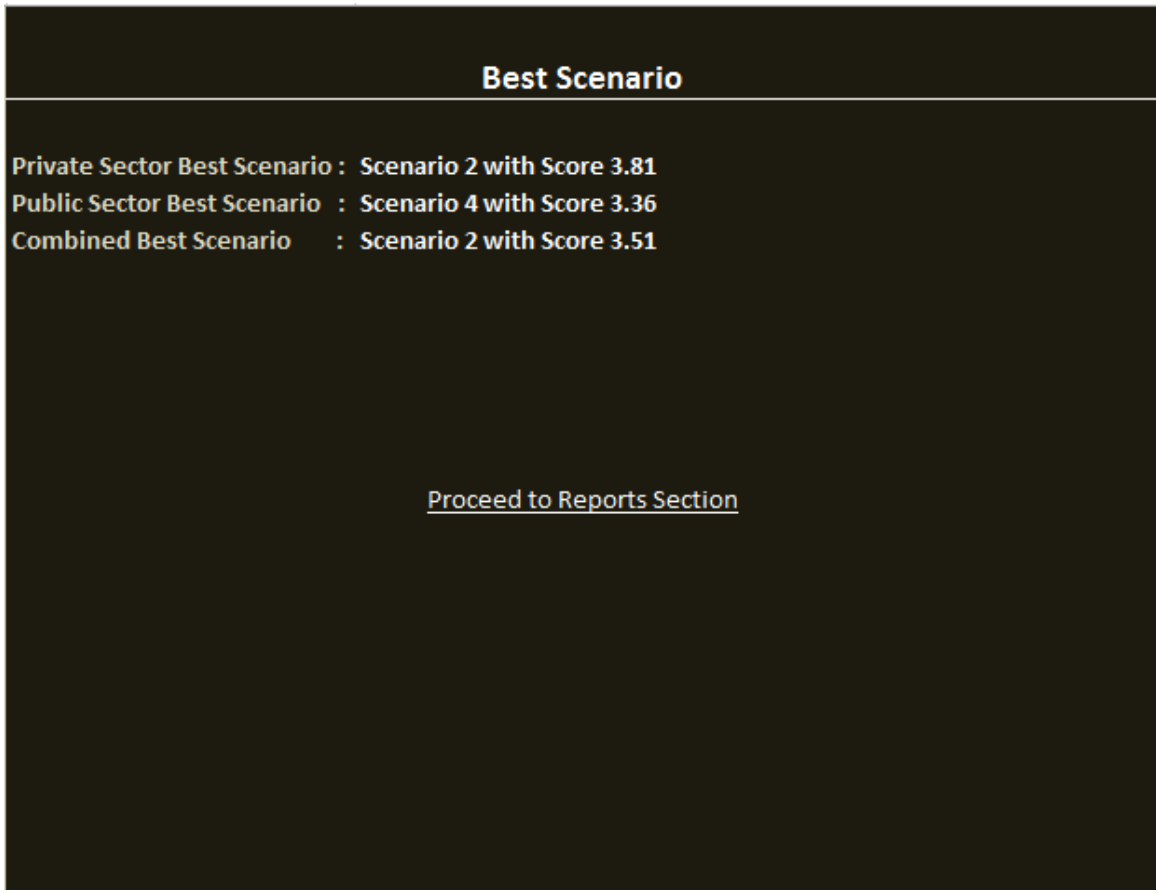


Figure 36: DSS User-interface no.7

5 . 2 . 7 The Reports Module

By clicking on the link at the bottom of Figure 36, the user will be directed to the reports module. The reports module includes all the outputs of the previous modules. The PPP concession value and the re-equilibrium value is also reported in this section; moreover, this section also includes the re-equilibrium scenarios reports and the best scenarios reports. The reports module also includes the risk allocation charts. The charts are located in Appendix A, yet a sample of the charts is shown in Figure 37. Risk allocation charts give a sense of which party is bearing the highest share of the risks.

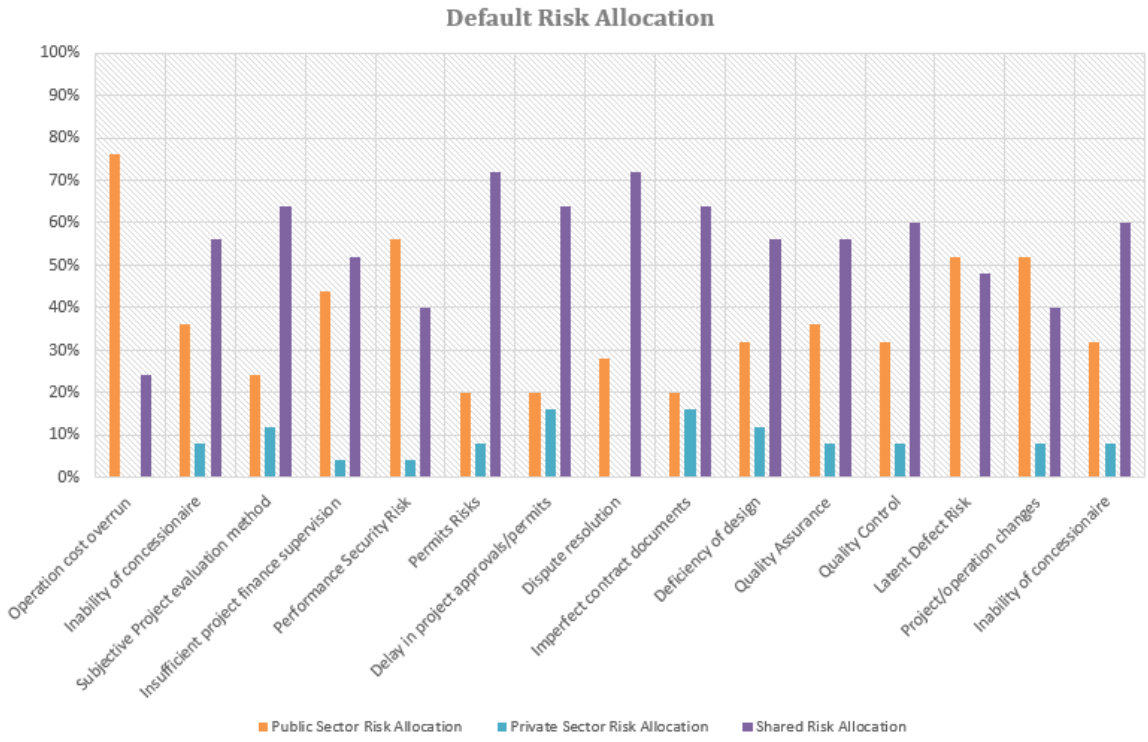


Figure 37: Default Risk Allocation Chart

The following set of reports is developed using Precision Tree 5.5 for Excel add-in. The following report is the decision tree showing the process of selecting the best scenario and calculating the expected monetary value (EMV). Three trees are formulated: one for the private sector best scenario, one for the public sector best scenario, and one for the best scenario considering both of them. The three charts are included in Appendix A. Three more charts are drawn to show only the optimal paths of the three trees, a sample of which is shown below in Figure 38. It belongs to the private sector decision tree. As shown previously, the second scenario is the scenario with the highest score, which means it is the preferable scenario for the private sector. Figure 38 shows the calculations of scenario two scores, where the first decision node represents the criteria of selection and the weights are shown at the arrows. The following decision nodes represent the sub-criteria, where the arrows have both their weights and the ranks, as well.

The following set of reports are the risk profile graphs, which consist of a probability chart, a cumulative graph, and a statistical summary. The purpose of these

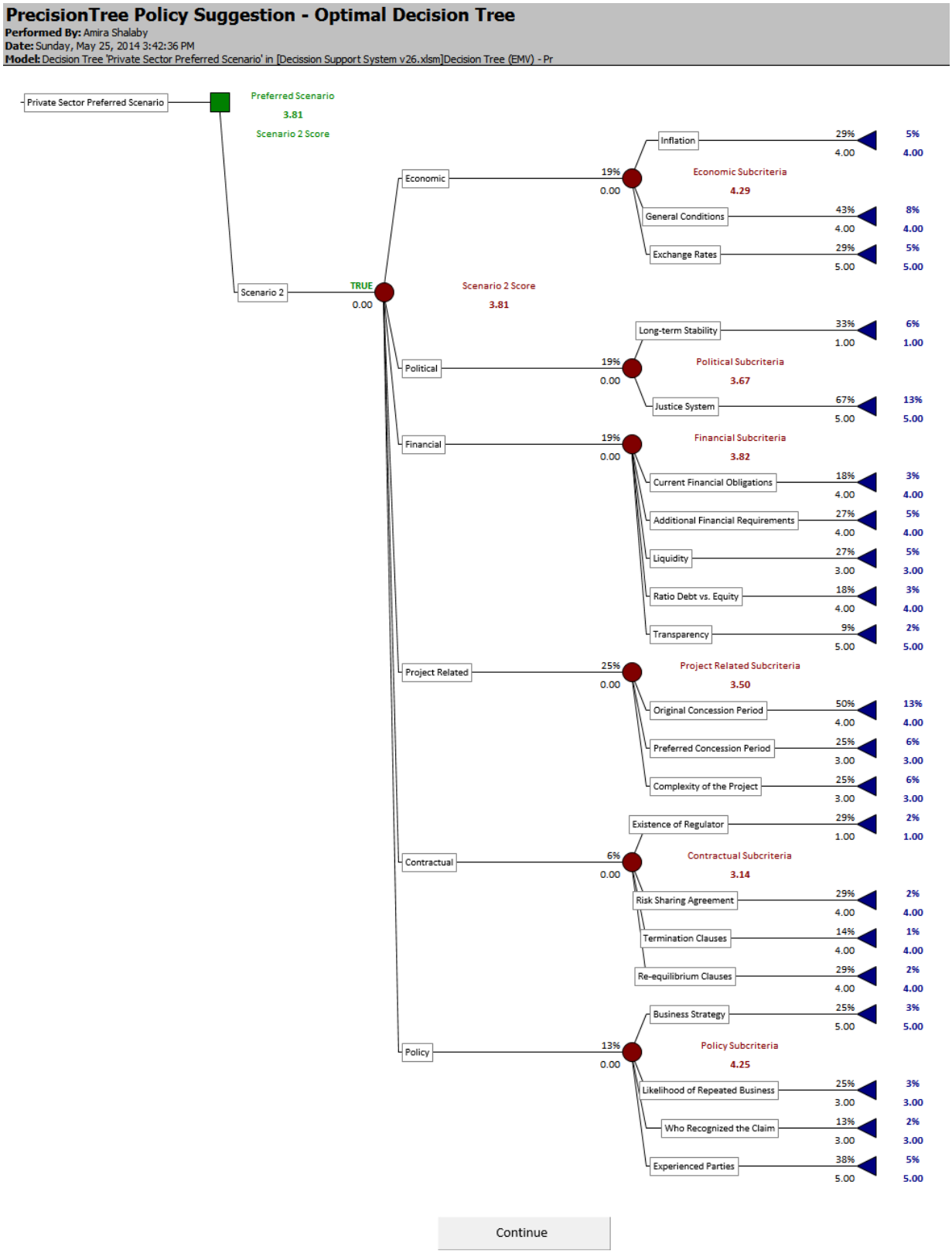


Figure 38: Private Sector Optimal Decision Tree

graphs is to show the risks and probability of selecting one scenario versus the other. The reports are included in Appendix A. A sample of the reports belonging to the private sector is shown below. Figure 39 demonstrates the first type of risk profile graph, the probability chart. The chart shows the different values for the four scenario scores and their probability of occurrence. For example, the probability that the scenario one score equals four is 46 percent, and the probability that the scenario three score equals three is 19 percent.

On the other hand, Figure 40 demonstrates the cumulative probability chart, in which the chart demonstrates the probability of a scenario score equal or less than a certain value. For instance, the probability that the scenario two score is less than or equal to three is 30 percent, while the probability that the scenario four score is less than or equal to one is 13 percent.

Figure 41 displays a statistical summary of the risk profile, which includes statistical information such as the mean, the standard deviation, the minimum and maximum values, the mode, the skewness, and the kurtosis. As shown in the figure, the expected value or the mean for scenario one is 3.54, for scenario two is 3.81, for scenario three is 3.43, and for scenario four is 3.52. From the expected value point of view only, scenario two is the optimum scenario to be selected by the private sector.

Figure 42 displays another type of reports called the policy suggestion reports. Those reports help the management see the broader picture, not only the scenario with the highest score. The decision trees and the optimal decision tree in Figure 38 are considered part of this section of reports. Figure 42 shows optimal decision selected at each decision node and what is called "benefit of the correct choice." Since the model has only one decision node, which is selecting the best scenario, the table has only one decision node, and its probability of occurrence is 100 percent. The benefit of the correct choice is the difference between the highest scenario score and the lowest scenario score. In the case of the private sector, the highest scenario score is a scenario two score which equals 3.81, and the lowest scenario score is scenario three which equals 3.43. The difference between the two scenarios is 0.38, which is the benefit of the correct choice in Figure 42. This helps the management get a sense of the whole spectrum when making their decision.

PrecisionTree Risk Profile - Probability Chart

Performed By: Amira Shalaby
Date: Sunday, May 25, 2014 3:30:46 PM
Model: Decision Tree 'Private Sector Preferred Scenario' in [Decission Support System v26.xlsm]Decision Tree (EMV) - Pr
Analysis: Choice Comparison for Node 'Preferred Scenario' (C66)

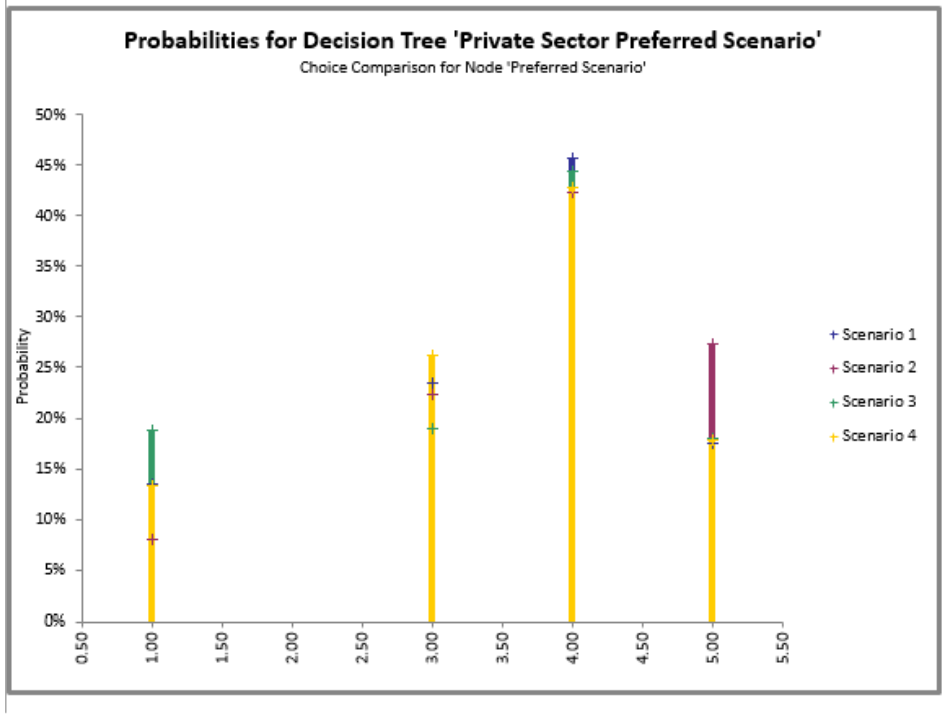


Chart Data

	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
	Value	Probability	Value	Probability	Value	Probability	Value	Probability
#1	1.00	13%	1.00	8%	1.00	19%	1.00	13%
#2	3.00	23%	3.00	22%	3.00	19%	3.00	26%
#3	4.00	46%	4.00	42%	4.00	44%	4.00	43%
#4	5.00	17%	5.00	27%	5.00	18%	5.00	18%

Continue

Figure 39: Private Sector Probability Chart

PrecisionTree RiskProfile - Cumulative Chart

Performed By: Amira Shalaby
Date: Sunday, May 25, 2014 3:30:48 PM
Model: Decision Tree 'Private Sector Preferred Scenario' in [Decission Support System v26.xlsm]Decision Tree (EMV) - Pr
Analysis: Choice Comparison for Node 'Preferred Scenario' (C66)

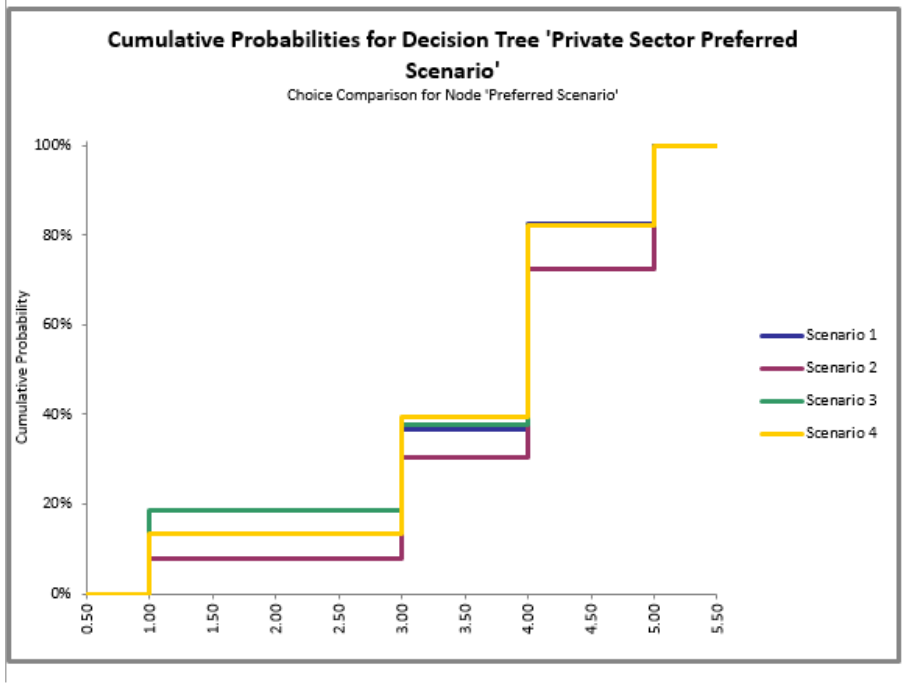


Chart Data

	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
	Value	Probability	Value	Probability	Value	Probability	Value	Probability
#1	-Infinity	0%	-Infinity	0%	-Infinity	0%	-Infinity	0%
#2	1.00	0%	1.00	0%	1.00	0%	1.00	0%
#3	1.00	13%	1.00	8%	1.00	19%	1.00	13%
#4	3.00	13%	3.00	8%	3.00	19%	3.00	13%
#5	3.00	37%	3.00	30%	3.00	38%	3.00	39%
#6	4.00	37%	4.00	30%	4.00	38%	4.00	39%
#7	4.00	83%	4.00	73%	4.00	82%	4.00	82%
#8	5.00	83%	5.00	73%	5.00	82%	5.00	82%
#9	5.00	100%	5.00	100%	5.00	100%	5.00	100%
#10	Infinity	100%	Infinity	100%	Infinity	100%	Infinity	100%

Continue

Figure 40: Private Sector Cumulative Chart

PrecisionTree Risk Profile - Statistical Summary

Performed By: Amira Shalaby
Date: Sunday, May 25, 2014 3:30:48 PM
Model: Decision Tree 'Private Sector Preferred Scenario' in [Decission Support System v26.xlsm]Decision Tree (EMV) - Pr
Analysis: Choice Comparison for Node 'Preferred Scenario' (C66)

Statistics	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Mean	3.54	3.81	3.43	3.52
Minimum	1.00	1.00	1.00	1.00
Maximum	5.00	5.00	5.00	5.00
Mode	4.00	4.00	4.00	4.00
Std. Deviation	1.19	1.09	1.32	1.19
Skewness	-0.9855	-1.1150	-0.8436	-0.9187
Kurtosis	3.2499	4.0348	2.5643	3.1620

Figure 41: Private Sector Statistical Summary

Continue

PrecisionTree Policy Suggestion - Decision Table

Performed By: Amira Shalaby
Date: Sunday, May 25, 2014 3:42:36 PM
Model: Decision Tree 'Private Sector Preferred Scenario' in [Decission Support System v26.xlsm]Decision Tree (EMV) - Pr

Decision	Optimal Choice	Arrival Probability	Benefit of Correct Choice
'Preferred Scenario' (C66)	Scenario 2	100%	0.38

Figure 42: Private Sector Policy Suggestion

Continue

5 . 2 . 8 The Sensitivity Analysis Module

The sensitivity analysis module is the final module in the Decision Support System. The sensitivity analysis is applied to the ranks of the sub-criteria. As the ranks change from very suitable, which is denoted by the number five, to very unsuitable, which is denoted by the number one, the scenario scores are affected. Hence, it is important to observe how sensitive the scenario scores are to the change in the rank of a certain sub-criteria. The sub-criteria with the highest ranks are chosen for the sensitivity analysis; moreover, double sensitivity analysis is also performed to study the effect of changing two sub-criteria ranks at the same time. The sensitivity analysis reports are included in Appendix A. A sample of the sensitivity analysis reports is presented below.

The sensitivity graph in Figure 43 shows the relationship between changing the ranking of the "exchange rates" sub-criteria and the expected monetary value (EMV) of the tree. The table on the right shows that if the ranking decreased by 80 percent, the EMV would decrease by almost six percent. In addition, if the ranking decreased by 20 percent, the EMV would decrease by almost one percent. The difference between the

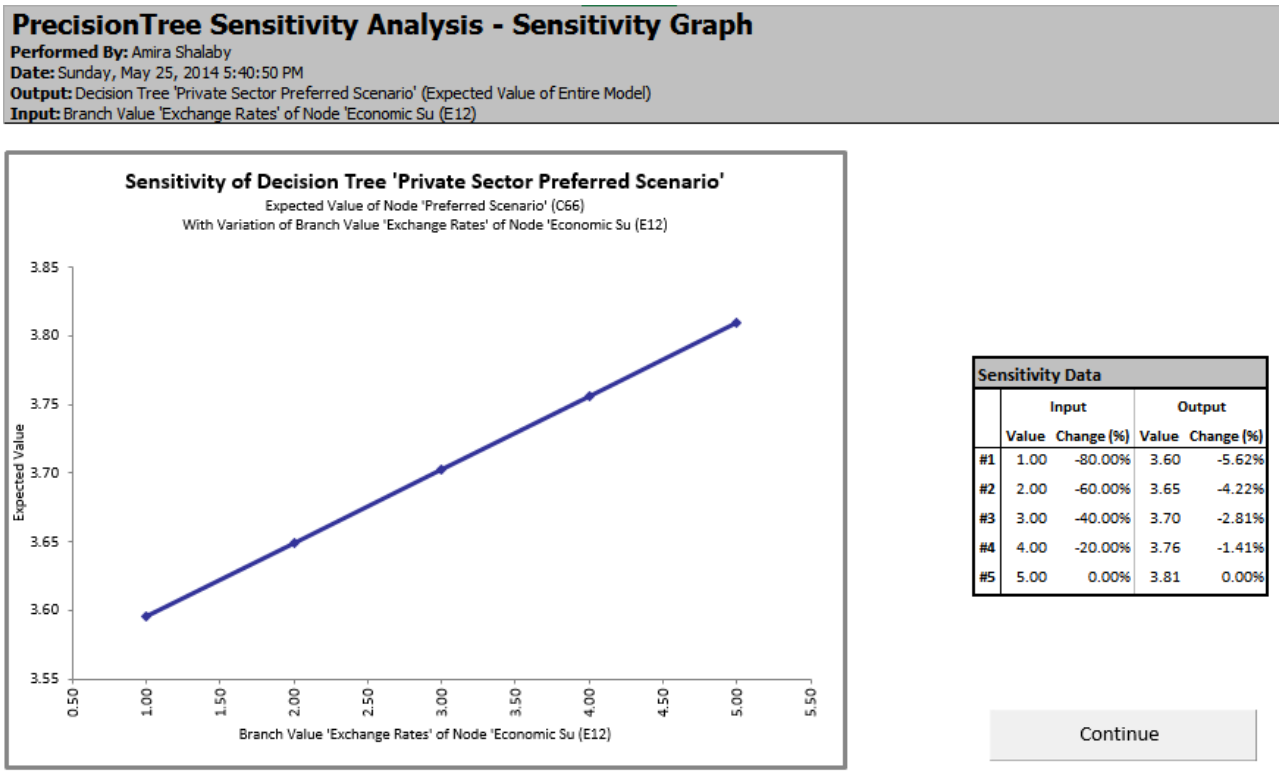


Figure 43: 'Exchange Rate' Sub-criteria Rank Sensitivity Graph

highest EMV and the lowest EMV is 0.21, more than half the "benefit of correct choice" value, which denotes that the change of ranking of the "exchange rates" sub-criteria is rather sensitive to the selection of the best scenario process.

Figure 44 is the second type of sensitivity report: the strategy region report. The strategy region report shows how sensitive each scenario score is to the change in the ranking of the "exchange rate" sub-criteria. The figure shows that for every possible value of the ranking of the "exchange rate" sub-criteria, scenario two shall always have the highest EMV. In other words, the result is not sensitive at all to the value of this variable. However, each scenario score is affected differently by the change of the ranking of this factor. For instance, the scenario four score is more sensitive to changing the ranking than the scenario one score, as the line is steeper.

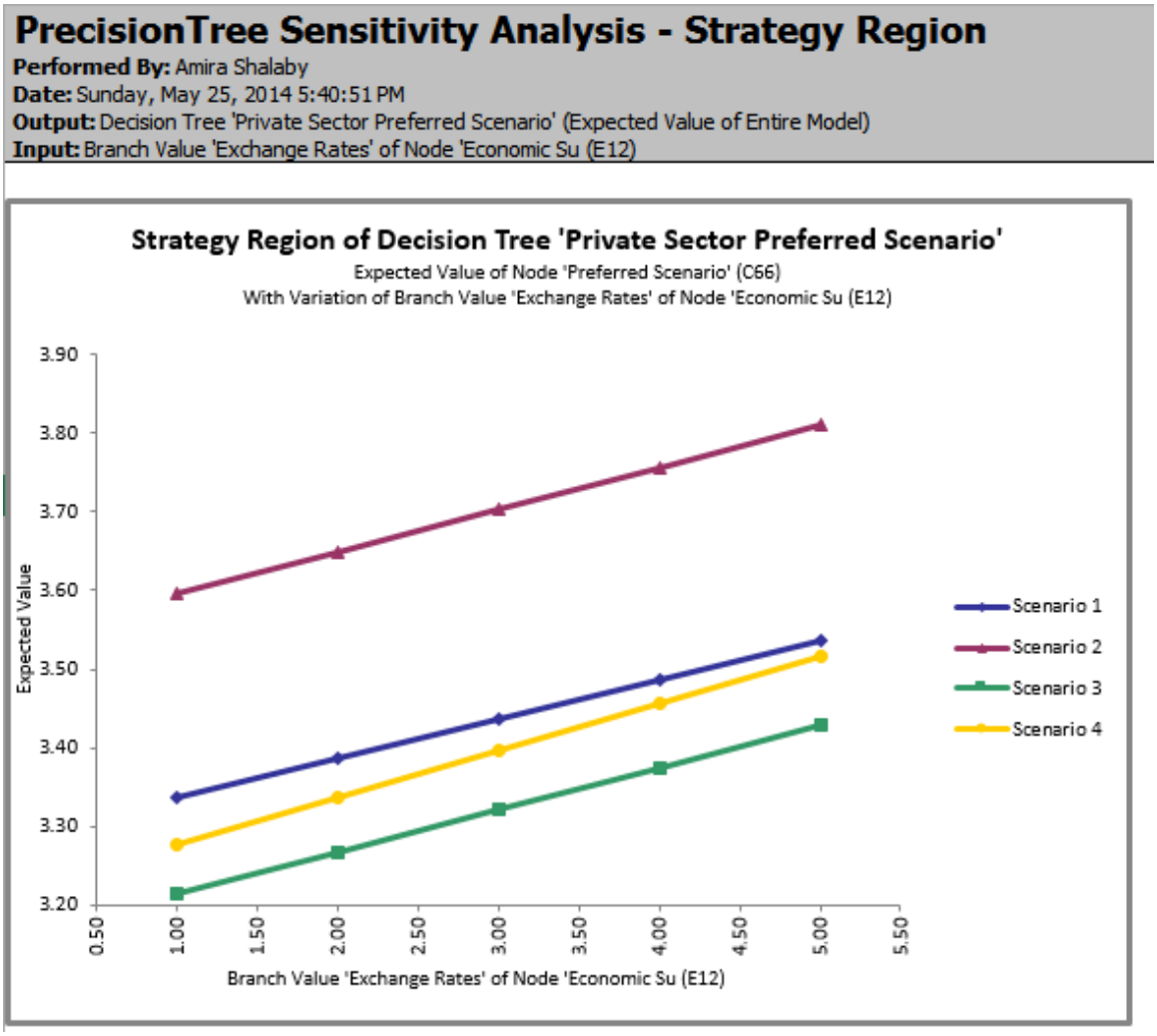


Figure 44: 'Exchange Rate' Sub-criteria Rank Strategy Region

Figure 45 shows the three sub-criteria: “long-term stability,” “exchange rates,” and “inflation.” The graph shows the EMV corresponding to each sub-criteria when its ranking varies from one to five. The first bar on the top is the “long term stability” sub-criteria. This bar is noticed to be the longest bar among the three, which shows that the EMV is more sensitive to the change of the ranking than the other sub-criteria.

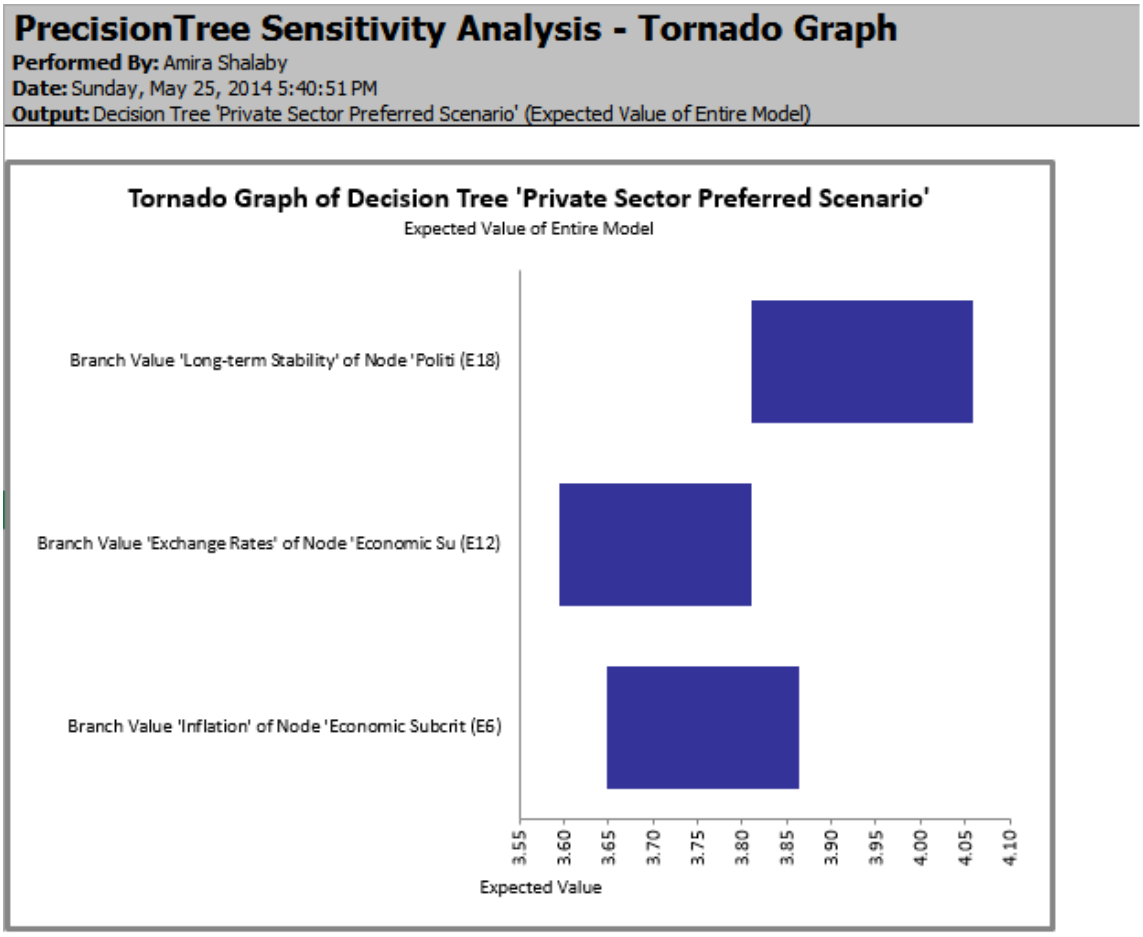


Figure 45: Private Sector Tornado Graph

The spider graph shown in Figure 46 confirms the same conclusion, as the line of the “long-term stability” sub-criteria is steeper than the other two lines, followed by the line of the “exchange rates” sub-criteria and in the end the line of the “inflation” sub-criteria. This concludes that the “long-term stability” is highly affected by the change in the ranks followed by the “exchange rates” sub-criteria and the “inflation” sub-criteria.

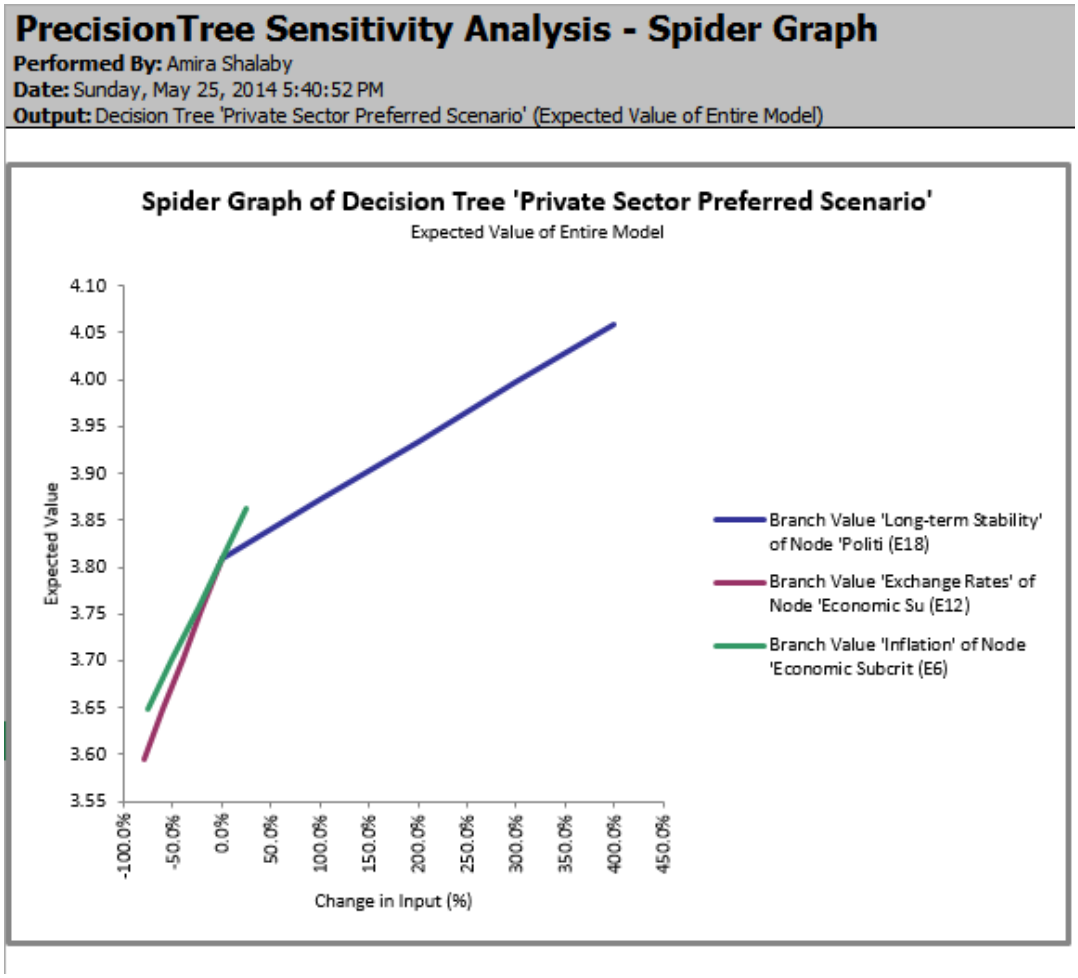
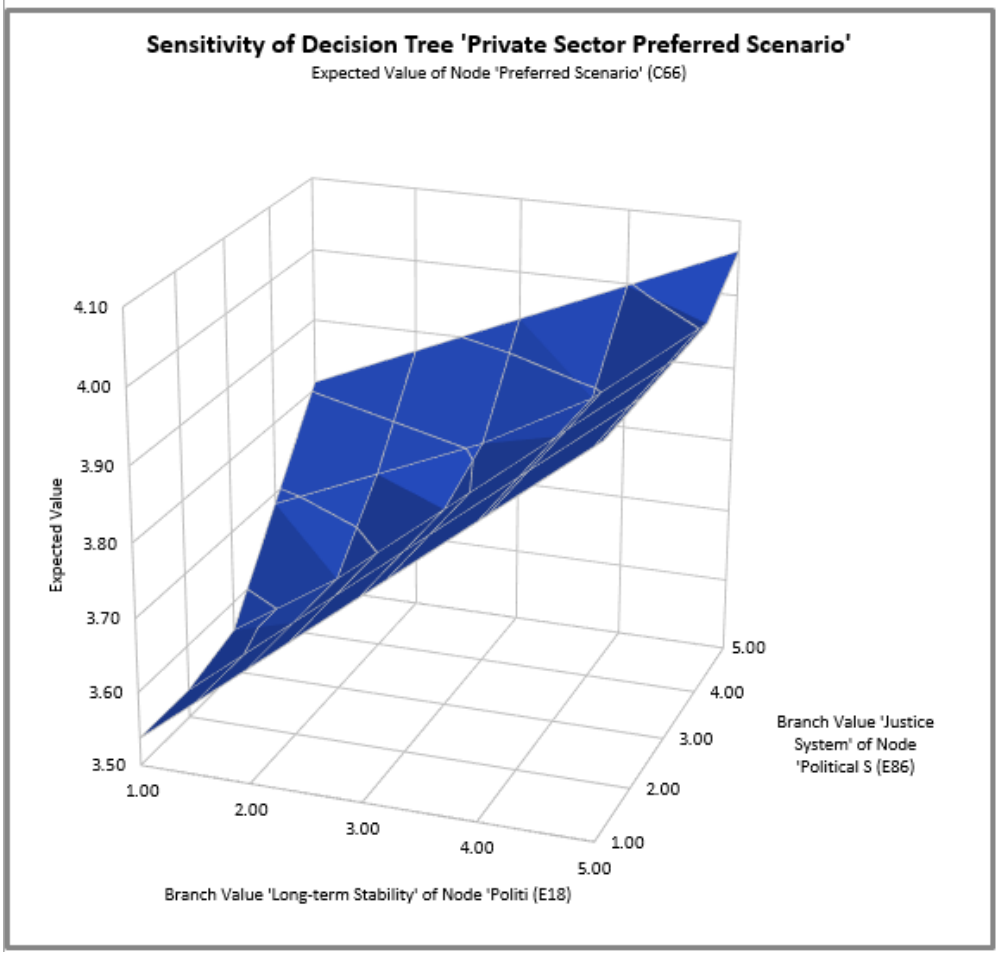


Figure 46: Private Sector Spider Graph

A two way sensitivity analysis is also performed to study the effect of changing the ranking of two sub-criteria at the same time on the expected monetary value of the decision tree or the preferred scenario. The two sub-criteria with the highest weights are selected, which are the "justice system" and the "long-term stability." Figure 47 shows the sensitivity graph for both sub-criteria with respect to the private sector EMV. The x-axis denotes the ranking of the "long-term stability" sub-criteria, the y-axis denotes the "justice system" sub-criteria, and finally, the z-axis denotes the EMV of the model. As shown in the figure and the attached table, as the rankings of the "justice system" sub-criteria and the "long-term stability" sub-criteria increase, the EMV increases, as well.

PrecisionTree Sensitivity Analysis - Sensitivity Graph (2-Way)

Performed By: Amira Shalaby
Date: Thursday, July 03, 2014 12:02:54 PM
Output: Decision Tree 'Private Sector Preferred Scenario' (Expected Value of Entire Model)
Input X: Branch Value 'Long-term Stability' of Node 'Politi (E18)
Input Y: Branch Value 'Justice System' of Node 'Political S (E86)



Two-Way Sensitivity Data of Decision Tree 'Private Sector Preferred Scenario' (Expected Value of Entire Model)

With Variation of Branch Value 'Long-term Stability' of Node 'Politi (E18) and Branch Value 'Justice System' of Node 'Political S (E86)

		Branch Value 'Long-term Stability' of Node 'Politi (E18)				
		1.00	**2.00**	**3.00**	**4.00**	**5.00**
Branch Value 'Justice System' of Node 'Political S (E86)	**1.00**	3.54	3.66	3.77	3.89	4.01
	2.00	3.54	3.66	3.77	3.89	4.01
	3.00	3.56	3.66	3.77	3.89	4.01
	4.00	3.68	3.75	3.81	3.89	4.01
	5.00	3.81	3.87	3.93	4.00	4.06

Figure 47: Two Way Sensitivity Graph

Another type of two way sensitivity analysis is the strategy region. Figure 48 shows the strategy region of the "justice system" sub-criteria and the "long term stability" sub-criteria for the private sector decision tree. The strategy region graph aims is to provide the user with every possible outcome for every combination of the sub-criteria rankings.

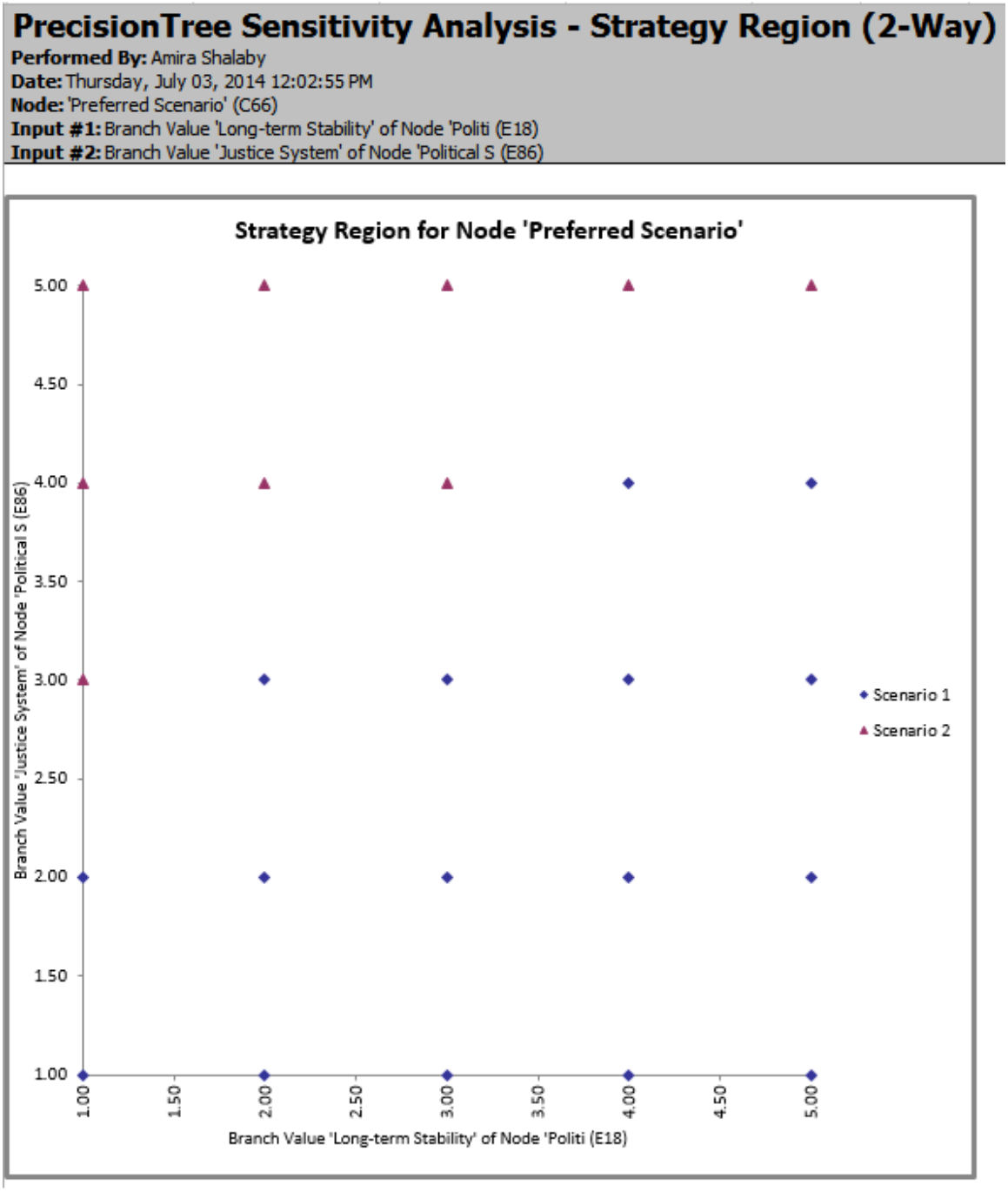


Figure 48: Two Way Sensitivity Analysis Strategy Region

For any combination of the rankings of the two sub-criteria, two possible preferred scenarios exist: either scenario one or scenario two. The probability of obtaining scenario one is higher than scenario two, as there exist a larger number of combinations resulting in scenario one than the number of combinations resulting in scenario two. It is also noticed from the graph that when the ranking of "justice system" sub-criteria approaches the maximum value and the ranking of the "long-term stability" sub-criteria approaches the minimum, scenario two becomes the optimum scenario, and vice versa.

5 . 3 The Prototype Model Verification and Validation

The verification of the model involves verifying the methods and techniques used in the Decision Support System prototype model; moreover, it includes verifying the outputs or the results obtained from the model. Calculations of the four scenarios, the weights of the criteria and sub-criteria, and the scenario scores were manually checked to avoid any numerical errors. Error messages were designed whenever possible to guide the users and avoid incorrect entries. An example of an error message is shown in Figure 49 where if the user enters risk allocation percentages to the public sector, the private sector, and shared that do not add up to 100 percent, the user is warned via an error message to adjust the allocations to avoid incorrect entry.

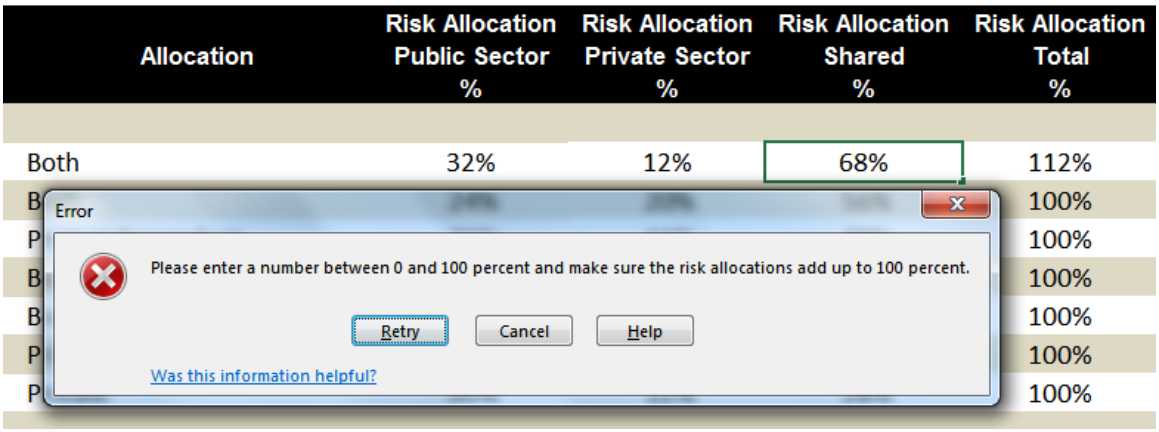


Figure 49: Risk Allocation Percentage Error Message

In addition, sensitivity analysis is one of the tools that was used to verify the Decision Support System prototype model. The sub-criteria with the highest ranks were used in order to monitor their effects on the expected monetary value (EMV) or the preferred scenario score. The sensitivity analysis provided the possible outcomes of the Decision Support System prototype model in uncertain conditions by providing all the possible ranks and testing the output (EMV) for each of the ranks. One way and two way sensitivity analyses were performed to measure the effect of changing the ranks of separate sub-criteria and changing the ranks of two sub-criteria at the same time. The sensitivity analysis module provided a variety of sensitivity charts and strategy region reports. Finally, the results of the prototype model were verified.

After verifying the results of the Decision Support System prototype model, the validity of the results is to be tested. One of the validation techniques is to compare the results to a real-life case and observe the deviation or the variance between the calculated results and the actual results obtained in real life.

The Decision Support System prototype model validation was conducted by applying data from a real-life case of a contract renegotiation situation in Egypt. The case study used was a wastewater treatment plant. Although the case study used is a treatment plant, the model can be customized through the user-interface screens to work with many other PPP projects. Moreover, the contract type of the case study is a design, build, finance, operate, maintain, renew, and transfer of ownership PPP contract (DBFOMRT), which combines many types of the typical PPP agreements. This validates that the model can work with a variety of PPP contract types.

The wastewater treatment plant in the case study faced unfortunate events which led to a delay in the operations start date. This was due to a delay by the New Urban Communities Authority (NUCA) in delivering the influent water (the water that will be treated) to the wastewater treatment plant, and a delay by NUCA to provide the effluent pumping station, which pumps the output of the treatment plant to the government network.

The impact of the above events, which belongs to the public sector, was calculated in order to obtain the updated cash flow of the project. Then, the four re-equilibrium scenarios — paying a lump sum amount to the private sector, increasing the service charges, increasing the concession period, or a combination of any of the

above — were calculated. Scenario three, which is increasing the concession period was not applicable because it exceeded the 30-year maximum concession period defined by the Egyptian Law of PPP. The four scenarios obtained from the model were compared to the scenarios that were developed by the Independent Financial Expert in real life. The results are shown in Table 5.

Table 5: Scenarios Percentage Variance

Scenarios	Model Value	Units	Percentage Variance
Scenario 1	270.34	M EGP	3.10%
Scenario 2	40.36	M EGP/Quarter	0.40%
Scenario 3	N/A	Years	N/A
Scenario 4	34.5	M EGP/Quarter	4.80%
	30	Years	-

In conclusion, the results obtained from the Decision Support System prototype model were very close to the ones obtained from the Independent Financial Expert of the Egyptian wastewater treatment plant. The percentage variance between the model calculated scenarios and the IFE obtained scenarios varied from almost zero percent in scenario two, which is adjusting the service charges, to a value not exceeding five percent in the other two.

CHAPTER 6 : CONCLUSION

6 . 1 Overview and Contributions

This research is concerned with the PPP contract re-equilibrium process, which seems to be an inevitability due to the long concession periods of the PPP contracts. The main objective of this research is to develop a tool that facilitates the lengthy and costly renegotiation process. In order to achieve this, a Decision Support System prototype tool has been developed with the aid of a number of computer programs, including Microsoft Excel 2013, Visual Basic for Applications (VBA) programming language, and the Precision Tree 5.5 for Excel add-in. These computer programs help in making the model user-friendly. In addition, the model is a multi-user model, in which both the public sector and the private sector are able to interact with its user-interface screens. The prototype model consists of eight modules: a user-interface module, a risk allocation module, a PPP valuation module, a financial model re-equilibrium module, a scenarios development module, a scenarios selection module, a reports module, and a sensitivity analysis module.

The main contribution of this research is that it develops an interdisciplinary framework that facilitates the PPP contract renegotiation process. The research tackled different fields, such as construction, finance, and management. The methodological framework is applied as a Decision Support System prototype model. The purpose of the suggested framework is to enable all contract stakeholders to agree on a unified method of developing the different re-equilibrium scenarios and choosing the optimal scenario that suits all parties. This will facilitate the PPP renegotiation process, which will, in turn, encourage investors to enter PPP projects. The developed framework is of great benefit to project stakeholders, including the private sector, the public sector, and the users of the service. It saves time and money invested in lengthy negotiations, and it enforces transparency and mutual trust between the different parties by providing a tool that tremendously minimizes conflicts during the renegotiation process and defines clear steps to be followed in order to reach an agreement that will maximize the benefits for both the private and the public sectors.

The verification of the model is done using three techniques. The first technique is through manual calculations of the four re-equilibrium scenarios, the weights of the

criteria and sub-criteria, and the scenario scores. The second technique is through error messages that appear to the user to guide him through the input process and avoid incorrect entries. The third technique is through the sensitivity analysis module, which verifies the output for all the possible ranks of the sub-criteria with the highest weights. On the other hand, the validation of the Decision Support System prototype model is conducted by comparing the results of the model with the case study. The case study used in the validation is a wastewater treatment plant in Egypt. The plant name is concealed due to confidentiality. The project contract type is a design, build, finance, operate, maintain, renew, and transfer of ownership PPP contract (DBFOMRT), which enabled the model to cover many aspects of the PPP approach at once. The operation start date of the plant was delayed due to a delay by the public sector to supply the influent water to the wastewater treatment plant and to provide the effluent pumping station. The impacts of those events were calculated and the base cash flow of the project was updated. The four re-equilibrium scenarios were then calculated and compared to the ones obtained by the Independent Financial Expert of the project. The results of the comparison were shown in Table 5, and the percentages variance from the real-life results were calculated. The comparison results are very close, relatively small percentage errors, which validates the prototype model.

To sum up, the key features of the model are as follows. The Decision Support System prototype model engages the private sector in the decision making process. Moreover, the proposed framework enhances the transparency and the mutual trust. It saves time and money invested in lengthy renegotiation process. In addition, a default risk matrix is integrated in the risk allocation module, which allows a quick access to the following modules. A filtration tool is also provided to only add the effects of the risks which are allocated to the party of concern. The prototype model is validated by data obtained from a case study of a wastewater treatment plant in Egypt.

6 . 2 Limitations

The model of the research has been tested on only one case study in Egypt due to the limited number of PPP contracts executed in Egypt at the time of the research. This was the wastewater treatment plant built in Egypt using PPP method during the

production of this research. A larger number of case studies should be tested in order to utilize and validate the model on a wider scale.

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APPENDIX A – PPP CONTRACT RENEGOTIATION DECISION SUPPORT SYSTEM

Model Screenshot 1: User-Interface Screens

PPP Contract Renegotiation DSS

v 1.1

Project General Information

Project Name	: Waste Water Treatment Plant
Contract Type	: DBFOMRT
Risk Matrix Used	: Default
Project Payment Mechanism	: Availability Payments
Payment Amount (M EGP)	: 32
Payment Intervals	: Quarterly

Click Here to Continue

Initial Payment Information

Project Start Date	SD	:	1-Jan-10
Project End Date	ED	:	31-Dec-29
Re-equilibrium Date	RD	:	1-Apr-13
Construction Period (Yrs)	T_0	:	2
Concession Period (Yrs)	T_c	:	20
Interest Rate %	i	:	10%
PPI	inf	:	108%
Capital Fund at time t (M EGP)	$Capex_t$	:	
Operation Income at time t (M EGP)	OI_t	:	
Government Subsidy at time t (M EGP)	GS_t	:	
Loan Principle at time t (M EGP)	LP_t	:	
Loan Balance at time t (M EGP)	LB_t	:	
Loan Interest at time t %	Li_t	:	
Operation Cost at time t (M EGP)	$Opex_t$	:	
Taxes at time t (M EGP)	T_t	:	
Output Quantity at time t (M Unit)	Q_t	:	

Input Payment Distribution

Click Here to Continue

Re-equilibrium Information

Please define the events leading to Contract Re-equilibrium

Event 1	: Delay in the Start of Operation Date
Corresponding Risk Factor :	Connection of Public utilities to site boundaries
Event 2	: NUCA delayed in providing the influent water
Corresponding Risk Factor :	Connection of Public utilities to site boundaries
Event 3	: NUCA delayed in providing the effluent pumping station
Corresponding Risk Factor :	Connection of Public utilities to site boundaries
Event 4	:
Corresponding Risk Factor :	
Event 5	:
Corresponding Risk Factor :	
Event 6	:
Corresponding Risk Factor :	
Event 7	:
Corresponding Risk Factor :	

Click Here to Continue

Model Screenshot 2: Public Sector Risk Filtration Process

#	Corresponding Risks	Risk Allocation	Risk Allocation Public	Risk Allocation Private	Risk Allocation Shared	Risk Allocation Total	Impact T_0	Impact T_C	Impact $Capex_t$	Impact OI_t	Impact GS_t	Impact LP_t	Impact LB_t	Impact Li_t	Impact $Opex_t$	Impact T_t	Impact Q_t	Impact inf
1	**Connection of Public utilities to site boundaries**	Project Dependent	20%	36%	44%	100%	0	1	1	1	0	0	0	0	1	0	1	0
2	**Connection of Public utilities to site boundaries**	Project Dependent	20%	36%	44%	100%	0	1	1	1	0	0	0	0	1	0	1	0
3	**Connection of Public utilities to site boundaries**	Project Dependent	20%	36%	44%	100%	0	1	1	1	0	0	0	0	1	0	1	0

Re-equilibrium Information

Please adjust the below to reflect impact of Event 1& Event 2& Event 3 reflecting the percentage of risk allocated to the public sector only:

Project Start Date	SD	:	1-Jan-10
Project End Date	ED	:	31-Dec-29
Construction Period (Yrs)	T_0	:	2
Inflation Rate %	inf	:	10%
Capital Fund at time t (M EGP)	$Capex_t$	:	
Operation Income at time t (M EGP)	OI_t	:	
Government Subsidy at time t (M EGP)	GS_t	:	
Loan Principle at time t (M EGP)	LP_t	:	
Loan Balance at time t (M EGP)	LB_t	:	
Loan Interest at time t %	Li_t	:	
Operation Cost at time t (M EGP)	$Opex_t$	:	
Taxes at time t (M EGP)	T_t	:	
Output Quantity at time t (M Unit)	Q_t	:	

Input Updated Payment Distribution

Click Here to view preliminary re-equilibrium scenarios

Project General Information

Please choose a combination for scenario 4	:	Quarterly Payment	+	Concession Extension
Please enter a value for	:	Concession Extension		
Concession Extension	:	30		

Click here for the final re-equilibrium scenarios

Best Scenario

Private Sector Best Scenario	:	Scenario 2 with Score 3.81
Public Sector Best Scenario	:	Scenario 4 with Score 3.36
Combined Best Scenario	:	Scenario 2 with Score 3.51

Proceed to Reports Section

Model Screenshot 3: User-Interface Screens

Model Screenshot 4: Typical Risk Matrix

Risk	Allocation	Risk Allocation Public	Risk Allocation Private	Risk Allocation Shared	Risk Allocation Total	Impact T_o	Impact T_c	Impact $Capex_t$	Impact OI_t	Impact GS_t	Impact LP_t	Impact LB_t	Impact Li_t	Impact $Opex_t$	Impact T_t	Impact Q_t	Impact inf
Country Risks:																	
Interest Rate Fluctuation	Both	32%	12%	56%	100%	☐	☐	☐	☐	☐	☐	☑	☑	☐	☐	☐	☐
Inflation	Both	24%	20%	56%	100%	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑
Foreign exchange fluctuation	Project Dependent	36%	16%	48%	100%	☐	☐	☑	☐	☐	☐	☐	☐	☑	☐	☐	☐
Public Credit	Both	20%	28%	52%	100%	☐	☐	☐	☐	☑	☐	☐	☐	☐	☑	☐	☐
Political Risk	Both	28%	8%	64%	100%	☐	☐	☐	☐	☑	☐	☐	☐	☐	☑	☐	☐
Nationalization/expropriation	Private	56%	16%	28%	100%	☐	☐	☑	☐	☐	☐	☐	☐	☐	☑	☐	☐
Government corruption	Private	60%	12%	28%	100%	☐	☐	☑	☐	☐	☐	☐	☐	☑	☑	☐	☐
Sector Risks:																	
Price Change	Both	40%	8%	52%	100%	☐	☐	☑	☑	☐	☐	☐	☐	☑	☐	☐	☐
Revenue Risk	Project Dependent	36%	24%	40%	100%	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐
Market competition	Both	36%	12%	52%	100%	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐
Supply and demand	Both	24%	16%	60%	100%	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐
Change in Market demand	Both	12%	24%	64%	100%	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐
Legislation changes	Project Dependent	32%	20%	48%	100%	☐	☐	☑	☑	☑	☐	☐	☐	☑	☑	☐	☐
Change in tax regulation	Project Dependent	36%	20%	44%	100%	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐
Government policy	Both	24%	16%	60%	100%	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☑
Political/Public opposition	Both	12%	24%	64%	100%	☑	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐
Swings in Public Opinion	Both	20%	16%	64%	100%	☐	☐	☐	☑	☑	☐	☐	☐	☐	☐	☐	☐
Regulatory/Contractual Risk	Project Dependent	44%	8%	48%	100%	☐	☐	☐	☐	☐	☑	☑	☑	☑	☐	☐	☐
Government Intervention	Project Dependent	40%	16%	44%	100%	☑	☐	☑	☑	☑	☐	☐	☐	☐	☐	☐	☐
Poor public decision making process	Project Dependent	36%	24%	40%	100%	☐	☑	☑	☑	☑	☐	☐	☐	☐	☐	☐	☐
Inadequate law and supervision system	Project Dependent	36%	32%	32%	100%	☐	☐	☐	☑	☐	☐	☐	☐	☐	☑	☑	☐
Lack of supporting infrastructure	Both	12%	20%	68%	100%	☐	☑	☑	☑	☐	☐	☐	☐	☐	☐	☐	☐
Project Risks:																	
Operation cost overrun	Private	76%	0%	24%	100%	☐	☐	☐	☑	☐	☐	☐	☐	☑	☐	☐	☐
Inability of concessionaire	Both	36%	8%	56%	100%	☐	☐	☑	☑	☐	☑	☑	☑	☑	☐	☐	☐
Subjective Project evaluation method	Both	24%	12%	64%	100%	☐	☐	☐	☐	☐	☑	☑	☑	☐	☐	☐	☐
Insufficient project finance supervision	Both	44%	4%	52%	100%	☐	☐	☑	☐	☐	☑	☑	☑	☐	☐	☐	☐
Performance Security Risk	Private	56%	4%	40%	100%	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐
Permits Risks	Both	20%	8%	72%	100%	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Delay in project approvals/permits	Both	20%	16%	64%	100%	☐	☑	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐
Dispute resolution	Both	28%	0%	72%	100%	☑	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Imperfect contract documents	Both	20%	16%	64%	100%	☐	☑	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐
Deficiency of design	Both	32%	12%	56%	100%	☐	☑	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐
Quality Assurance	Both	36%	8%	56%	100%	☐	☑	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐
Quality Control	Both	32%	8%	60%	100%	☐	☑	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐
Latent Defect Risk	Private	52%	0%	48%	100%	☐	☑	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐
Project/operation changes	Private	52%	8%	40%	100%	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☑	☐
Inability of concessionaire	Both	32%	8%	60%	100%	☐	☐	☐	☐	☐	☑	☑	☑	☐	☐	☑	☐
Transformers, substations or backup power	Both	38%	8%	56%	102%	☐	☑	☑	☐	☐	☐	☐	☐	☑	☐	☐	☐
Construction Risk	Private	76%	0%	24%	100%	☐	☑	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐
Organization risk	Private	64%	0%	36%	100%	☐	☑	☑	☐	☐	☑	☑	☑	☑	☐	☑	☐
Coordination risks	Both	44%	4%	52%	100%	☐	☐	☐	☑	☐	☐	☐	☐	☑	☐	☑	☐
Land acquisition	Both	22%	32%	56%	110%	☐	☑	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐
Physical Obstacles that cannot be avoided	Both	28%	20%	52%	100%	☐	☑	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐
Maintenance Risks	Private	60%	12%	28%	100%	☐	☐	☐	☑	☐	☐	☐	☐	☑	☐	☑	☐
Access and delivery of site	Project Dependent	32%	20%	48%	100%	☐	☑	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐
Connection of Public utilities to site boundaries	Project Dependent	20%	36%	44%	100%	☐	☑	☑	☑	☐	☐	☐	☐	☑	☐	☑	☐
Connection to boundary of Site	Project Dependent	24%	44%	32%	100%	☐	☐	☐	☑	☐	☐	☐	☐	☑	☐	☑	☐
Labor unavailability	Private	72%	4%	24%	100%	☐	☑	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐
Material shortage	Private	72%	4%	24%	100%	☐	☑	☑	☑	☐	☐	☐	☐	☑	☐	☐	☐
Third party delay/violation	Private	56%	0%	44%	100%	☐	☑	☑	☑	☐	☐	☐	☐	☑	☐	☐	☐
Planning risks	Private	52%	12%	36%	100%	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Inspection of Construction works	Private	68%	4%	28%	100%	☐	☑	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐
Technological Risks	Private	60%	12%	28%	100%	☐	☑	☑	☑	☐	☐	☐	☐	☑	☐	☐	☐
Completion risk	Project Dependent	48%	4%	48%	100%	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Sustainability Risk	Project Dependent	24%	32%	44%	100%	☐	☐	☐	☑	☐	☐	☐	☐	☑	☐	☐	☐
Antiquities Risks	Project Dependent	20%	36%	44%	100%	☐	☑	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐
Unforeseen Weather conditions	Private	56%	4%	40%	100%	☐	☑	☑	☑	☐	☐	☐	☐	☑	☐	☐	☐
Unforeseen geotechnical conditions	Private	52%	8%	40%	100%	☐	☑	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐
Force majeure	Both	20%	0%	80%	100%	☐	☑	☑	☑	☐	☐	☐	☐	☑	☐	☑	☐

Model Screenshot 5: Base Payment Distribution

		Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11
Capital Fund at time t (M EGP)	$Capex_t$	124.81	8.07	11.22	14.71	17.80	20.35	19.92	21.45	26.53	31.69	34.91	42.25	43.89	55.11	60.53	51.36	38.62	34.48	20.16	20.07	20.47	14.28	12.12	50.19
Loan Payments (M EGP)				100.88			37.00			47.53			76.19			111.67			87.12			42.49			53.61
Operation Income at time t (M EGP)	OI_t																								
Government Subsidy at time t (M EGP)	GS_t																								
Loan Principle at time t (M EGP)	LP_t																								
Loan Interest at time t (M EGP)																									
Loan Interest at time t %	Li_t																								
Operation Cost at time t (M EGP)	$Opex_t$																								
Taxes at time t (M EGP)	T_t																								
Output Quantity at time t (M Unit)	Q_t																								

		Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13
Capital Fund at time t (M EGP)	$Capex_t$																								
Loan Payments (M EGP)																									
Operation Income at time t (M EGP)	OI_t			38.93			38.93			38.93			38.93			39.83			39.83			39.83			39.83
Government Subsidy at time t (M EGP)	GS_t			1.45			1.45			1.45			1.45			1.56			1.56			1.56			1.56
Loan Principle at time t (M EGP)	LP_t						2.78						2.78						18.36						18.36
Loan Interest at time t (M EGP)							35.90						35.90						34.68						34.68
Loan Interest at time t %	Li_t	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
Operation Cost at time t (M EGP)	$Opex_t$			18.92			18.92			18.92			18.92			18.83			18.83			18.83			18.83
Taxes at time t (M EGP)	T_t																								
Output Quantity at time t (M Unit)	Q_t	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50

		Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15
Capital Fund at time t (M EGP)	$Capex_t$																								
Loan Payments (M EGP)																									
Operation Income at time t (M EGP)	OI_t			40.35			40.35			40.35			40.35			40.89			40.89			40.89			40.89
Government Subsidy at time t (M EGP)	GS_t			1.69			1.69			1.69			1.69			1.82			1.82			1.82			1.82
Loan Principle at time t (M EGP)	LP_t						20.87						20.87						23.62						23.62
Loan Interest at time t (M EGP)							32.06						32.06						29.32						29.32
Loan Interest at time t %	Li_t	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
Operation Cost at time t (M EGP)	$Opex_t$			19.47			19.47			19.47			19.47			20.16			20.16			20.16			20.16
Taxes at time t (M EGP)	T_t																								
Output Quantity at time t (M Unit)	Q_t	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50

Model Screenshot 6: Base Payment Distribution (Cont.)

		Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Jan-17	Feb-17	Mar-17	Apr-17	May-17	Jun-17	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17
Capital Fund at time t (M EGP)	$Capex_t$																								
Loan Payments (M EGP)																									
Operation Income at time t (M EGP)	OI_t			41.42			41.42			41.42			41.42			42.00			42.00			42.00			42.00
Government Subsidy at time t (M EGP)	GS_t			1.97			1.97			1.97			1.97			2.12			2.12			2.12			2.12
Loan Principle at time t (M EGP)	LP_t						23.62						23.62						23.62						23.62
Loan Interest at time t (M EGP)							26.32						26.32						23.33						23.33
Loan Interest at time t %	Li_t	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
Operation Cost at time t (M EGP)	$Opex_t$			20.91			20.91			20.91			20.91			21.71			21.71			21.71			21.71
Taxes at time t (M EGP)	T_t																								
Output Quantity at time t (M Unit)	Q_t	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50

		Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19
Capital Fund at time t (M EGP)	$Capex_t$																								
Loan Payments (M EGP)																									
Operation Income at time t (M EGP)	OI_t			43.01			43.01			43.01			43.01			43.70			43.70			43.70			43.70
Government Subsidy at time t (M EGP)	GS_t			2.29			2.29			2.29			2.29			2.48			2.48			2.48			2.48
Loan Principle at time t (M EGP)	LP_t						23.62						23.62						23.62						23.62
Loan Interest at time t (M EGP)							20.33						20.33						17.33						17.33
Loan Interest at time t %	Li_t	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
Operation Cost at time t (M EGP)	$Opex_t$			22.58			22.58			22.58			22.58			23.51			23.51			23.51			23.51
Taxes at time t (M EGP)	T_t												4.20												12.42
Output Quantity at time t (M Unit)	Q_t	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50

		Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21
Capital Fund at time t (M EGP)	$Capex_t$																								
Loan Payments (M EGP)																									
Operation Income at time t (M EGP)	OI_t			44.46			44.46			44.46			44.46			45.27			45.27			45.27			45.27
Government Subsidy at time t (M EGP)	GS_t			2.68			2.68			2.68			2.68			2.89			2.89			2.89			2.89
Loan Principle at time t (M EGP)	LP_t						23.62						23.62						23.62						23.62
Loan Interest at time t (M EGP)							14.33						14.33						11.33						11.33
Loan Interest at time t %	Li_t	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
Operation Cost at time t (M EGP)	$Opex_t$			24.52			24.52			24.52			24.52			25.61			25.61			25.61			25.61
Taxes at time t (M EGP)	T_t												14.17												15.77
Output Quantity at time t (M Unit)	Q_t	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50

Model Screenshot 7: Base Payment Distribution (Cont.)

		Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22	Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23
Capital Fund at time t (M EGP)	$Capex_t$																								
Loan Payments (M EGP)																									
Operation Income at time t (M EGP)	OI_t			46.16			46.16			46.16			46.16			47.12			47.12			47.12			47.12
Government Subsidy at time t (M EGP)	GS_t			3.12			3.12			3.12			3.12			3.37			3.37			3.37			3.37
Loan Principle at time t (M EGP)	LP_t						23.62						23.62						23.62						23.62
Loan Interest at time t (M EGP)							8.34						8.34						5.34						5.34
Loan Interest at time t %	Li_t	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
Operation Cost at time t (M EGP)	$Opex_t$			26.79			26.79			26.79			26.79			28.06			28.06			28.06			28.06
Taxes at time t (M EGP)	T_t												17.25												18.64
Output Quantity at time t (M Unit)	Q_t	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50

		Jan-24	Feb-24	Mar-24	Apr-24	May-24	Jun-24	Jul-24	Aug-24	Sep-24	Oct-24	Nov-24	Dec-24	Jan-25	Feb-25	Mar-25	Apr-25	May-25	Jun-25	Jul-25	Aug-25	Sep-25	Oct-25	Nov-25	Dec-25
Capital Fund at time t (M EGP)	$Capex_t$																								
Loan Payments (M EGP)																									
Operation Income at time t (M EGP)	OI_t			48.18			48.18			48.18			48.18			48.81			48.81			48.81			48.81
Government Subsidy at time t (M EGP)	GS_t			3.64			3.64			3.64			3.64			3.93			3.93			3.93			3.93
Loan Principle at time t (M EGP)	LP_t						23.62						23.62												
Loan Interest at time t (M EGP)							2.34						2.34						0.05						0.05
Loan Interest at time t %	Li_t	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
Operation Cost at time t (M EGP)	$Opex_t$			29.43			29.43			29.43			29.43			30.90			30.90			30.90			30.90
Taxes at time t (M EGP)	T_t												19.98												20.57
Output Quantity at time t (M Unit)	Q_t	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50

		Jan-26	Feb-26	Mar-26	Apr-26	May-26	Jun-26	Jul-26	Aug-26	Sep-26	Oct-26	Nov-26	Dec-26	Jan-27	Feb-27	Mar-27	Apr-27	May-27	Jun-27	Jul-27	Aug-27	Sep-27	Oct-27	Nov-27	Dec-27
Capital Fund at time t (M EGP)	$Capex_t$																								
Loan Payments (M EGP)																									
Operation Income at time t (M EGP)	OI_t			50.11			50.11			50.11			50.11			51.51			51.51			51.51			51.51
Government Subsidy at time t (M EGP)	GS_t			4.25			4.25			4.25			4.25			4.59			4.59			4.59			4.59
Loan Principle at time t (M EGP)	LP_t																								
Loan Interest at time t (M EGP)							0.06						0.06						0.06						0.06
Loan Interest at time t %	Li_t	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
Operation Cost at time t (M EGP)	$Opex_t$			32.50			32.50			32.50			32.50			34.22			34.22			34.22			34.22
Taxes at time t (M EGP)	T_t												20.66												20.72
Output Quantity at time t (M Unit)	Q_t	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50

Model Screenshot 8: Base Payment Distribution (Cont.)

		Jan-28	Feb-28	Mar-28	Apr-28	May-28	Jun-28	Jul-28	Aug-28	Sep-28	Oct-28	Nov-28	Dec-28	Jan-29	Feb-29	Mar-29	Apr-29	May-29	Jun-29	Jul-29	Aug-29	Sep-29	Oct-29	Nov-29	Dec-29
Capital Fund at time t (M EGP)	$Capex_t$																								
Loan Payments (M EGP)																									
Operation Income at time t (M EGP)	OI_t			53.03			53.03			53.03			53.03			54.66			54.66			54.66			54.66
Government Subsidy at time t (M EGP)	GS_t			4.95			4.95			4.95			4.95			5.35			5.35			5.35			5.35
Loan Principle at time t (M EGP)	LP_t																								
Loan Interest at time t (M EGP)							0.07						0.07						0.07						0.07
Loan Interest at time t %	Li_t	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
Operation Cost at time t (M EGP)	$Opex_t$			36.08			36.08			36.08			36.08			38.09			38.09			38.09			38.09
Taxes at time t (M EGP)	T_t												20.76												20.79
Output Quantity at time t (M Unit)	Q_t	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50

Model Screenshot 9: Updated Payment Distribution

Go Back to Input Sheet

		Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11
Capital Fund at time t (M EGP)	$Capex_t$	124.81	8.07	11.22	14.71	17.80	20.35	19.92	21.45	26.53	31.69	34.91	42.25	43.89	55.11	60.53	51.36	38.62	34.48	20.16	20.07	20.47	14.28	12.12	50.19
Loan Payments (M EGP)				100.88			37.00			47.53			76.19			111.67			87.12			42.49			53.61
Operation Income at time t (M EGP)	OI_t																								
Government Subsidy at time t (M EGP)	GS_t																								
Loan Principle at time t (M EGP)	LP_t																								
Loan Interest at time t (M EGP)																									
Loan Interest at time t %	Li_t																								
Operation Cost at time t (M EGP)	$Opex_t$																								
Taxes at time t (M EGP)	T_t																								
Output Quantity at time t (M Unit)	Q_t																								

		Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13
Capital Fund at time t (M EGP)	$Capex_t$																								
Loan Payments (M EGP)																									
Operation Income at time t (M EGP)	OI_t																		39.83			39.83			39.83
Government Subsidy at time t (M EGP)	GS_t																		1.56			1.56			1.56
Loan Principle at time t (M EGP)	LP_t						2.78						2.78						18.36						18.36
Loan Interest at time t (M EGP)							35.90						35.90						34.68						34.68
Loan Interest at time t %	Li_t	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
Operation Cost at time t (M EGP)	$Opex_t$			18.92			18.92			18.92			18.92			18.83			18.83			18.83			18.83
Taxes at time t (M EGP)	T_t																								
Output Quantity at time t (M Unit)	Q_t																7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50

Model Screenshot 10: Updated Payment Distribution (Cont.)

		Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15
Capital Fund at time t (M EGP)	$Capex_t$																								
Loan Payments (M EGP)																									
Operation Income at time t (M EGP)	OI_t			40.35			40.35			40.35			40.35			40.89			40.89			40.89			40.89
Government Subsidy at time t (M EGP)	GS_t			1.69			1.69			1.69			1.69			1.82			1.82			1.82			1.82
Loan Principle at time t (M EGP)	LP_t						20.87						20.87						23.62						23.62
Loan Interest at time t (M EGP)							32.06						32.06						29.32						29.32
Loan Interest at time t %	Li_t	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
Operation Cost at time t (M EGP)	$Opex_t$			19.47			19.47			19.47			19.47			20.16			20.16			20.16			20.16
Taxes at time t (M EGP)	T_t																								
Output Quantity at time t (M Unit)	Q_t	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50

		Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Jan-17	Feb-17	Mar-17	Apr-17	May-17	Jun-17	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17
Capital Fund at time t (M EGP)	$Capex_t$																								
Loan Payments (M EGP)																									
Operation Income at time t (M EGP)	OI_t			41.42			41.42			41.42			41.42			42.00			42.00			42.00			42.00
Government Subsidy at time t (M EGP)	GS_t			1.97			1.97			1.97			1.97			2.12			2.12			2.12			2.12
Loan Principle at time t (M EGP)	LP_t						23.62						23.62						23.62						23.62
Loan Interest at time t (M EGP)							26.32						26.32						23.33						23.33
Loan Interest at time t %	Li_t	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
Operation Cost at time t (M EGP)	$Opex_t$			20.91			20.91			20.91			20.91			21.71			21.71			21.71			21.71
Taxes at time t (M EGP)	T_t																								
Output Quantity at time t (M Unit)	Q_t	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50

		Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19
Capital Fund at time t (M EGP)	$Capex_t$																								
Loan Payments (M EGP)																									
Operation Income at time t (M EGP)	OI_t			43.01			43.01			43.01			43.01			43.70			43.70			43.70			43.70
Government Subsidy at time t (M EGP)	GS_t			2.29			2.29			2.29			2.29			2.48			2.48			2.48			2.48
Loan Principle at time t (M EGP)	LP_t						23.62						23.62						23.62						23.62
Loan Interest at time t (M EGP)							20.33						20.33						17.33						17.33
Loan Interest at time t %	Li_t	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
Operation Cost at time t (M EGP)	$Opex_t$			22.58			22.58			22.58			22.58			23.51			23.51			23.51			23.51
Taxes at time t (M EGP)	T_t												4.20												12.42
Output Quantity at time t (M Unit)	Q_t	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50

Model Screenshot 11: Updated Payment Distribution (Cont.)

		Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21
Capital Fund at time t (M EGP)	$Capex_t$																								
Loan Payments (M EGP)																									
Operation Income at time t (M EGP)	OI_t			44.46			44.46			44.46			44.46			45.27			45.27			45.27			45.27
Government Subsidy at time t (M EGP)	GS_t			2.68			2.68			2.68			2.68			2.89			2.89			2.89			2.89
Loan Principle at time t (M EGP)	LP_t						23.62						23.62						23.62						23.62
Loan Interest at time t (M EGP)							14.33						14.33						11.33						11.33
Loan Interest at time t %	Li_t	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
Operation Cost at time t (M EGP)	$Opex_t$			24.52			24.52			24.52			24.52			25.61			25.61			25.61			25.61
Taxes at time t (M EGP)	T_t												14.17												15.77
Output Quantity at time t (M Unit)	Q_t	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50

		Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22	Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23
Capital Fund at time t (M EGP)	$Capex_t$																								
Loan Payments (M EGP)																									
Operation Income at time t (M EGP)	OI_t			46.16			46.16			46.16			46.16			47.12			47.12			47.12			47.12
Government Subsidy at time t (M EGP)	GS_t			3.12			3.12			3.12			3.12			3.37			3.37			3.37			3.37
Loan Principle at time t (M EGP)	LP_t						23.62						23.62						23.62						23.62
Loan Interest at time t (M EGP)							8.34						8.34						5.34						5.34
Loan Interest at time t %	Li_t	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
Operation Cost at time t (M EGP)	$Opex_t$			26.79			26.79			26.79			26.79			28.06			28.06			28.06			28.06
Taxes at time t (M EGP)	T_t												17.25												18.64
Output Quantity at time t (M Unit)	Q_t	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50

		Jan-24	Feb-24	Mar-24	Apr-24	May-24	Jun-24	Jul-24	Aug-24	Sep-24	Oct-24	Nov-24	Dec-24	Jan-25	Feb-25	Mar-25	Apr-25	May-25	Jun-25	Jul-25	Aug-25	Sep-25	Oct-25	Nov-25	Dec-25
Capital Fund at time t (M EGP)	$Capex_t$																								
Loan Payments (M EGP)																									
Operation Income at time t (M EGP)	OI_t			48.18			48.18			48.18			48.18			48.81			48.81			48.81			48.81
Government Subsidy at time t (M EGP)	GS_t			3.64			3.64			3.64			3.64			3.93			3.93			3.93			3.93
Loan Principle at time t (M EGP)	LP_t						23.62						23.62												
Loan Interest at time t (M EGP)							2.34						2.34						0.05						0.05
Loan Interest at time t %	Li_t	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
Operation Cost at time t (M EGP)	$Opex_t$			29.43			29.43			29.43			29.43			30.90			30.90			30.90			30.90
Taxes at time t (M EGP)	T_t												19.98												20.57
Output Quantity at time t (M Unit)	Q_t	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50

Model Screenshot 12: Updated Payment Distribution (Cont.)

		Jan-26	Feb-26	Mar-26	Apr-26	May-26	Jun-26	Jul-26	Aug-26	Sep-26	Oct-26	Nov-26	Dec-26	Jan-27	Feb-27	Mar-27	Apr-27	May-27	Jun-27	Jul-27	Aug-27	Sep-27	Oct-27	Nov-27	Dec-27
Capital Fund at time t (M EGP)	$Capex_t$																								
Loan Payments (M EGP)																									
Operation Income at time t (M EGP)	OI_t			50.11			50.11			50.11			50.11			51.51			51.51			51.51			51.51
Government Subsidy at time t (M EGP)	GS_t			4.25			4.25			4.25			4.25			4.59			4.59			4.59			4.59
Loan Principle at time t (M EGP)	LP_t																								
Loan Interest at time t (M EGP)							0.06						0.06						0.06						0.06
Loan Interest at time t %	Li_t	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
Operation Cost at time t (M EGP)	$Opex_t$			32.50			32.50			32.50			32.50			34.22			34.22			34.22			34.22
Taxes at time t (M EGP)	T_t												20.66												20.72
Output Quantity at time t (M Unit)	Q_t	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50

		Jan-28	Feb-28	Mar-28	Apr-28	May-28	Jun-28	Jul-28	Aug-28	Sep-28	Oct-28	Nov-28	Dec-28	Jan-29	Feb-29	Mar-29	Apr-29	May-29	Jun-29	Jul-29	Aug-29	Sep-29	Oct-29	Nov-29	Dec-29
Capital Fund at time t (M EGP)	$Capex_t$																								
Loan Payments (M EGP)																									
Operation Income at time t (M EGP)	OI_t			53.03			53.03			53.03			53.03			54.66			54.66			54.66			54.66
Government Subsidy at time t (M EGP)	GS_t			4.95			4.95			4.95			4.95			5.35			5.35			5.35			5.35
Loan Principle at time t (M EGP)	LP_t																								
Loan Interest at time t (M EGP)							0.07						0.07						0.07						0.07
Loan Interest at time t %	Li_t	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
Operation Cost at time t (M EGP)	$Opex_t$			36.08			36.08			36.08			36.08			38.09			38.09			38.09			38.09
Taxes at time t (M EGP)	T_t												20.76												20.79
Output Quantity at time t (M Unit)	Q_t	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50

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Model Screenshot 13: IRR Calculations for Base Values

		Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11
Capital Fund at time t (M EGP)	$Capex_t$	124.81	8.07	11.22	14.71	17.80	20.35	19.92	21.45	26.53	31.69	34.91	42.25	43.89	55.11	60.53	51.36	38.62	34.48	20.16	20.07	20.47	14.28	12.12	50.19
Loan Payments				100.88			37.00			47.53			76.19			111.67			87.12			42.49			53.61
Operation Income at time t (M EGP)	OI_t																								
Government Subsidy at time t (M EGP)	GS_t																								
Loan Principle at time t (M EGP)	LP_t																								
Loan Interest at time t (M EGP)																									
Operation Cost at time t (M EGP)	$Opex_t$																								
Taxes at time t (M EGP)	T_t																								
Output Quantity at time t (M Unit)	Q_t																								
Base IRR%	19.95%	-124.81	-8.07	89.65	-14.71	-17.80	16.65	-19.92	-21.45	21.00	-31.69	-34.91	33.94	-43.89	-55.11	51.14	-51.36	-38.62	52.64	-20.16	-20.07	22.02	-14.28	-12.12	3.42

		Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13
Capital Fund at time t (M EGP)	$Capex_t$																								
Loan Payments																									
Operation Income at time t (M EGP)	OI_t			38.93			38.93			38.93			38.93			39.83			39.83			39.83			39.83
Government Subsidy at time t (M EGP)	GS_t			1.45			1.45			1.45			1.45			1.56			1.56			1.56			1.56
Loan Principle at time t (M EGP)	LP_t						2.78						2.78						18.36						18.36
Loan Interest at time t (M EGP)							35.90						35.90						34.68						34.68
Operation Cost at time t (M EGP)	$Opex_t$			18.92			18.92			18.92			18.92			18.83			18.83			18.83			18.83
Taxes at time t (M EGP)	T_t																								
Output Quantity at time t (M Unit)	Q_t	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
Base IRR%	19.95%			21.46			-17.22			21.46			-17.22			22.56			-30.49			22.56			-30.49

		Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15
Capital Fund at time t (M EGP)	$Capex_t$																								
Loan Payments																									
Operation Income at time t (M EGP)	OI_t			40.35			40.35			40.35			40.35			40.89			40.89			40.89			40.89
Government Subsidy at time t (M EGP)	GS_t			1.69			1.69			1.69			1.69			1.82			1.82			1.82			1.82
Loan Principle at time t (M EGP)	LP_t						20.87						20.87						23.62						23.62
Loan Interest at time t (M EGP)							32.06						32.06						29.32						29.32
Operation Cost at time t (M EGP)	$Opex_t$			19.47			19.47			19.47			19.47			20.16			20.16			20.16			20.16
Taxes at time t (M EGP)	T_t																								
Output Quantity at time t (M Unit)	Q_t	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
Base IRR%	19.95%			22.56			-30.36			22.56			-30.36			22.55			-30.39			22.55			-30.39

Model Screenshot 14: IRR Calculations for Base Values (Cont.)

		Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Jan-17	Feb-17	Mar-17	Apr-17	May-17	Jun-17	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17
Capital Fund at time t (M EGP)	$Capex_t$																								
Loan Payments																									
Operation Income at time t (M EGP)	OI_t			41.42			41.42			41.42			41.42			42.00			42.00			42.00			42.00
Government Subsidy at time t (M EGP)	GS_t			1.97			1.97			1.97			1.97			2.12			2.12			2.12			2.12
Loan Principle at time t (M EGP)	LP_t						23.62						23.62						23.62						23.62
Loan Interest at time t (M EGP)							26.32						26.32						23.33						23.33
Operation Cost at time t (M EGP)	$Opex_t$			20.91			20.91			20.91			20.91			21.71			21.71			21.71			21.71
Taxes at time t (M EGP)	T_t																								
Output Quantity at time t (M Unit)	Q_t	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
Base IRR%	19.95%			22.48			-27.46			22.48			-27.46			22.42			-24.53			22.42			-24.53

		Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19
Capital Fund at time t (M EGP)	$Capex_t$																								
Loan Payments																									
Operation Income at time t (M EGP)	OI_t			43.01			43.01			43.01			43.01			43.70			43.70			43.70			43.70
Government Subsidy at time t (M EGP)	GS_t			2.29			2.29			2.29			2.29			2.48			2.48			2.48			2.48
Loan Principle at time t (M EGP)	LP_t						23.62						23.62						23.62						23.62
Loan Interest at time t (M EGP)							20.33						20.33						17.33						17.33
Operation Cost at time t (M EGP)	$Opex_t$			22.58			22.58			22.58			22.58			23.51			23.51			23.51			23.51
Taxes at time t (M EGP)	T_t												4.20												12.42
Output Quantity at time t (M Unit)	Q_t	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
Base IRR%	19.95%			22.73			-21.22			22.73			-25.42			22.67			-18.28			22.67			-30.70

		Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21
Capital Fund at time t (M EGP)	$Capex_t$																								
Loan Payments																									
Operation Income at time t (M EGP)	OI_t			44.46			44.46			44.46			44.46			45.27			45.27			45.27			45.27
Government Subsidy at time t (M EGP)	GS_t			2.68			2.68			2.68			2.68			2.89			2.89			2.89			2.89
Loan Principle at time t (M EGP)	LP_t						23.62						23.62						23.62						23.62
Loan Interest at time t (M EGP)							14.33						14.33						11.33						11.33
Operation Cost at time t (M EGP)	$Opex_t$			24.52			24.52			24.52			24.52			25.61			25.61			25.61			25.61
Taxes at time t (M EGP)	T_t												14.17												15.77
Output Quantity at time t (M Unit)	Q_t	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
Base IRR%	19.95%			22.61			-15.35			22.61			-29.52			22.55			-12.41			22.55			-28.18

Model Screenshot 15: IRR Calculations for Base Values (Cont.)

		Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22	Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23
Capital Fund at time t (M EGP)	$Capex_t$																								
Loan Payments																									
Operation Income at time t (M EGP)	OI_t			46.16			46.16			46.16			46.16			47.12			47.12			47.12			47.12
Government Subsidy at time t (M EGP)	GS_t			3.12			3.12			3.12			3.12			3.37			3.37			3.37			3.37
Loan Principle at time t (M EGP)	LP_t						23.62						23.62						23.62						23.62
Loan Interest at time t (M EGP)							8.34						8.34						5.34						5.34
Operation Cost at time t (M EGP)	$Opex_t$			26.79			26.79			26.79			26.79			28.06			28.06			28.06			28.06
Taxes at time t (M EGP)	T_t												17.25												18.64
Output Quantity at time t (M Unit)	Q_t	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
Base IRR%	19.95%			22.49			-9.47			22.49			-26.72			22.44			-6.52			22.44			-25.17

		Jan-24	Feb-24	Mar-24	Apr-24	May-24	Jun-24	Jul-24	Aug-24	Sep-24	Oct-24	Nov-24	Dec-24	Jan-25	Feb-25	Mar-25	Apr-25	May-25	Jun-25	Jul-25	Aug-25	Sep-25	Oct-25	Nov-25	Dec-25
Capital Fund at time t (M EGP)	$Capex_t$																								
Loan Payments																									
Operation Income at time t (M EGP)	OI_t			48.18			48.18			48.18			48.18			48.81			48.81			48.81			48.81
Government Subsidy at time t (M EGP)	GS_t			3.64			3.64			3.64			3.64			3.93			3.93			3.93			3.93
Loan Principle at time t (M EGP)	LP_t						23.62						23.62												
Loan Interest at time t (M EGP)							2.34						2.34						0.05						0.05
Operation Cost at time t (M EGP)	$Opex_t$			29.43			29.43			29.43			29.43			30.90			30.90			30.90			30.90
Taxes at time t (M EGP)	T_t												19.98												20.57
Output Quantity at time t (M Unit)	Q_t	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
Base IRR%	19.95%			22.40			-3.57			22.40			-23.55			21.84			21.79			21.84			1.22

		Jan-26	Feb-26	Mar-26	Apr-26	May-26	Jun-26	Jul-26	Aug-26	Sep-26	Oct-26	Nov-26	Dec-26	Jan-27	Feb-27	Mar-27	Apr-27	May-27	Jun-27	Jul-27	Aug-27	Sep-27	Oct-27	Nov-27	Dec-27
Capital Fund at time t (M EGP)	$Capex_t$																								
Loan Payments																									
Operation Income at time t (M EGP)	OI_t			50.11			50.11			50.11			50.11			51.51			51.51			51.51			51.51
Government Subsidy at time t (M EGP)	GS_t			4.25			4.25			4.25			4.25			4.59			4.59			4.59			4.59
Loan Principle at time t (M EGP)	LP_t																								
Loan Interest at time t (M EGP)							0.06						0.06						0.06						0.06
Operation Cost at time t (M EGP)	$Opex_t$			32.50			32.50			32.50			32.50			34.22			34.22			34.22			34.22
Taxes at time t (M EGP)	T_t												20.66												20.72
Output Quantity at time t (M Unit)	Q_t	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
Base IRR%	19.95%			21.85			21.80			21.85			1.14			21.87			21.81			21.87			1.09

Model Screenshot 16: IRR Calculations for Base Values (Cont.)

		Jan-28	Feb-28	Mar-28	Apr-28	May-28	Jun-28	Jul-28	Aug-28	Sep-28	Oct-28	Nov-28	Dec-28	Jan-29	Feb-29	Mar-29	Apr-29	May-29	Jun-29	Jul-29	Aug-29	Sep-29	Oct-29	Nov-29	Dec-29
Capital Fund at time t (M EGP)	$Capex_t$																								
Loan Payments																									
Operation Income at time t (M EGP)	OI_t			53.03			53.03			53.03			53.03			54.66			54.66			54.66			54.66
Government Subsidy at time t (M EGP)	GS_t			4.95			4.95			4.95			4.95			5.35			5.35			5.35			5.35
Loan Principle at time t (M EGP)	LP_t																								
Loan Interest at time t (M EGP)							0.07						0.07						0.07						0.07
Operation Cost at time t (M EGP)	$Opex_t$			36.08			36.08			36.08			36.08			38.09			38.09			38.09			38.09
Taxes at time t (M EGP)	T_t												20.76												20.79
Output Quantity at time t (M Unit)	Q_t	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
Base IRR%	19.95%			21.90			21.83			21.90			1.06			21.92			21.85			21.92			1.06

Model Screenshot 17: IRR Calculations for Updated Values

		Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11
Capital Fund at time t (M EGP)	$Capex_t$	124.81	8.07	11.22	14.71	17.80	20.35	19.92	21.45	26.53	31.69	34.91	42.25	43.89	55.11	60.53	51.36	38.62	34.48	20.16	20.07	20.47	14.28	12.12	50.19
Loan Payments				100.88			37.00			47.53			76.19			111.67			87.12			42.49			53.61
Operation Income at time t (M EGP)	OI_t																								
Government Subsidy at time t (M EGP)	GS_t																								
Loan Principle at time t (M EGP)	LP_t																								
Loan Interest at time t (M EGP)																									
Operation Cost at time t (M EGP)	$Opex_t$																								
Taxes at time t (M EGP)	T_t																								
Output Quantity at time t (M Unit)	Q_t																								
Updated IRR%	-22.78%	-124.81	-8.07	89.65	-14.71	-17.80	16.65	-19.92	-21.45	21.00	-31.69	-34.91	33.94	-43.89	-55.11	51.14	-51.36	-38.62	52.64	-20.16	-20.07	22.02	-14.28	-12.12	3.42

		Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13
Capital Fund at time t (M EGP)	$Capex_t$																								
Loan Payments																									
Operation Income at time t (M EGP)	OI_t																		39.83			39.83			39.83
Government Subsidy at time t (M EGP)	GS_t																		1.56			1.56			1.56
Loan Principle at time t (M EGP)	LP_t						2.78						2.78						18.36						18.36
Loan Interest at time t (M EGP)							35.90						35.90						34.68						34.68
Operation Cost at time t (M EGP)	$Opex_t$			18.92			18.92			18.92			18.92			18.83			18.83			18.83			18.83
Taxes at time t (M EGP)	T_t																								
Output Quantity at time t (M Unit)	Q_t																7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
Updated IRR%	-22.78%			-18.92			-57.59			-18.92			-57.59			-18.83			-30.49			22.56			-30.49

Model Screenshot 18: IRR Calculations for Updated Values (Cont.)

		Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15
Capital Fund at time t (M EGP)	$Capex_t$																								
Loan Payments																									
Operation Income at time t (M EGP)	OI_t			40.35			40.35			40.35			40.35			40.89			40.89			40.89			40.89
Government Subsidy at time t (M EGP)	GS_t			1.69			1.69			1.69			1.69			1.82			1.82			1.82			1.82
Loan Principle at time t (M EGP)	LP_t						20.87						20.87						23.62						23.62
Loan Interest at time t (M EGP)							32.06						32.06						29.32						29.32
Operation Cost at time t (M EGP)	$Opex_t$			19.47			19.47			19.47			19.47			20.16			20.16			20.16			20.16
Taxes at time t (M EGP)	T_t																								
Output Quantity at time t (M Unit)	Q_t	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
Updated IRR%	-22.78%			22.56			-30.36			22.56			-30.36			22.55			-30.39			22.55			-30.39

		Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Jan-17	Feb-17	Mar-17	Apr-17	May-17	Jun-17	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17
Capital Fund at time t (M EGP)	$Capex_t$																								
Loan Payments																									
Operation Income at time t (M EGP)	OI_t			41.42			41.42			41.42			41.42			42.00			42.00			42.00			42.00
Government Subsidy at time t (M EGP)	GS_t			1.97			1.97			1.97			1.97			2.12			2.12			2.12			2.12
Loan Principle at time t (M EGP)	LP_t						23.62						23.62						23.62						23.62
Loan Interest at time t (M EGP)							26.32						26.32						23.33						23.33
Operation Cost at time t (M EGP)	$Opex_t$			20.91			20.91			20.91			20.91			21.71			21.71			21.71			21.71
Taxes at time t (M EGP)	T_t																								
Output Quantity at time t (M Unit)	Q_t	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
Updated IRR%	-22.78%			22.48			-27.46			22.48			-27.46			22.42			-24.53			22.42			-24.53

		Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19
Capital Fund at time t (M EGP)	$Capex_t$																								
Loan Payments																									
Operation Income at time t (M EGP)	OI_t			43.01			43.01			43.01			43.01			43.70			43.70			43.70			43.70
Government Subsidy at time t (M EGP)	GS_t			2.29			2.29			2.29			2.29			2.48			2.48			2.48			2.48
Loan Principle at time t (M EGP)	LP_t						23.62						23.62						23.62						23.62
Loan Interest at time t (M EGP)							20.33						20.33						17.33						17.33
Operation Cost at time t (M EGP)	$Opex_t$			22.58			22.58			22.58			22.58			23.51			23.51			23.51			23.51
Taxes at time t (M EGP)	T_t												4.20												12.42
Output Quantity at time t (M Unit)	Q_t	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
Updated IRR%	-22.78%			22.73			-21.22			22.73			-25.42			22.67			-18.28			22.67			-30.70

Model Screenshot 19: IRR Calculations for Updated Values (Cont.)

		Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21
Capital Fund at time t (M EGP)	$Capex_t$																								
Loan Payments																									
Operation Income at time t (M EGP)	OI_t			44.46			44.46			44.46			44.46			45.27			45.27			45.27			45.27
Government Subsidy at time t (M EGP)	GS_t			2.68			2.68			2.68			2.68			2.89			2.89			2.89			2.89
Loan Principle at time t (M EGP)	LP_t						23.62						23.62						23.62						23.62
Loan Interest at time t (M EGP)							14.33						14.33						11.33						11.33
Operation Cost at time t (M EGP)	$Opex_t$			24.52			24.52			24.52			24.52			25.61			25.61			25.61			25.61
Taxes at time t (M EGP)	T_t												14.17												15.77
Output Quantity at time t (M Unit)	Q_t	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
Updated IRR%	-22.78%			22.61			-15.35			22.61			-29.52			22.55			-12.41			22.55			-28.18

		Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22	Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23
Capital Fund at time t (M EGP)	$Capex_t$																								
Loan Payments																									
Operation Income at time t (M EGP)	OI_t			46.16			46.16			46.16			46.16			47.12			47.12			47.12			47.12
Government Subsidy at time t (M EGP)	GS_t			3.12			3.12			3.12			3.12			3.37			3.37			3.37			3.37
Loan Principle at time t (M EGP)	LP_t						23.62						23.62						23.62						23.62
Loan Interest at time t (M EGP)							8.34						8.34						5.34						5.34
Operation Cost at time t (M EGP)	$Opex_t$			26.79			26.79			26.79			26.79			28.06			28.06			28.06			28.06
Taxes at time t (M EGP)	T_t												17.25												18.64
Output Quantity at time t (M Unit)	Q_t	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
Updated IRR%	-22.78%			22.49			-9.47			22.49			-26.72			22.44			-6.52			22.44			-25.17

		Jan-24	Feb-24	Mar-24	Apr-24	May-24	Jun-24	Jul-24	Aug-24	Sep-24	Oct-24	Nov-24	Dec-24	Jan-25	Feb-25	Mar-25	Apr-25	May-25	Jun-25	Jul-25	Aug-25	Sep-25	Oct-25	Nov-25	Dec-25
Capital Fund at time t (M EGP)	$Capex_t$																								
Loan Payments																									
Operation Income at time t (M EGP)	OI_t			48.18			48.18			48.18			48.18			48.81			48.81			48.81			48.81
Government Subsidy at time t (M EGP)	GS_t			3.64			3.64			3.64			3.64			3.93			3.93			3.93			3.93
Loan Principle at time t (M EGP)	LP_t						23.62						23.62												
Loan Interest at time t (M EGP)							2.34						2.34						0.05						0.05
Operation Cost at time t (M EGP)	$Opex_t$			29.43			29.43			29.43			29.43			30.90			30.90			30.90			30.90
Taxes at time t (M EGP)	T_t												19.98												20.57
Output Quantity at time t (M Unit)	Q_t	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
Updated IRR%	-22.78%			22.40			-3.57			22.40			-23.55			21.84			21.79			21.84			1.22

Model Screenshot 20: IRR Calculations for Updated Values (Cont.)

		Jan-26	Feb-26	Mar-26	Apr-26	May-26	Jun-26	Jul-26	Aug-26	Sep-26	Oct-26	Nov-26	Dec-26	Jan-27	Feb-27	Mar-27	Apr-27	May-27	Jun-27	Jul-27	Aug-27	Sep-27	Oct-27	Nov-27	Dec-27
Capital Fund at time t (M EGP)	$Capex_t$																								
Loan Payments																									
Operation Income at time t (M EGP)	OI_t			50.11			50.11			50.11			50.11			51.51			51.51			51.51			51.51
Government Subsidy at time t (M EGP)	GS_t			4.25			4.25			4.25			4.25			4.59			4.59			4.59			4.59
Loan Principle at time t (M EGP)	LP_t																								
Loan Interest at time t (M EGP)							0.06						0.06						0.06						0.06
Operation Cost at time t (M EGP)	$Opex_t$			32.50			32.50			32.50			32.50			34.22			34.22			34.22			34.22
Taxes at time t (M EGP)	T_t												20.66												20.72
Output Quantity at time t (M Unit)	Q_t	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
Updated IRR%	-22.78%			21.85			21.80			21.85			1.14			21.87			21.81			21.87			1.09

		Jan-28	Feb-28	Mar-28	Apr-28	May-28	Jun-28	Jul-28	Aug-28	Sep-28	Oct-28	Nov-28	Dec-28	Jan-29	Feb-29	Mar-29	Apr-29	May-29	Jun-29	Jul-29	Aug-29	Sep-29	Oct-29	Nov-29	Dec-29
Capital Fund at time t (M EGP)	$Capex_t$																								
Loan Payments																									
Operation Income at time t (M EGP)	OI_t			53.03			53.03			53.03			53.03			54.66			54.66			54.66			54.66
Government Subsidy at time t (M EGP)	GS_t			4.95			4.95			4.95			4.95			5.35			5.35			5.35			5.35
Loan Principle at time t (M EGP)	LP_t																								
Loan Interest at time t (M EGP)							0.07						0.07						0.07						0.07
Operation Cost at time t (M EGP)	$Opex_t$			36.08			36.08			36.08			36.08			38.09			38.09			38.09			38.09
Taxes at time t (M EGP)	T_t												20.76												20.79
Output Quantity at time t (M Unit)	Q_t	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
Updated IRR%	-22.78%			21.90			21.83			21.90			1.06			21.92			21.85			21.92			1.06

Model Screenshot 21: Scenarios Development

Contract Payment Information - Present Values	
Base IRR	19.95%
Capital Fund (M EGP)	788.51
Loan Payments (M EGP)	551.50
Operation Income (M EGP)	2,978.61
Government Subsidy (M EGP)	194.38
Loan Principle (M EGP)	515.21
Loan Interest (M EGP)	494.22
Operation Cost (M EGP)	1,707.63
Taxes (M EGP)	181.39
Output Quantity (M Unit)	1,620.00

Re-equilibrium Information - Present Values	
Updated IRR	0.00%
Capital Fund (M EGP)	788.51
Loan Payments (M EGP)	551.50
Operation Income (M EGP)	2,787.46
Government Subsidy (M EGP)	187.20
Loan Principle (M EGP)	515.21
Loan Interest (M EGP)	494.22
Operation Cost (M EGP)	1,707.63
Taxes (M EGP)	181.39
Output Quantity (M Unit)	1,507.50

Calculating the Concession Value at (t = 0) :

	Base	Updated	Re-equilibrium
Concession Value at t = 0	37.52	(160.81)	198.33

Calculating Re-equilibrium Scenarios:

Scenario 1: Lump Sum Payment at re-equilibrium time

	Base	Updated	Lump Sum Payment
Concession Price	37.52	(160.81)	270.34

Scenario 2: Adjusted Payment

	Base	Required to Re-equilibrium	Adjusted
User Charges	-	-	-
Usage Payments	-	-	-
Availability Payments	32.00	8.36	40.36

Scenario 3: Adjusted Concession Period

	Base	Required to Re-equilibrium	Adjusted
Concession Period	20	N/A	N/A

Scenario 4: Combination of the above

	Quarterly Payment	Concession Extension
Limitation	-	30.00
Remaining Value	-	10.00
Adjusted	34.50	30.00

Model Screenshot 22: Re-equilibrium Scenarios

Scenarios	Scenarios Description	Concession Value at time 0 (M EGP)	IRR %	Lump Sum Payment (M EGP)	Payment (M EGP)	Concession Period # of years
Base Scenario	Contract Information	37.52	19.95%	-	32.00	20.00
Updated Scenario	Updated Information	(160.81)	-22.78%	-	32.00	20.00
Re-equilibrium Scenario 1	Lump Sum Payment at RD	37.52	19.95%	270.34	32.00	20.00
Re-equilibrium Scenario 2	Adjusted Payment	37.52	19.95%	-	40.36	20.00
Re-equilibrium Scenario 3	Adjusted Concession Period	37.52	19.95%	-	32.00	N/A
Re-equilibrium Scenario 4	Combination of the above	37.52	19.95%	-	34.50	30.00

Model Screenshot 23: Re-equilibrium Scenarios Presented to the User

The Three Re-equilibrium Scenarios

Scenarios	Scenarios Description	Concession Value at time 0 (M EGP)	IRR %	Lump Sum Payment (M EGP)	Payment (M EGP)	Concession Period # of years
Base Scenario	Contract Information	37.52	19.95%	-	32.00	20.00
Updated Scenario	Updated Information	(160.81)	0.00%	-	32.00	20.00
Re-equilibrium Scenario 1	Lump Sum Payment at RD	37.52	19.95%	270.34	32.00	20.00
Re-equilibrium Scenario 2	Adjusted Payment	37.52	19.95%	-	40.36	20.00
Re-equilibrium Scenario 3	Adjusted Concession Period	37.52	19.95%	-	32.00	N/A

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Final Re-equilibrium Scenarios

Scenarios	Scenarios Description	Concession Value at time 0 (M EGP)	IRR %	Lump Sum Payment (M EGP)	Payment (M EGP)	Concession Period # of years
Base Scenario	Contract Information	37.52	19.95%	-	32.00	20.00
Updated Scenario	Updated Information	(160.81)	0.00%	-	32.00	20.00
Re-equilibrium Scenario 1	Lump Sum Payment at RD	37.52	19.95%	270.34	32.00	20.00
Re-equilibrium Scenario 2	Adjusted Payment	37.52	19.95%	-	40.36	20.00
Re-equilibrium Scenario 3	Adjusted Concession Period	37.52	19.95%	-	32.00	N/A
Re-equilibrium Scenario 4	Combination of the above	37.52	19.95%	-	34.50	30.00

Input Re-equilibrium Criteria

Model Screenshot 24: Re-equilibrium Criteria

Economic	Political	Financial	Project Related	Contractual	Policy
Inflation	Long-term Stability	Current Financial Obligations	Original Concession Period	Existence of Regulator	Business Strategy
General Conditions	Current Political Situation	Additional Financial Requirements	Preferred Concession Period	Risk Sharing Agreement	Likelihood of Repeated Business
Exchange Rates	Justice System	Liquidity	Complexity of the Project	Termination Clauses	Who Recognized the Claim
Effect on IRR		Ratio Debt vs. Equity		Re-equilibrium Clauses	Experienced Parties
		Transparency			

Click to Input S1 Priorities

Model Screenshot 25: Scenario One Weights Calculations

Criteria Priorities:

Criteria	Criteria 1	Criteria 2	Which is more important?
Economic	Political	Economic	Political
Political	Financial	Economic	Financial / Economic
Financial	Financial	Political	Financial
Project Related	Project Related	Economic	Economic
Contractual	Project Related	Political	Project Related
Policy	Project Related	Financial	Project Related
	Contractual	Economic	Contractual
	Contractual	Political	Political
	Contractual	Financial	Financial
	Contractual	Project Related	Project Related
	Policy	Economic	Economic
	Policy	Political	Political
	Policy	Financial	Financial
	Policy	Project Related	Policy / Project Related
	Policy	Contractual	Policy

Economic	Subcriteria 1	Subcriteria 2	Which is more important?
Inflation	General Conditions	Inflation	General Conditions
General Conditions	Exchange Rates	Inflation	Inflation
Exchange Rates	Exchange Rates	General Conditions	Exchange Rates / General Conditions
Effect on IRR	Effect on IRR	Inflation	Inflation
	Effect on IRR	General Conditions	General Conditions
	Effect on IRR	Exchange Rates	Exchange Rates

Political	Subcriteria 1	Subcriteria 2	Which is more important?
Long-term Stability	Current Political Situation	Long-term Stability	Long-term Stability
Current Political Situation	Justice System	Long-term Stability	Long-term Stability
Justice System	Justice System	Current Political Situation	Justice System

Model Screenshot 26: Scenario One Weights Calculations (Cont.

Subcriteria	Financial
	Current Financial Obligations
	Additional Financial Requirements
	Liquidity
	Ratio Debt vs. Equity
	Transparency

Subcriteria 1	Subcriteria 2	Which is more important?
Additional Financial Requirements	Current Financial Obligations	Current Financial Obligations
Liquidity	Current Financial Obligations	Current Financial Obligations
Liquidity	Additional Financial Requirements	Additional Financial Requirements
Ratio Debt vs. Equity	Current Financial Obligations	Current Financial Obligations
Ratio Debt vs. Equity	Additional Financial Requirements	Additional Financial Requirements
Ratio Debt vs. Equity	Liquidity	Liquidity
Transparency	Current Financial Obligations	Transparency / Current Financial Obligations
Transparency	Additional Financial Requirements	Additional Financial Requirements
Transparency	Liquidity	Liquidity
Transparency	Ratio Debt vs. Equity	Ratio Debt vs. Equity

Subcriteria	Project Related
	Original Concession Period
	Preferred Concession Period
	Complexity of the Project

Subcriteria 1	Subcriteria 2	Which is more important?
Preferred Concession Period	Original Concession Period	Preferred Concession Period / Original Concession Period
Complexity of the Project	Original Concession Period	Original Concession Period
Complexity of the Project	Preferred Concession Period	Complexity of the Project

Subcriteria	Contractual
	Existence of Regulator
	Risk Sharing Agreement
	Termination Clauses
	Re-equilibrium Clauses

Subcriteria 1	Subcriteria 2	Which is more important?
Risk Sharing Agreement	Existence of Regulator	Risk Sharing Agreement
Termination Clauses	Existence of Regulator	Existence of Regulator
Termination Clauses	Risk Sharing Agreement	Risk Sharing Agreement
Re-equilibrium Clauses	Existence of Regulator	Re-equilibrium Clauses / Existence of Regulator
Re-equilibrium Clauses	Risk Sharing Agreement	Risk Sharing Agreement
Re-equilibrium Clauses	Termination Clauses	Termination Clauses

Subcriteria	Policy
	Business Strategy
	Likelihood of Repeated Business
	Who Recognized the Claim
	Experienced Parties

Subcriteria 1	Subcriteria 2	Which is more important?
Likelihood of Repeated Business	Business Strategy	Likelihood of Repeated Business / Business Strategy
Who Recognized the Claim	Business Strategy	Who Recognized the Claim
Who Recognized the Claim	Likelihood of Repeated Business	Who Recognized the Claim / Likelihood of Repeated Business
Experienced Parties	Business Strategy	Experienced Parties
Experienced Parties	Likelihood of Repeated Business	Experienced Parties
Experienced Parties	Who Recognized the Claim	Who Recognized the Claim

Click to Input S2 Priorities

Model Screenshot 27: Scenario One Decision Matrix

Criteria

Criteria	Economic	Political	Financial	Project Related	Contractual	Policy
Economic		Political	Financial / Economic	Economic	Contractual	Economic
Political			Financial	Project Related	Political	Political
Financial				Project Related	Financial	Financial
Project Related					Project Related	Policy / Project Related
Contractual						Policy
Policy						

Criteria	# of Occurrence	Weight
Economic	3	18%
Political	3	18%
Financial	4	24%
Project Related	4	24%
Contractual	1	6%
Policy	2	12%

Economic

Economic	Inflation	General Conditions	Exchange Rates	Effect on IRR
Inflation		General Conditions	Inflation	Inflation
General Conditions			Exchange Rates / General Conditions	General Conditions
Exchange Rates				Exchange Rates
Effect on IRR				

Economic	# of Occurrence	Weight
Inflation	2	29%
General Conditions	3	43%
Exchange Rates	2	29%
Effect on IRR	0	0%

Model Screenshot 28: Scenario One Decision Matrix (Cont.)

Political

Political	Long-term Stability	Current Political Situation	Justice System
Long-term Stability		Long-term Stability	Long-term Stability
Current Political Situation			Justice System
Justice System			

Political	# of Occurrence	Weight
Long-term Stability	2	67%
Current Political Situation	0	0%
Justice System	1	33%

Financial

Financial	Current Financial Obligations	Additional Financial Requirements	Liquidity	Ratio Debt vs. Equity	Transparency
Current Financial Obligations		Current Financial Obligations	Current Financial Obligations	Current Financial Obligations	Transparency / Current Financial Obligations
Additional Financial Requirements			Additional Financial Requirements	Additional Financial Requirements	Additional Financial Requirements
Liquidity				Liquidity	Liquidity
Ratio Debt vs. Equity					Ratio Debt vs. Equity
Transparency					

Financial	# of Occurrence	Weight
Current Financial Obligations	4	36%
Additional Financial Requirements	3	27%
Liquidity	2	18%
Ratio Debt vs. Equity	1	9%
Transparency	1	9%

Project Related

Project Related	Original Concession Period	Preferred Concession Period	Complexity of the Project
Original Concession Period		Preferred Concession Period / Original Concession Period	Original Concession Period
Preferred Concession Period			Complexity of the Project
Complexity of the Project			

Project Related	# of Occurrence	Weight
Original Concession Period	2	50%
Preferred Concession Period	1	25%
Complexity of the Project	1	25%

Model Screenshot 29: Scenario One Decision Matrix (Cont.)

Contractual

Contractual	Existence of Regulator	Risk Sharing Agreement	Termination Clauses	Re-equilibrium Clauses
Existence of Regulator		Risk Sharing Agreement	Existence of Regulator	Re-equilibrium Clauses / Existence of Regulator
Risk Sharing Agreement			Risk Sharing Agreement	Risk Sharing Agreement
Termination Clauses				Termination Clauses
Re-equilibrium Clauses				

Contractual	# of Occurrence	Weight
Existence of Regulator	2	29%
Risk Sharing Agreement	3	43%
Termination Clauses	1	14%
Re-equilibrium Clauses	1	14%

Policy

Policy	Business Strategy	Likelihood of Repeated Business	Who Recognized the Claim	Experienced Parties
Business Strategy		Likelihood of Repeated Business / Business Strategy	Who Recognized the Claim	Experienced Parties
Likelihood of Repeated Business			Who Recognized the Claim / Likelihood of Repeated Business	Experienced Parties
Who Recognized the Claim				Who Recognized the Claim
Experienced Parties				

Policy	# of Occurrence	Weight
Business Strategy	1	13%
Likelihood of Repeated Business	2	25%
Who Recognized the Claim	3	38%
Experienced Parties	2	25%

Model Screenshot 30: Scenario Two Weights Calculations

Criteria Priorities:

Criteria	Criteria 1	Criteria 2	Which is more important?
Economic	Political	Economic	Economic
Political	Financial	Economic	Financial
Financial	Financial	Political	Political
Project Related	Project Related	Economic	Economic
Contractual	Project Related	Political	Project Related
Policy	Project Related	Financial	Project Related
	Contractual	Economic	Contractual
	Contractual	Political	Political
	Contractual	Financial	Financial
	Contractual	Project Related	Project Related
	Policy	Economic	Economic
	Policy	Political	Political
	Policy	Financial	Financial
	Policy	Project Related	Policy / Project Related
	Policy	Contractual	Policy

Economic	Subcriteria 1	Subcriteria 2	Which is more important?
Inflation	General Conditions	Inflation	General Conditions
General Conditions	Exchange Rates	Inflation	Inflation
Exchange Rates	Exchange Rates	General Conditions	Exchange Rates / General Conditions
Effect on IRR	Effect on IRR	Inflation	Inflation
	Effect on IRR	General Conditions	General Conditions
	Effect on IRR	Exchange Rates	Exchange Rates

Political	Subcriteria 1	Subcriteria 2	Which is more important?
Long-term Stability	Current Political Situation	Long-term Stability	Long-term Stability
Current Political Situation	Justice System	Long-term Stability	Justice System
Justice System	Justice System	Current Political Situation	Justice System

Subcriteria	Financial
	Current Financial Obligations
	Additional Financial Requirements
	Liquidity
	Ratio Debt vs. Equity
	Transparency

Subcriteria 1	Subcriteria 2	Which is more important?
Additional Financial Requirements	Current Financial Obligations	Current Financial Obligations
Liquidity	Current Financial Obligations	Liquidity
Liquidity	Additional Financial Requirements	Additional Financial Requirements
Ratio Debt vs. Equity	Current Financial Obligations	Ratio Debt vs. Equity / Current Financial Obligations
Ratio Debt vs. Equity	Additional Financial Requirements	Additional Financial Requirements
Ratio Debt vs. Equity	Liquidity	Liquidity
Transparency	Current Financial Obligations	Transparency
Transparency	Additional Financial Requirements	Additional Financial Requirements
Transparency	Liquidity	Liquidity
Transparency	Ratio Debt vs. Equity	Ratio Debt vs. Equity

Subcriteria	Contractual
	Existence of Regulator
	Risk Sharing Agreement
	Termination Clauses
	Re-equilibrium Clauses

Subcriteria 1	Subcriteria 2	Which is more important?
Risk Sharing Agreement	Existence of Regulator	Risk Sharing Agreement
Termination Clauses	Existence of Regulator	Existence of Regulator
Termination Clauses	Risk Sharing Agreement	Risk Sharing Agreement
Re-equilibrium Clauses	Existence of Regulator	Re-equilibrium Clauses / Existence of Regulator
Re-equilibrium Clauses	Risk Sharing Agreement	Re-equilibrium Clauses
Re-equilibrium Clauses	Termination Clauses	Termination Clauses

Subcriteria	Project Related
	Original Concession Period
	Preferred Concession Period
	Complexity of the Project

Subcriteria 1	Subcriteria 2	Which is more important?
Preferred Concession Period	Original Concession Period	Preferred Concession Period / Original Concession Period
Complexity of the Project	Original Concession Period	Original Concession Period
Complexity of the Project	Preferred Concession Period	Complexity of the Project

Subcriteria	Policy
	Business Strategy
	Likelihood of Repeated Business
	Who Recognized the Claim
	Experienced Parties

Subcriteria 1	Subcriteria 2	Which is more important?
Likelihood of Repeated Business	Business Strategy	Likelihood of Repeated Business / Business Strategy
Who Recognized the Claim	Business Strategy	Business Strategy
Who Recognized the Claim	Likelihood of Repeated Business	Who Recognized the Claim / Likelihood of Repeated Business
Experienced Parties	Business Strategy	Experienced Parties
Experienced Parties	Likelihood of Repeated Business	Experienced Parties
Experienced Parties	Who Recognized the Claim	Experienced Parties

Click to Input S3 Priorities

Model Screenshot 31: Scenario Two Decision Matrix

Criteria

Criteria	Economic	Political	Financial	Project Related	Contractual	Policy
Economic		Economic	Financial	Economic	Contractual	Economic
Political			Political	Project Related	Political	Political
Financial				Project Related	Financial	Financial
Project Related					Project Related	Policy / Project Related
Contractual						Policy
Policy						

Criteria	# of Occurrence	Weight
Economic	3	19%
Political	3	19%
Financial	3	19%
Project Related	4	25%
Contractual	1	6%
Policy	2	13%

Economic

Economic	Inflation	General Conditions	Exchange Rates	Effect on IRR
Inflation		General Conditions	Inflation	Inflation
General Conditions			Exchange Rates / General Conditions	General Conditions
Exchange Rates				Exchange Rates
Effect on IRR				

Economic	# of Occurrence	Weight
Inflation	2	29%
General Conditions	3	43%
Exchange Rates	2	29%
Effect on IRR	0	0%

Model Screenshot 32: Scenario Two Weights Calculations (Cont.)

Political

Political	Long-term Stability	Current Political Situation	Justice System
Long-term Stability		Long-term Stability	Justice System
Current Political Situation			Justice System
Justice System			

Political	# of Occurrence	Weight
Long-term Stability	1	33%
Current Political Situation	0	0%
Justice System	2	67%

Financial

Financial	Current Financial Obligations	Additional Financial Requirements	Liquidity	Ratio Debt vs. Equity	Transparency
Current Financial Obligations		Current Financial Obligations	Liquidity	Ratio Debt vs. Equity / Current Financial Obligations	Transparency
Additional Financial Requirements			Additional Financial Requirements	Additional Financial Requirements	Additional Financial Requirements
Liquidity				Liquidity	Liquidity
Ratio Debt vs. Equity					Ratio Debt vs. Equity
Transparency					

Financial	# of Occurrence	Weight
Current Financial Obligations	2	18%
Additional Financial Requirements	3	27%
Liquidity	3	27%
Ratio Debt vs. Equity	2	18%
Transparency	1	9%

Project Related

Project Related	Original Concession Period	Preferred Concession Period	Complexity of the Project
Original Concession Period		Preferred Concession Period / Original Concession Period	Original Concession Period
Preferred Concession Period			Complexity of the Project
Complexity of the Project			

Project Related	# of Occurrence	Weight
Original Concession Period	2	50%
Preferred Concession Period	1	25%
Complexity of the Project	1	25%

Model Screenshot 33: Scenario Two Weights Calculations (Cont.)

Contractual

Contractual	Existence of Regulator	Risk Sharing Agreement	Termination Clauses	Re-equilibrium Clauses
Existence of Regulator		Risk Sharing Agreement	Existence of Regulator	Re-equilibrium Clauses / Existence of Regulator
Risk Sharing Agreement			Risk Sharing Agreement	Re-equilibrium Clauses
Termination Clauses				Termination Clauses
Re-equilibrium Clauses				

Contractual	# of Occurrence	Weight
Existence of Regulator	2	29%
Risk Sharing Agreement	2	29%
Termination Clauses	1	14%
Re-equilibrium Clauses	2	29%

Policy

Policy	Business Strategy	Likelihood of Repeated Business	Who Recognized the Claim	Experienced Parties
Business Strategy		Likelihood of Repeated Business / Business Strategy	Business Strategy	Experienced Parties
Likelihood of Repeated Business			Who Recognized the Claim / Likelihood of Repeated Business	Experienced Parties
Who Recognized the Claim				Experienced Parties
Experienced Parties				

Policy	# of Occurrence	Weight
Business Strategy	2	25%
Likelihood of Repeated Business	2	25%
Who Recognized the Claim	1	13%
Experienced Parties	3	38%

Model Screenshot 34: Scenario Three Weights Calculations

Criteria Priorities:

Criteria	Criteria 1	Criteria 2	Which is more important?
Economic	Political	Economic	Political
Political	Financial	Economic	Financial / Economic
Financial	Financial	Political	Financial
Project Related	Project Related	Economic	Economic
Contractual	Project Related	Political	Project Related
Policy	Project Related	Financial	Project Related
	Contractual	Economic	Contractual
	Contractual	Political	Political
	Contractual	Financial	Contractual
	Contractual	Project Related	Project Related
	Policy	Economic	Economic
	Policy	Political	Political
	Policy	Financial	Financial
	Policy	Project Related	Policy
	Policy	Contractual	Policy

Economic	Subcriteria 1	Subcriteria 2	Which is more important?
Inflation	General Conditions	Inflation	General Conditions
General Conditions	Exchange Rates	Inflation	Inflation
Exchange Rates	Exchange Rates	General Conditions	Exchange Rates / General Conditions
Effect on IRR	Effect on IRR	Inflation	Effect on IRR
	Effect on IRR	General Conditions	General Conditions
	Effect on IRR	Exchange Rates	Exchange Rates

Political	Subcriteria 1	Subcriteria 2	Which is more important?
Long-term Stability	Current Political Situation	Long-term Stability	Long-term Stability
Current Political Situation	Justice System	Long-term Stability	Long-term Stability
Justice System	Justice System	Current Political Situation	Justice System

Model Screenshot 35: Scenario Three Weights Calculations (Cont.)

Subcriteria	Financial
	Current Financial Obligations
	Additional Financial Requirements
	Liquidity
	Ratio Debt vs. Equity
	Transparency

Subcriteria 1	Subcriteria 2	Which is more important?
Additional Financial Requirements	Current Financial Obligations	Current Financial Obligations
Liquidity	Current Financial Obligations	Current Financial Obligations
Liquidity	Additional Financial Requirements	Additional Financial Requirements
Ratio Debt vs. Equity	Current Financial Obligations	Current Financial Obligations
Ratio Debt vs. Equity	Additional Financial Requirements	Additional Financial Requirements
Ratio Debt vs. Equity	Liquidity	Ratio Debt vs. Equity
Transparency	Current Financial Obligations	Transparency / Current Financial Obligations
Transparency	Additional Financial Requirements	Additional Financial Requirements
Transparency	Liquidity	Liquidity
Transparency	Ratio Debt vs. Equity	Ratio Debt vs. Equity

Subcriteria	Project Related
	Original Concession Period
	Preferred Concession Period
	Complexity of the Project

Subcriteria 1	Subcriteria 2	Which is more important?
Preferred Concession Period	Original Concession Period	Preferred Concession Period / Original Concession Period
Complexity of the Project	Original Concession Period	Original Concession Period
Complexity of the Project	Preferred Concession Period	Complexity of the Project

Subcriteria	Contractual
	Existence of Regulator
	Risk Sharing Agreement
	Termination Clauses
	Re-equilibrium Clauses

Subcriteria 1	Subcriteria 2	Which is more important?
Risk Sharing Agreement	Existence of Regulator	Risk Sharing Agreement
Termination Clauses	Existence of Regulator	Existence of Regulator
Termination Clauses	Risk Sharing Agreement	Risk Sharing Agreement
Re-equilibrium Clauses	Existence of Regulator	Re-equilibrium Clauses / Existence of Regulator
Re-equilibrium Clauses	Risk Sharing Agreement	Risk Sharing Agreement
Re-equilibrium Clauses	Termination Clauses	Termination Clauses

Subcriteria	Policy
	Business Strategy
	Likelihood of Repeated Business
	Who Recognized the Claim
	Experienced Parties

Subcriteria 1	Subcriteria 2	Which is more important?
Likelihood of Repeated Business	Business Strategy	Likelihood of Repeated Business / Business Strategy
Who Recognized the Claim	Business Strategy	Who Recognized the Claim
Who Recognized the Claim	Likelihood of Repeated Business	Who Recognized the Claim / Likelihood of Repeated Business
Experienced Parties	Business Strategy	Experienced Parties
Experienced Parties	Likelihood of Repeated Business	Experienced Parties
Experienced Parties	Who Recognized the Claim	Who Recognized the Claim

Click to Input S4 Priorities

Model Screenshot 36: Scenario Three Decision Matrix

Criteria

Criteria	Economic	Political	Financial	Project Related	Contractual	Policy
Economic		Political	Financial / Economic	Economic	Contractual	Economic
Political			Financial	Project Related	Political	Political
Financial				Project Related	Contractual	Financial
Project Related					Project Related	Policy
Contractual						Policy
Policy						

Criteria	# of Occurrence	Weight
Economic	3	19%
Political	3	19%
Financial	3	19%
Project Related	3	19%
Contractual	2	13%
Policy	2	13%

Economic

Economic	Inflation	General Conditions	Exchange Rates	Effect on IRR
Inflation		General Conditions	Inflation	Effect on IRR
General Conditions			Exchange Rates / General Conditions	General Conditions
Exchange Rates				Exchange Rates
Effect on IRR				

Economic	# of Occurrence	Weight
Inflation	1	14%
General Conditions	3	43%
Exchange Rates	2	29%
Effect on IRR	1	14%

Model Screenshot 37: Scenario Three Decision Matrix (Cont.)

Political

Political	Long-term Stability	Current Political Situation	Justice System
Long-term Stability		Long-term Stability	Long-term Stability
Current Political Situation			Justice System
Justice System			

Political	# of Occurrence	Weight
Long-term Stability	2	67%
Current Political Situation	0	0%
Justice System	1	33%

Financial

Financial	Current Financial Obligations	Additional Financial Requirements	Liquidity	Ratio Debt vs. Equity	Transparency
Current Financial Obligations		Current Financial Obligations	Current Financial Obligations	Current Financial Obligations	Transparency / Current Financial Obligations
Additional Financial Requirements			Additional Financial Requirements	Additional Financial Requirements	Additional Financial Requirements
Liquidity				Ratio Debt vs. Equity	Liquidity
Ratio Debt vs. Equity					Ratio Debt vs. Equity
Transparency					

Financial	# of Occurrence	Weight
Current Financial Obligations	4	36%
Additional Financial Requirements	3	27%
Liquidity	1	9%
Ratio Debt vs. Equity	2	18%
Transparency	1	9%

Project Related

Project Related	Original Concession Period	Preferred Concession Period	Complexity of the Project
Original Concession Period		Preferred Concession Period / Original Concession Period	Original Concession Period
Preferred Concession Period			Complexity of the Project
Complexity of the Project			

Project Related	# of Occurrence	Weight
Original Concession Period	2	50%
Preferred Concession Period	1	25%
Complexity of the Project	1	25%

Model Screenshot 38: Scenario Three Decision Matrix (Cont.)

Contractual

Contractual	Existence of Regulator	Risk Sharing Agreement	Termination Clauses	Re-equilibrium Clauses
Existence of Regulator		Risk Sharing Agreement	Existence of Regulator	Re-equilibrium Clauses / Existence of Regulator
Risk Sharing Agreement			Risk Sharing Agreement	Risk Sharing Agreement
Termination Clauses				Termination Clauses
Re-equilibrium Clauses				

Contractual	# of Occurrence	Weight
Existence of Regulator	2	29%
Risk Sharing Agreement	3	43%
Termination Clauses	1	14%
Re-equilibrium Clauses	1	14%

Policy

Policy	Business Strategy	Likelihood of Repeated Business	Who Recognized the Claim	Experienced Parties
Business Strategy		Likelihood of Repeated Business / Business Strategy	Who Recognized the Claim	Experienced Parties
Likelihood of Repeated Business			Who Recognized the Claim / Likelihood of Repeated Business	Experienced Parties
Who Recognized the Claim				Who Recognized the Claim
Experienced Parties				

Policy	# of Occurrence	Weight
Business Strategy	1	13%
Likelihood of Repeated Business	2	25%
Who Recognized the Claim	3	38%
Experienced Parties	2	25%

Model Screenshot 39: Scenario Four Weights Calculations

Criteria Priorities:

Criteria	Criteria 1	Criteria 2	Which is more important?
Economic	Political	Economic	Political
Political	Financial	Economic	Financial / Economic
Financial	Financial	Political	Financial
Project Related	Project Related	Economic	Economic
Contractual	Project Related	Political	Project Related
Policy	Project Related	Financial	Project Related
	Contractual	Economic	Contractual / Economic
	Contractual	Political	Political
	Contractual	Financial	Financial
	Contractual	Project Related	Project Related
	Policy	Economic	Economic
	Policy	Political	Policy / Political
	Policy	Financial	Financial
	Policy	Project Related	Policy / Project Related
	Policy	Contractual	Policy

Economic	Subcriteria 1	Subcriteria 2	Which is more important?
Inflation	General Conditions	Inflation	General Conditions
General Conditions	Exchange Rates	Inflation	Inflation
Exchange Rates	Exchange Rates	General Conditions	Exchange Rates / General Conditions
Effect on IRR	Effect on IRR	Inflation	Inflation
	Effect on IRR	General Conditions	General Conditions
	Effect on IRR	Exchange Rates	Exchange Rates

Political	Subcriteria 1	Subcriteria 2	Which is more important?
Long-term Stability	Current Political Situation	Long-term Stability	Long-term Stability
Current Political Situation	Justice System	Long-term Stability	Long-term Stability
Justice System	Justice System	Current Political Situation	Justice System / Current Political Situation

Model Screenshot 40: Scenario Four Weights Calculations (Cont.)

Subcriteria	Financial
	Current Financial Obligations
	Additional Financial Requirements
	Liquidity
	Ratio Debt vs. Equity
	Transparency

Subcriteria 1	Subcriteria 2	Which is more important?
Additional Financial Requirements	Current Financial Obligations	Current Financial Obligations
Liquidity	Current Financial Obligations	Liquidity
Liquidity	Additional Financial Requirements	Additional Financial Requirements
Ratio Debt vs. Equity	Current Financial Obligations	Current Financial Obligations
Ratio Debt vs. Equity	Additional Financial Requirements	Additional Financial Requirements
Ratio Debt vs. Equity	Liquidity	Liquidity
Transparency	Current Financial Obligations	Transparency / Current Financial Obligations
Transparency	Additional Financial Requirements	Additional Financial Requirements
Transparency	Liquidity	Liquidity
Transparency	Ratio Debt vs. Equity	Ratio Debt vs. Equity

Subcriteria	Project Related
	Original Concession Period
	Preferred Concession Period
	Complexity of the Project

Subcriteria 1	Subcriteria 2	Which is more important?
Preferred Concession Period	Original Concession Period	Preferred Concession Period / Original Concession Period
Complexity of the Project	Original Concession Period	Original Concession Period
Complexity of the Project	Preferred Concession Period	Complexity of the Project

Subcriteria	Contractual
	Existence of Regulator
	Risk Sharing Agreement
	Termination Clauses
	Re-equilibrium Clauses

Subcriteria 1	Subcriteria 2	Which is more important?
Risk Sharing Agreement	Existence of Regulator	Risk Sharing Agreement
Termination Clauses	Existence of Regulator	Existence of Regulator
Termination Clauses	Risk Sharing Agreement	Termination Clauses
Re-equilibrium Clauses	Existence of Regulator	Re-equilibrium Clauses / Existence of Regulator
Re-equilibrium Clauses	Risk Sharing Agreement	Risk Sharing Agreement
Re-equilibrium Clauses	Termination Clauses	Termination Clauses

Subcriteria	Policy
	Business Strategy
	Likelihood of Repeated Business
	Who Recognized the Claim
	Experienced Parties

Subcriteria 1	Subcriteria 2	Which is more important?
Likelihood of Repeated Business	Business Strategy	Likelihood of Repeated Business / Business Strategy
Who Recognized the Claim	Business Strategy	Who Recognized the Claim
Who Recognized the Claim	Likelihood of Repeated Business	Who Recognized the Claim / Likelihood of Repeated Business
Experienced Parties	Business Strategy	Business Strategy
Experienced Parties	Likelihood of Repeated Business	Experienced Parties
Experienced Parties	Who Recognized the Claim	Who Recognized the Claim

Input Private Sector Ranking

Model Screenshot 41: Scenario Four Risk Matrix

Criteria

Criteria	Economic	Political	Financial	Project Related	Contractual	Policy
Economic		Political	Financial / Economic	Economic	Contractual / Economic	Economic
Political			Financial	Project Related	Political	Policy / Political
Financial				Project Related	Financial	Financial
Project Related					Project Related	Policy / Project Related
Contractual						Policy
Policy						

Criteria	# of Occurrence	Weight
Economic	4	21%
Political	3	16%
Financial	4	21%
Project Related	4	21%
Contractual	1	5%
Policy	3	16%

Economic

Economic	Inflation	General Conditions	Exchange Rates	Effect on IRR
Inflation		General Conditions	Inflation	Inflation
General Conditions			Exchange Rates / General Conditions	General Conditions
Exchange Rates				Exchange Rates
Effect on IRR				

Economic	# of Occurrence	Weight
Inflation	2	29%
General Conditions	3	43%
Exchange Rates	2	29%
Effect on IRR	0	0%

Model Screenshot 42: Scenario Four Risk Matrix (Cont.)

Political

Political	Long-term Stability	Current Political Situation	Justice System
Long-term Stability		Long-term Stability	Long-term Stability
Current Political Situation			Justice System / Current Political Situation
Justice System			

Political	# of Occurrence	Weight
Long-term Stability	2	50%
Current Political Situation	1	25%
Justice System	1	25%

Financial

Financial	Current Financial Obligations	Additional Financial Requirements	Liquidity	Ratio Debt vs. Equity	Transparency
Current Financial Obligations		Current Financial Obligations	Liquidity	Current Financial Obligations	Transparency / Current Financial Obligations
Additional Financial Requirements			Additional Financial Requirements	Additional Financial Requirements	Additional Financial Requirements
Liquidity				Liquidity	Liquidity
Ratio Debt vs. Equity					Ratio Debt vs. Equity
Transparency					

Financial	# of Occurrence	Weight
Current Financial Obligations	3	27%
Additional Financial Requirements	3	27%
Liquidity	3	27%
Ratio Debt vs. Equity	1	9%
Transparency	1	9%

Project Related

Project Related	Original Concession Period	Preferred Concession Period	Complexity of the Project
Original Concession Period		Preferred Concession Period / Original Concession Period	Original Concession Period
Preferred Concession Period			Complexity of the Project
Complexity of the Project			

Project Related	# of Occurrence	Weight
Original Concession Period	2	50%
Preferred Concession Period	1	25%
Complexity of the Project	1	25%

Model Screenshot 43: Scenario Four Risk Matrix (Cont.)

Contractual

Contractual	Existence of Regulator	Risk Sharing Agreement	Termination Clauses	Re-equilibrium Clauses
Existence of Regulator		Risk Sharing Agreement	Existence of Regulator	Re-equilibrium Clauses / Existence of Regulator
Risk Sharing Agreement			Termination Clauses	Risk Sharing Agreement
Termination Clauses				Termination Clauses
Re-equilibrium Clauses				

Contractual	# of Occurrence	Weight
Existence of Regulator	2	29%
Risk Sharing Agreement	2	29%
Termination Clauses	2	29%
Re-equilibrium Clauses	1	14%

Policy

Policy	Business Strategy	Likelihood of Repeated Business	Who Recognized the Claim	Experienced Parties
Business Strategy		Likelihood of Repeated Business / Business Strategy	Who Recognized the Claim	Business Strategy
Likelihood of Repeated Business			Who Recognized the Claim / Likelihood of Repeated Business	Experienced Parties
Who Recognized the Claim				Who Recognized the Claim
Experienced Parties				

Policy	# of Occurrence	Weight
Business Strategy	2	25%
Likelihood of Repeated Business	2	25%
Who Recognized the Claim	3	38%
Experienced Parties	1	13%

Criteria Ranking - Private Sector:

Please describe the status of the below criteria and whether it is in favor of your party or not:

Criteria	Related Risk	Risk Allocation	Rank	Rank #
Economic				
Inflation	Inflation	Primarily to Private Sector	Suitable	4
General Conditions	Influential economic events	Primarily to Private Sector	Suitable	4
Exchange Rates	Interest rate	Solely to Private Sector	Very Suitable	5
Effect on IRR	Operational revenue below par	Solely to Private Sector	Very Unsuitable	1
Political				
Long-term Stability	Government stability	Public Sector	Very Unsuitable	1
Current Political Situation	Poor political decision-making process	Public Sector	Very Unsuitable	1
Justice System	Legislation change	Shared	Very Suitable	5
Financial				
Current Financial Obligations	Lack of commitment from public/private partner	Shared	Suitable	4
Additional Financial Requirements	Financial market	Solely to Private Sector	Suitable	4
Liquidity	Availability of finance	Solely to Private Sector	Neutral	3
Ratio Debt vs. Equity	High financing cost	Solely to Private Sector	Suitable	4
Project Related				
Original Concession Period	Construction time delay	Solely to Private Sector	Suitable	4
Preferred Concession Period	Construction time delay	Solely to Private Sector	Neutral	3
Complexity of the Project	Quality of workmanship	Solely to Private Sector	Neutral	3
Contractual				
Existence of Regulator	Industrial regulatory change	Solely to Private Sector	Very Unsuitable	1
Risk Sharing Agreement	Responsibilities and risk distribution	Shared	Suitable	4
Termination Clauses	Force majeure	Shared	Suitable	4
Re-equilibrium Clauses	Contract variation	Strongly Depending	Suitable	4
Policy				
Business Strategy	Financial attraction of project	Primarily to Private Sector	Very Suitable	5
Likelihood of Repeated Business	Residual risk	Primarily to Private Sector	Neutral	3
Who Recognized the Claim	Level of public support	Strongly Depending	Neutral	3
Experienced Parties	Lack of experiences in PPP arrangement	Strongly Depending	Very Suitable	5

Input Public Sector Ranking

Model Screenshot 44: Private Sector Ranks

Criteria Ranking - Public Sector:

Please describe the status of the below criteria and whether it is in favor of your party or not:

Criteria	Related Risk	Risk Allocation	Rank	Rank #
Economic				
Inflation	Inflation	Primarily to Private Sector	Very Suitable	5
General Conditions	Influential economic events	Primarily to Private Sector	Unsuitable	2
Exchange Rates	Interest rate	Solely to Private Sector	Unsuitable	2
Effect on IRR	Operational revenue below par	Solely to Private Sector	Very Unsuitable	1
Political				
Long-term Stability	Government stability	Public Sector	Unsuitable	2
Current Political Situation	Poor political decision-making process	Public Sector	Neutral	3
Justice System	Legislation change	Shared	Unsuitable	2
Financial				
Current Financial Obligations	Lack of commitment from public/private partner	Shared	Suitable	4
Additional Financial Requirements	Financial market	Solely to Private Sector	Suitable	4
Liquidity	Availability of finance	Solely to Private Sector	Neutral	3
Ratio Debt vs. Equity	High financing cost	Solely to Private Sector	Unsuitable	2
Transparency	Level of public support	Strongly Depending	Suitable	4
Project Related				
Original Concession Period	Construction time delay	Solely to Private Sector	Suitable	4
Preferred Concession Period	Construction time delay	Solely to Private Sector	Neutral	3
Complexity of the Project	Quality of workmanship	Solely to Private Sector	Suitable	4
Contractual				
Existence of Regulator	Industrial regulatory change	Solely to Private Sector	Suitable	4
Risk Sharing Agreement	Responsibilities and risk distribution	Shared	Unsuitable	2
Termination Clauses	Force majeure	Shared	Suitable	4
Re-equilibrium Clauses	Contract variation	Strongly Depending	Very Unsuitable	1
Policy				
Business Strategy	Financial attraction of project	Primarily to Private Sector	Very Suitable	5
Likelihood of Repeated Business	Residual risk	Primarily to Private Sector	Neutral	3
Who Recognized the Claim	Level of public support	Strongly Depending	Very Suitable	5
Experienced Parties	Lack of experiences in PPP arrangement	Strongly Depending	Very Suitable	5

Proceed to Results

Model Screenshot 45: Public Sector Ranks

Model Screenshot 46: Weighted Sum Module

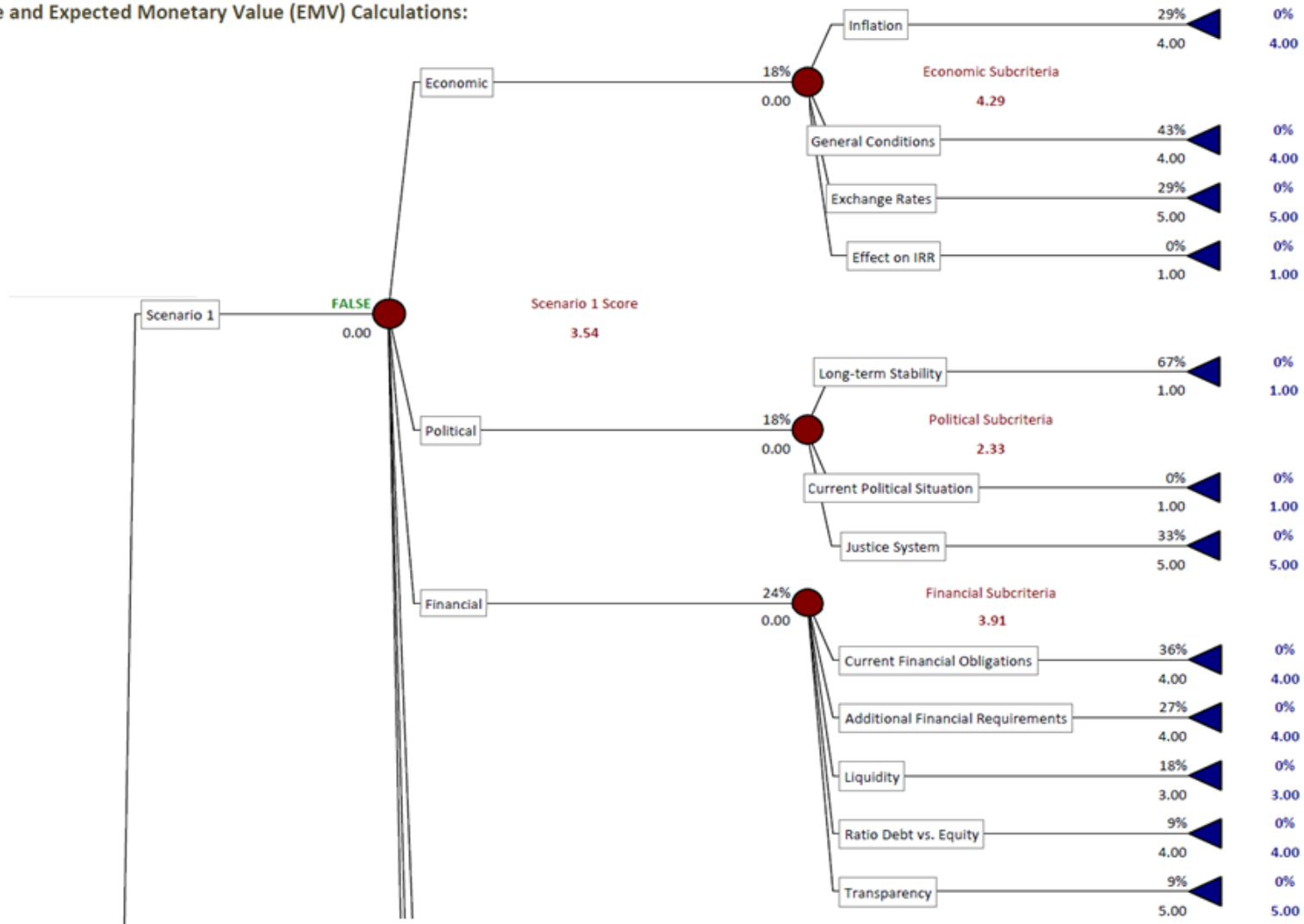
Criteria	Scenario 1 Weights	Scenario 2 Weights	Scenario 3 Weights	Scenario 4 Weights	Private Sector Ranks	Public Sector Ranks	Combined Ranks
Economic	18%	19%	19%	21%			
Inflation	29%	29%	14%	29%	4	5	4.5
General Conditions	43%	43%	43%	43%	4	2	3
Exchange Rates	29%	29%	29%	29%	5	2	3.5
Effect on IRR	0%	0%	14%	0%	1	1	1
Political	18%	19%	19%	16%			
Long-term Stability	67%	33%	67%	50%	1	2	1.5
Current Political Situation	0%	0%	0%	25%	1	3	2
Justice System	33%	67%	33%	25%	5	2	3.5
Financial	24%	19%	19%	21%			
Current Financial Obligations	36%	18%	36%	27%	4	4	4
Additional Financial Requirements	27%	27%	27%	27%	4	4	4
Liquidity	18%	27%	9%	27%	3	3	3
Ratio Debt vs. Equity	9%	18%	18%	9%	4	2	3
Transparency	9%	9%	9%	9%	5	4	4.5
Project Related	24%	25%	19%	21%			
Original Concession Period	50%	50%	50%	50%	4	4	4
Preferred Concession Period	25%	25%	25%	25%	3	3	3
Complexity of the Project	25%	25%	25%	25%	3	4	3.5
Contractual	6%	6%	13%	5%			
Existence of Regulator	29%	29%	29%	29%	1	4	2.5
Risk Sharing Agreement	43%	29%	43%	29%	4	2	3
Termination Clauses	14%	14%	14%	29%	4	4	4
Re-equilibrium Clauses	14%	29%	14%	14%	4	1	2.5
Policy	12%	13%	13%	16%			
Business Strategy	13%	25%	13%	25%	5	5	5
Likelihood of Repeated Business	25%	25%	25%	25%	3	3	3
Who Recognized the Claim	38%	13%	38%	38%	3	5	4
Experienced Parties	25%	38%	25%	13%	5	5	5

Model Screenshot 47: Best Scenario Scores

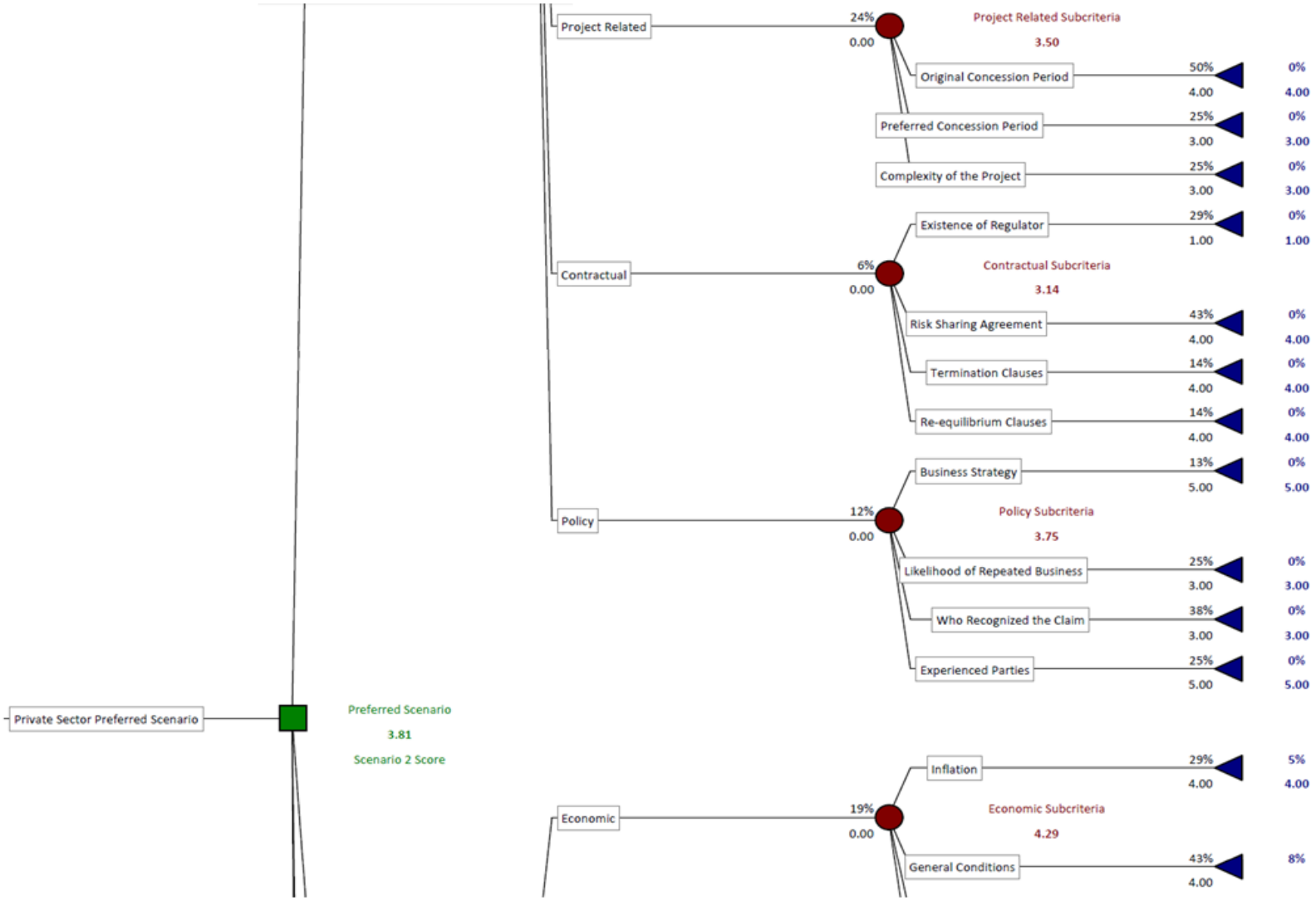
	Scenario 1 Score	Scenario 2 Score	Scenario 3 Score	Scenario 4 Score	Best Scenario
Private Sector	3.54	3.81	3.43	3.52	**Scenario 2 with Score 3.81**
Public Sector	3.28	3.20	3.07	3.36	**Scenario 4 with Score 3.36**
Combined	3.41	3.51	3.25	3.44	**Scenario 2 with Score 3.51**

Model Screenshot 48: Reports Section

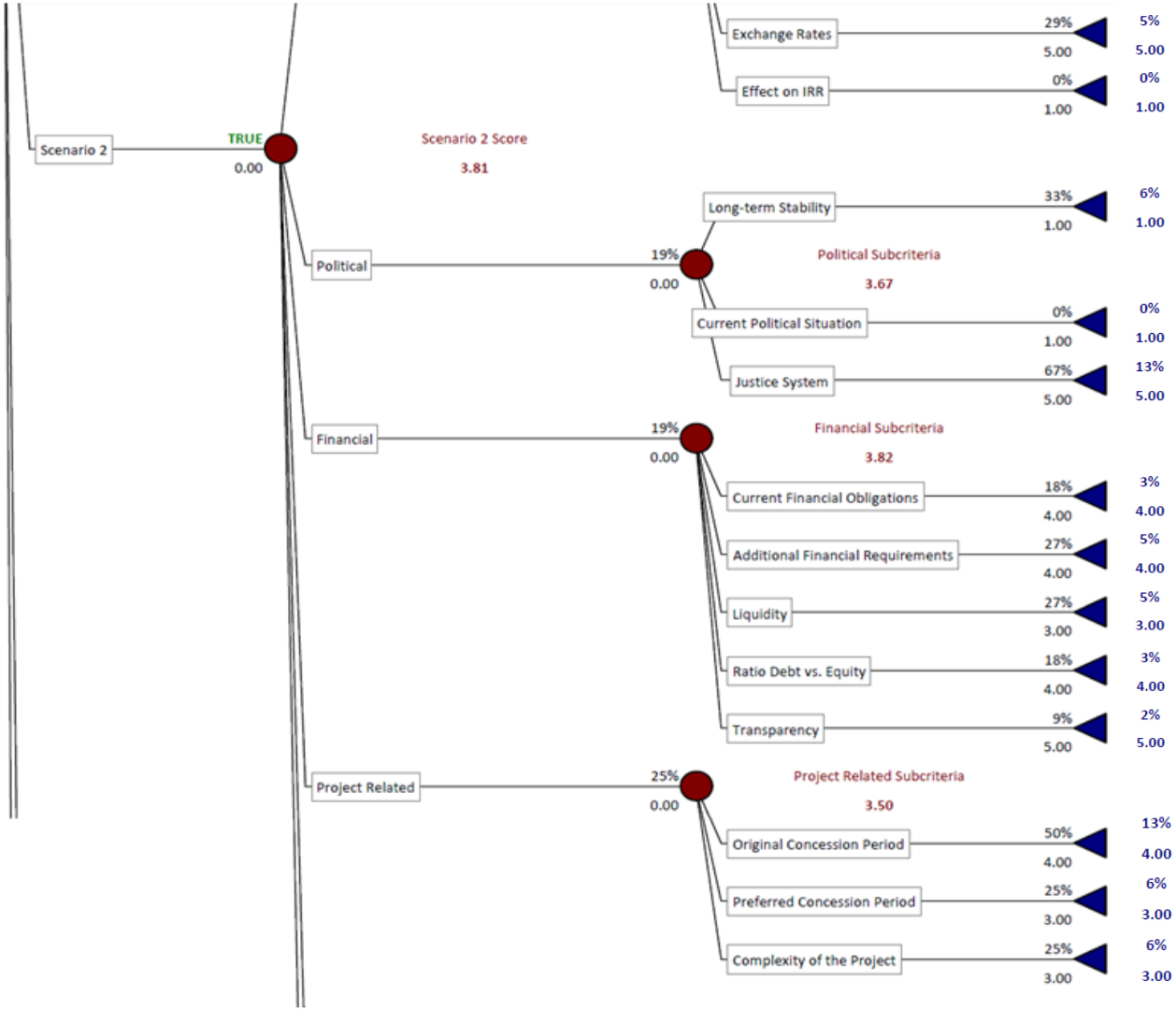
Private Sector Decision Tree and Expected Monetary Value (EMV) Calculations:



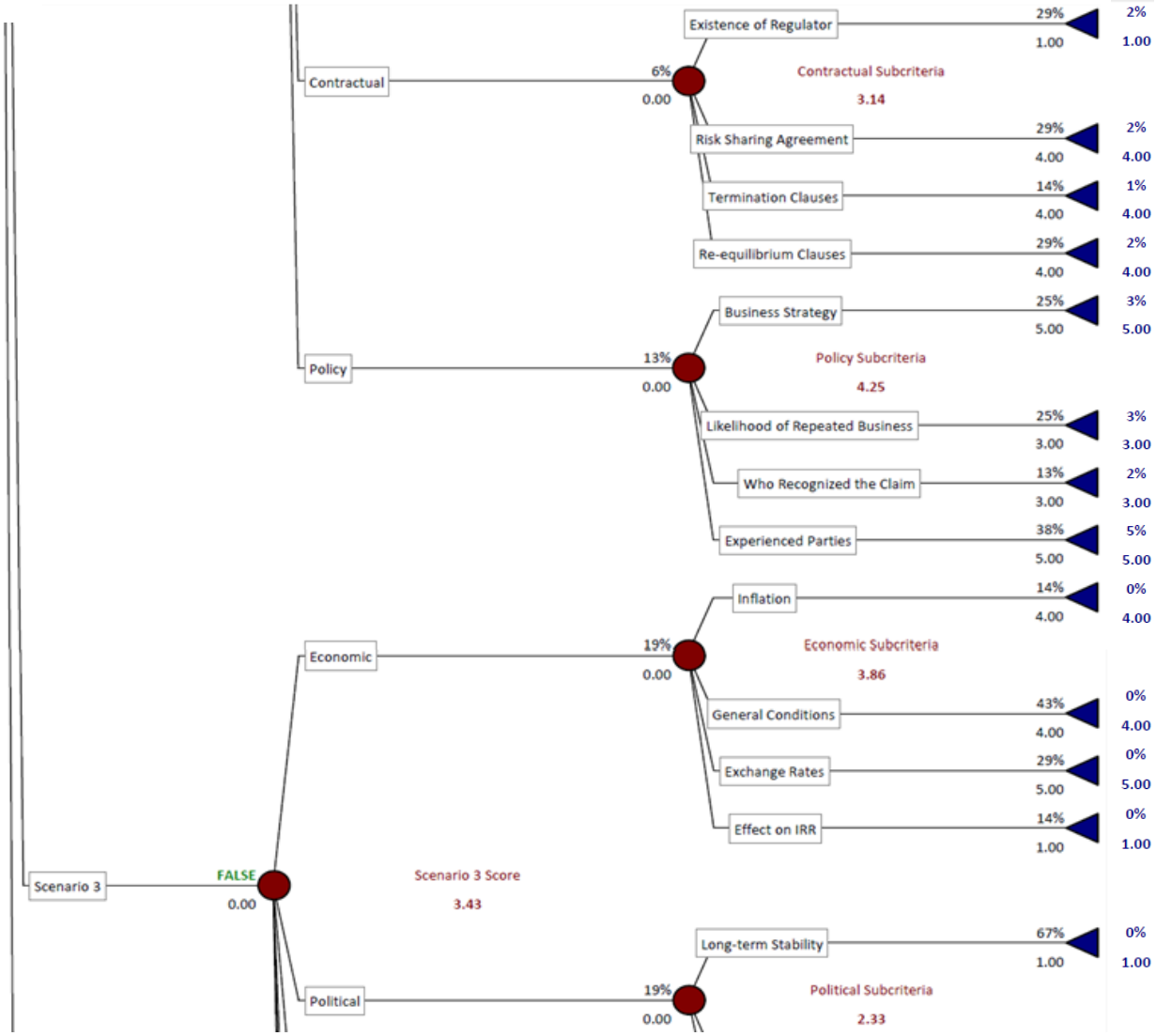
Model Screenshot 49: Reports Section (Cont.)



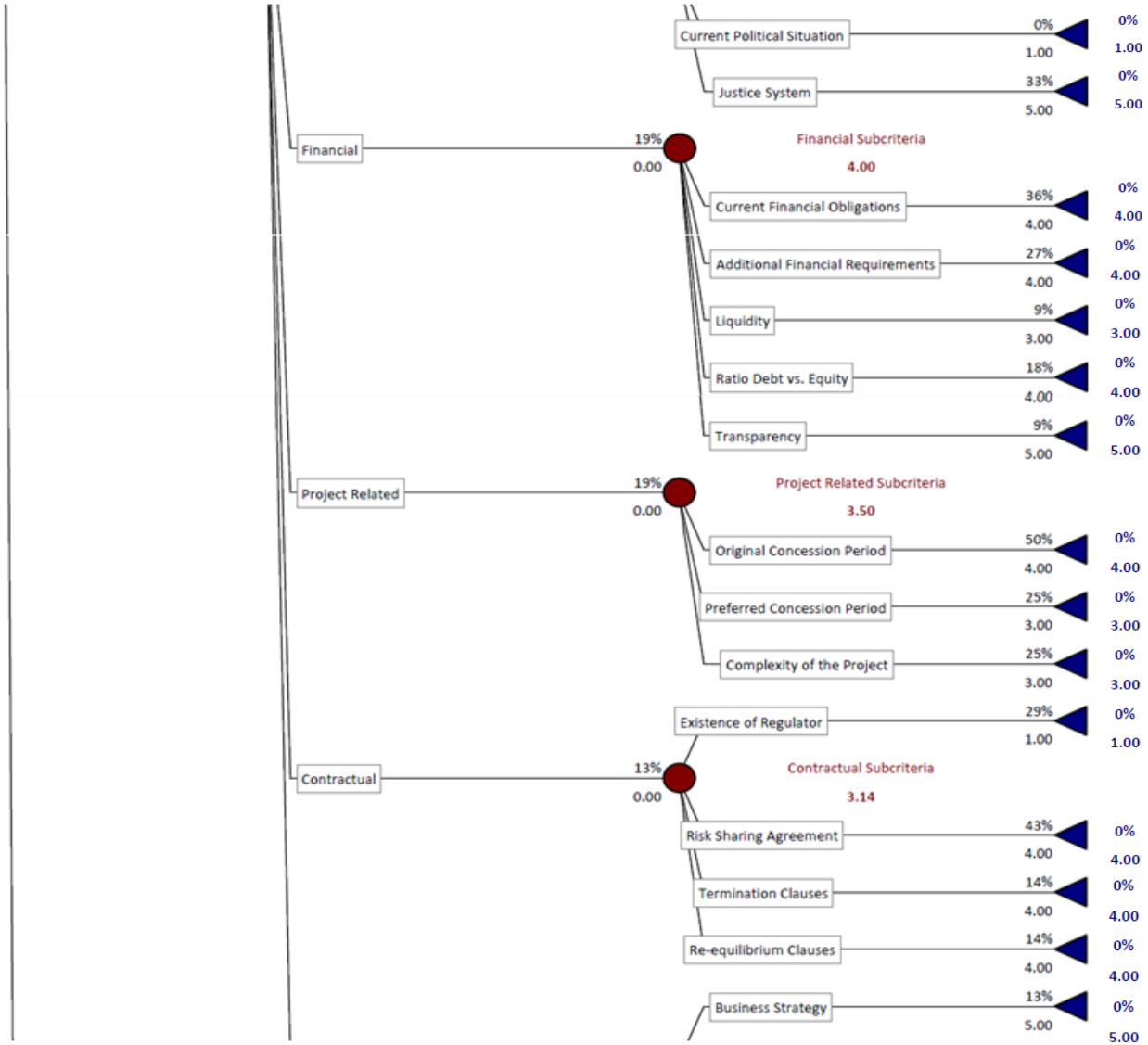
Model Screenshot 50: Reports Section (Cont.)



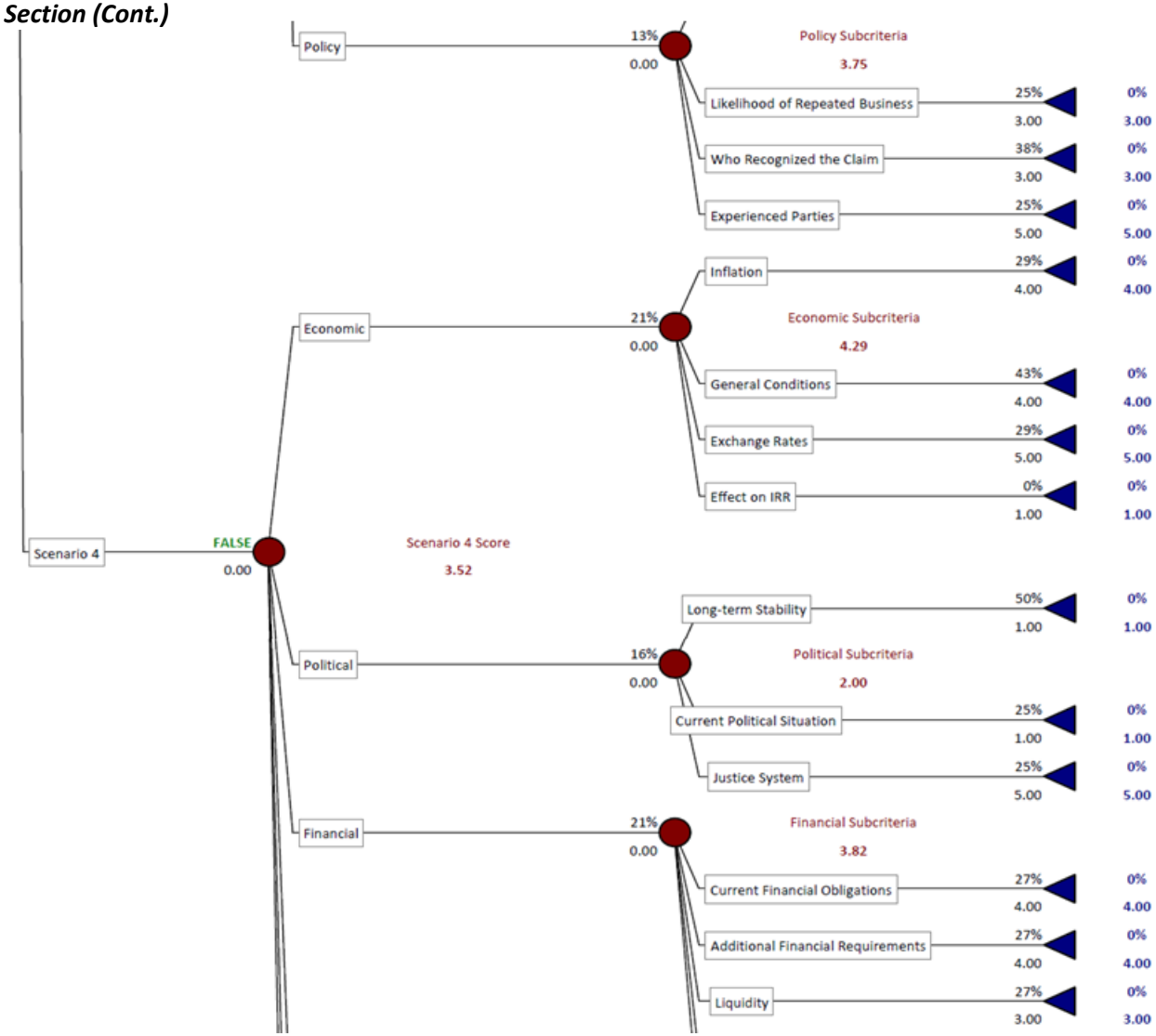
Model Screenshot 51: Reports Section (Cont.)



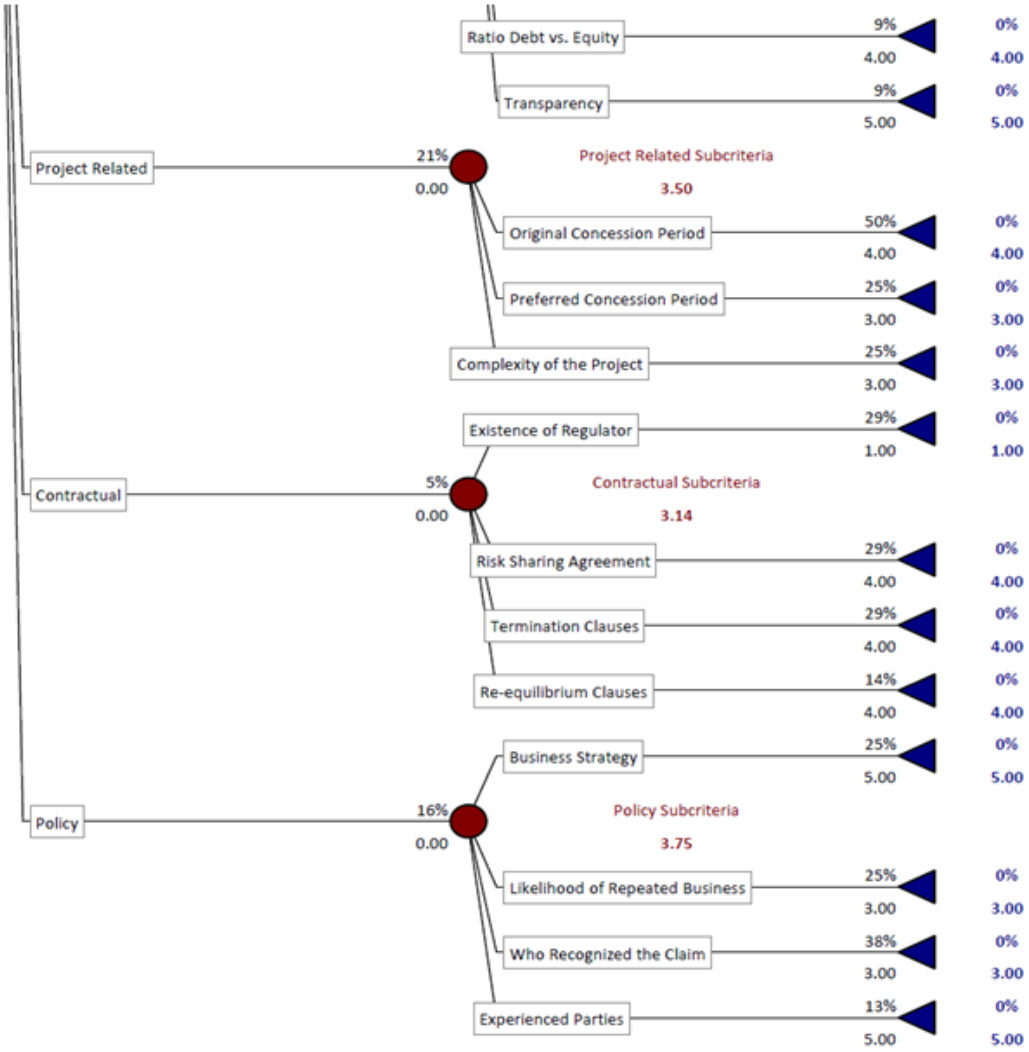
Model Screenshot 52: Reports Section (Cont.)



Model Screenshot 53: Reports Section (Cont.)

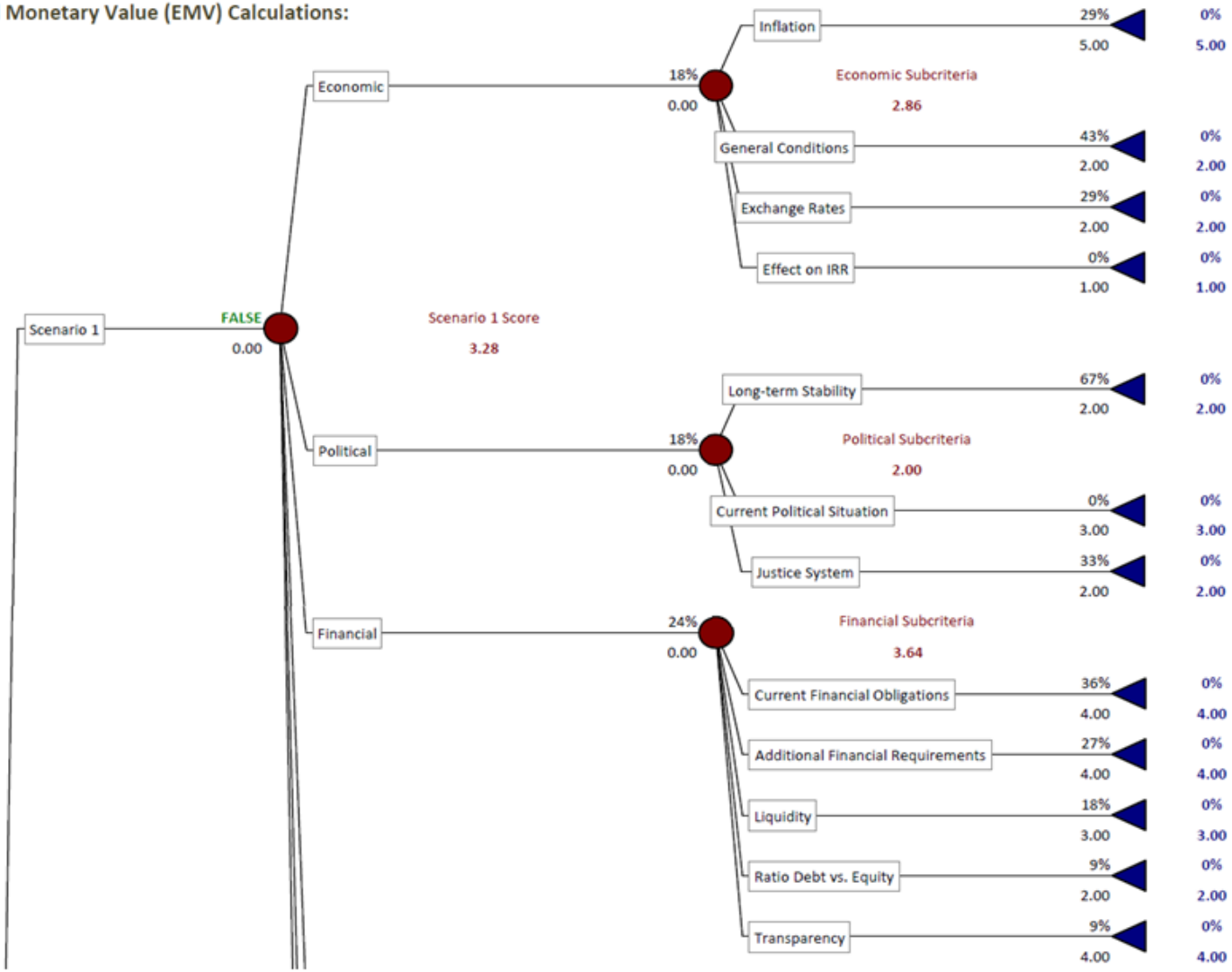


Model Screenshot 54: Reports Section (Cont.)

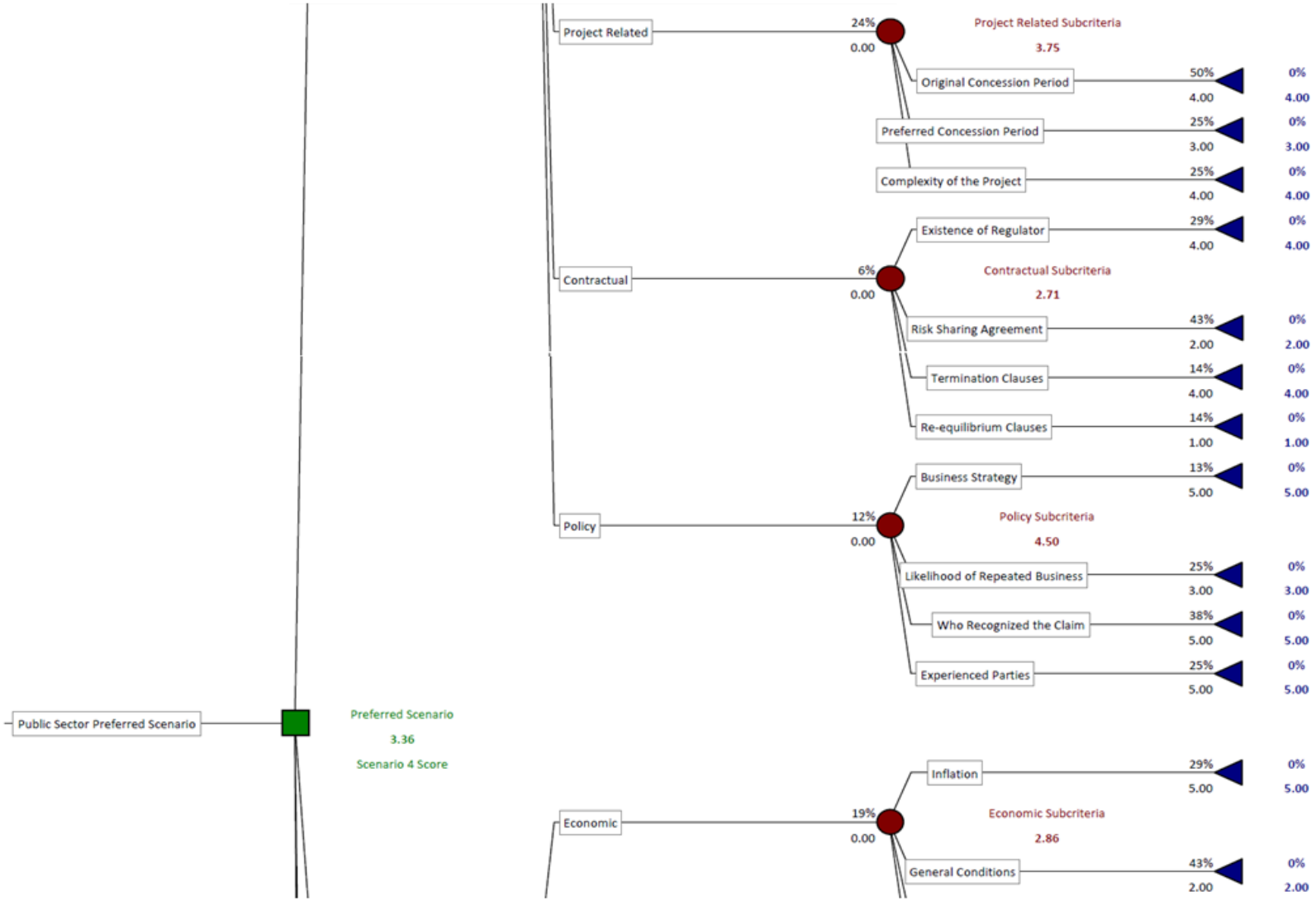


Model Screenshot 55: Reports Section (Cont.)

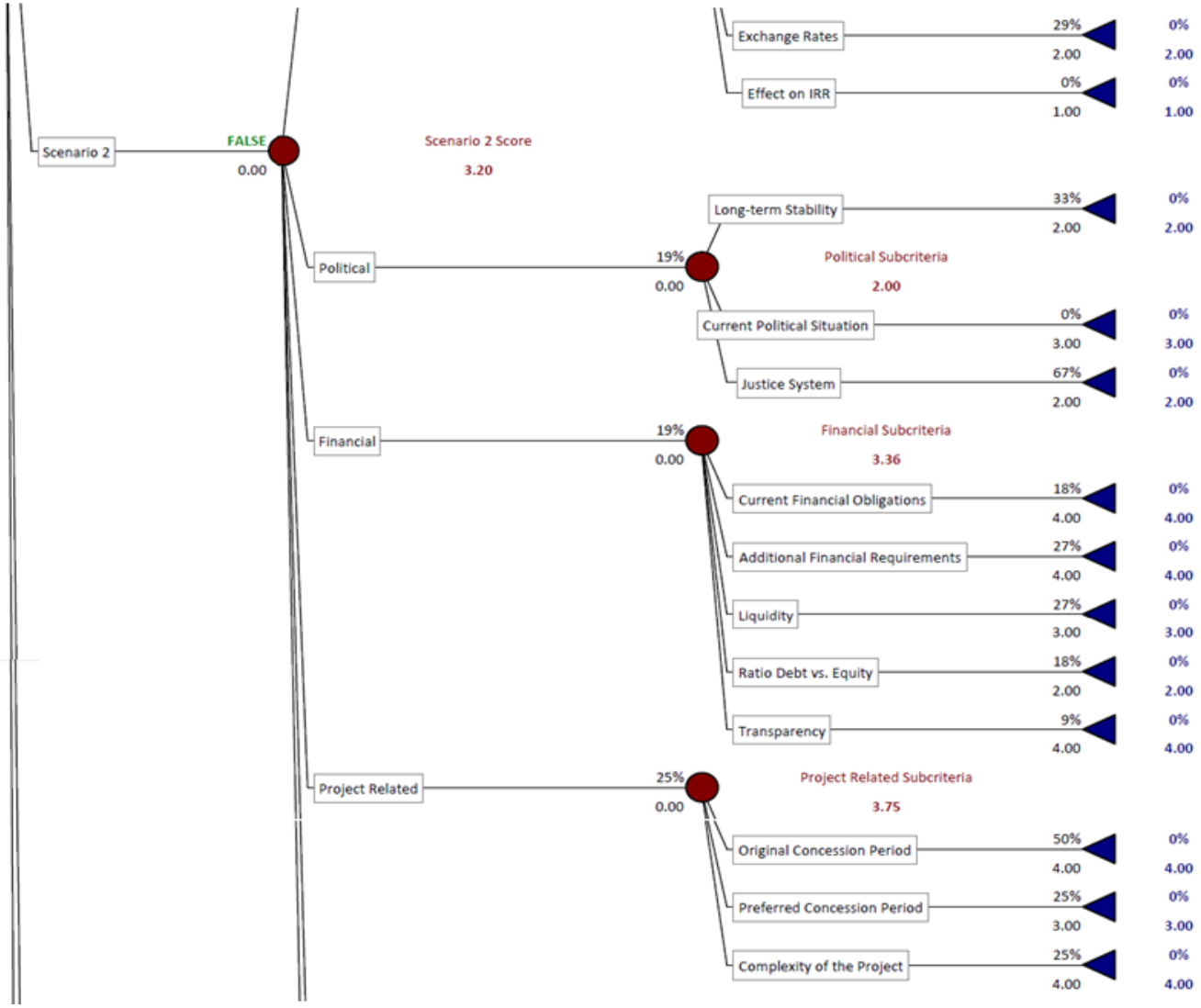
Public Sector Decision Tree and Expected Monetary Value (EMV) Calculations:



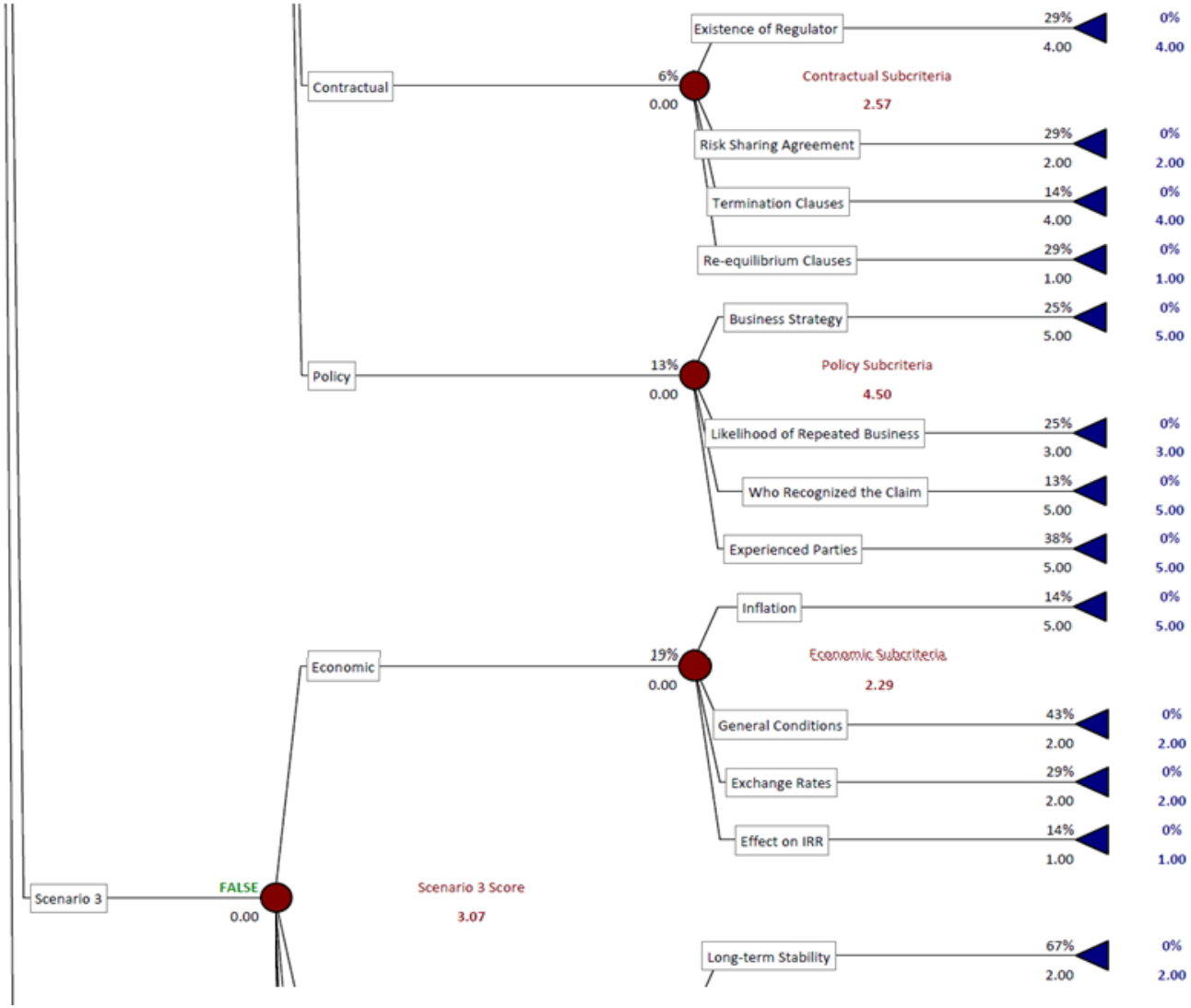
Model Screenshot 56: Reports Section (Cont.)



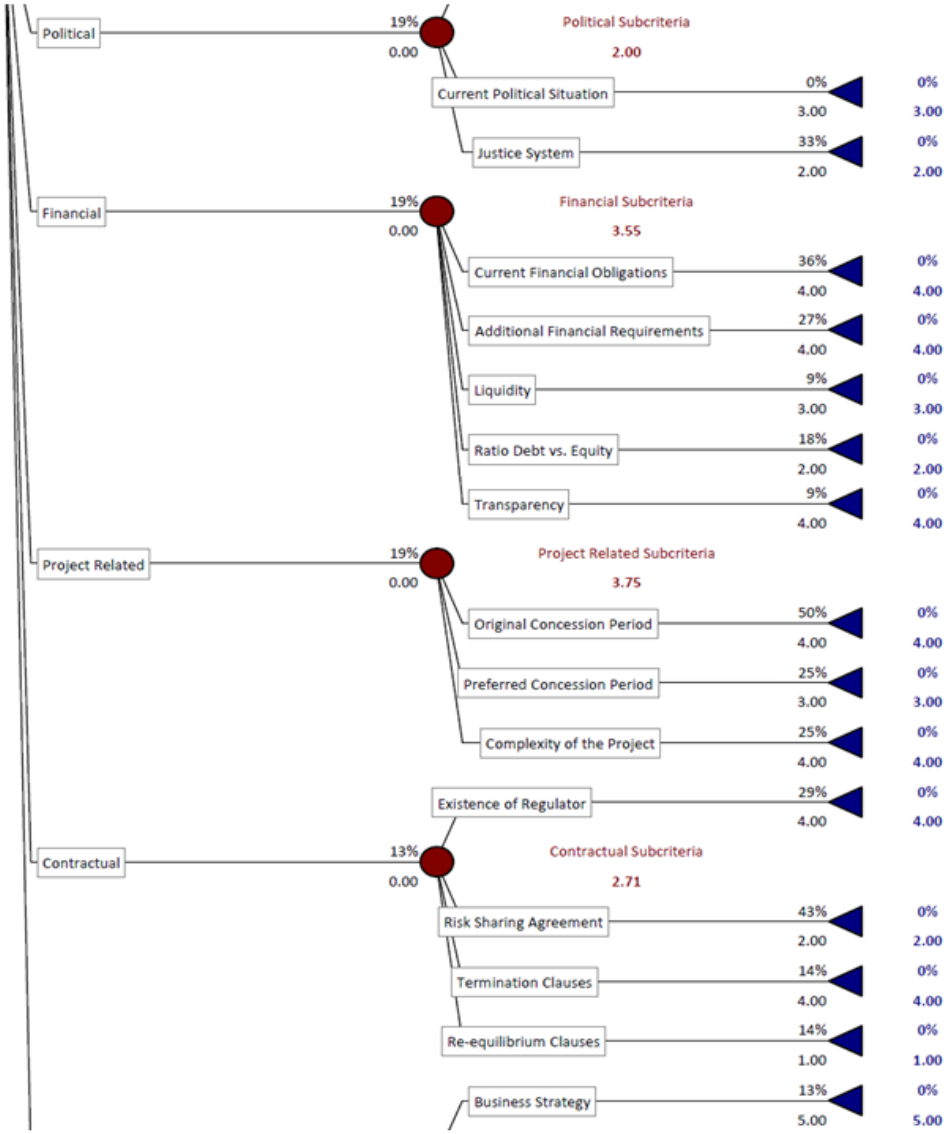
Model Screenshot 57: Reports Section (Cont.)



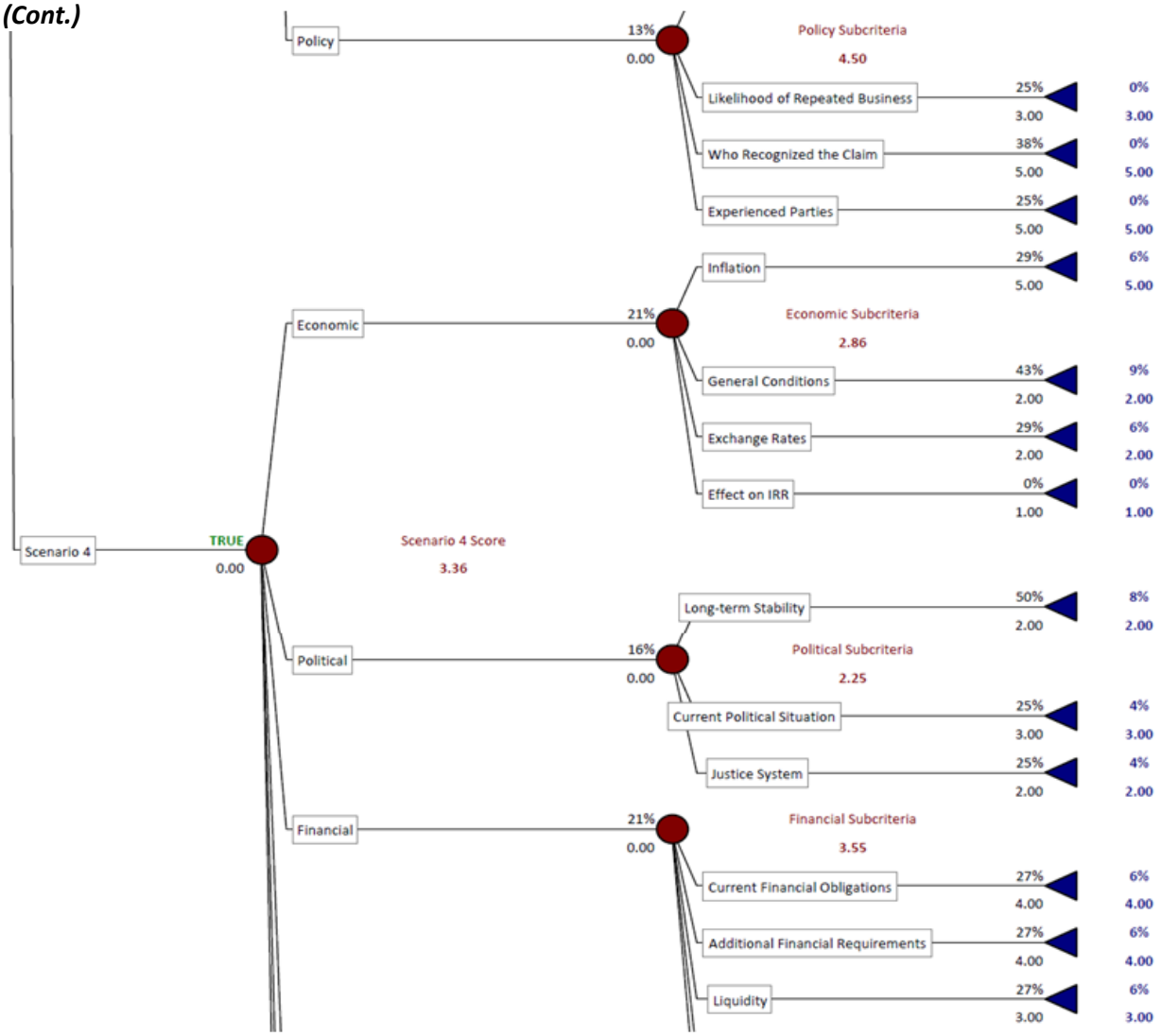
Model Screenshot 58: Reports Section (Cont.)



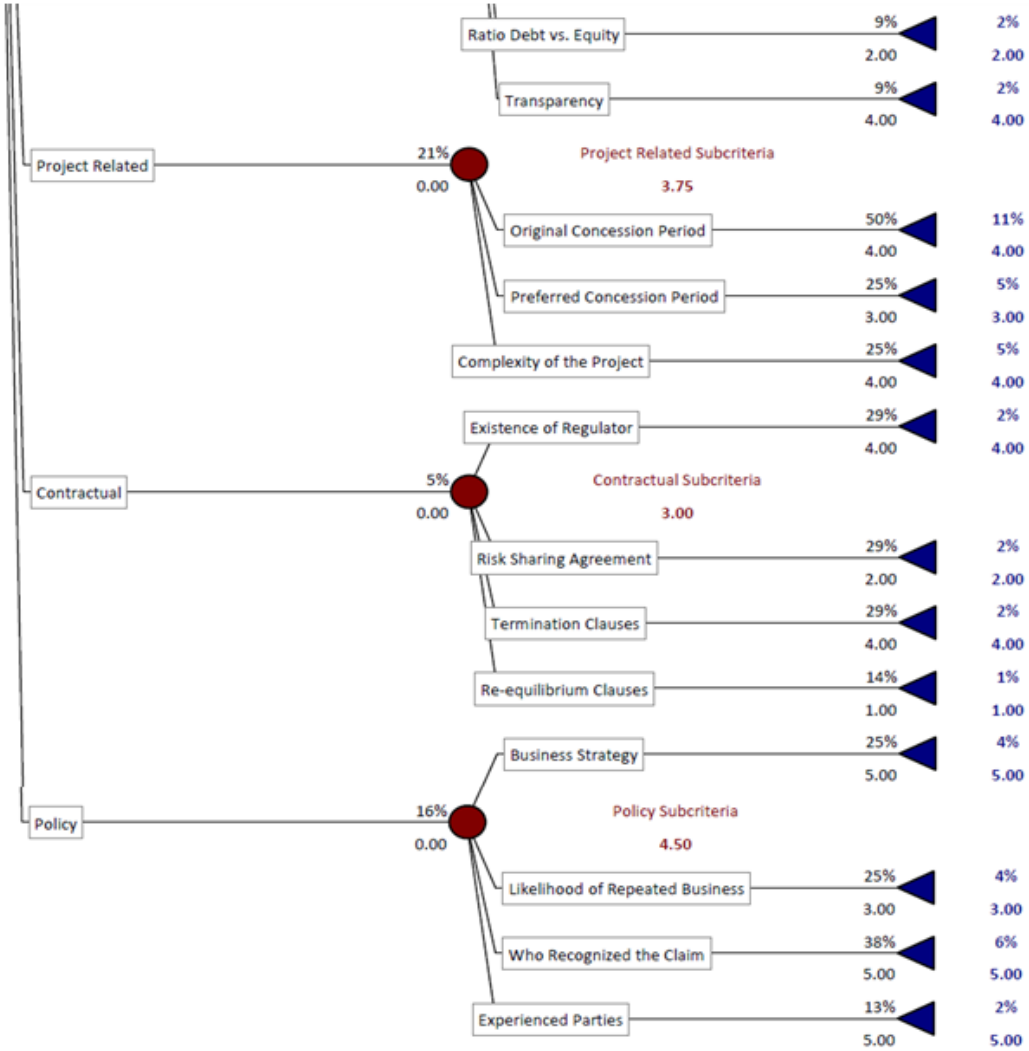
Model Screenshot 59: Reports Section (Cont.)



Model Screenshot 60: Reports Section (Cont.)

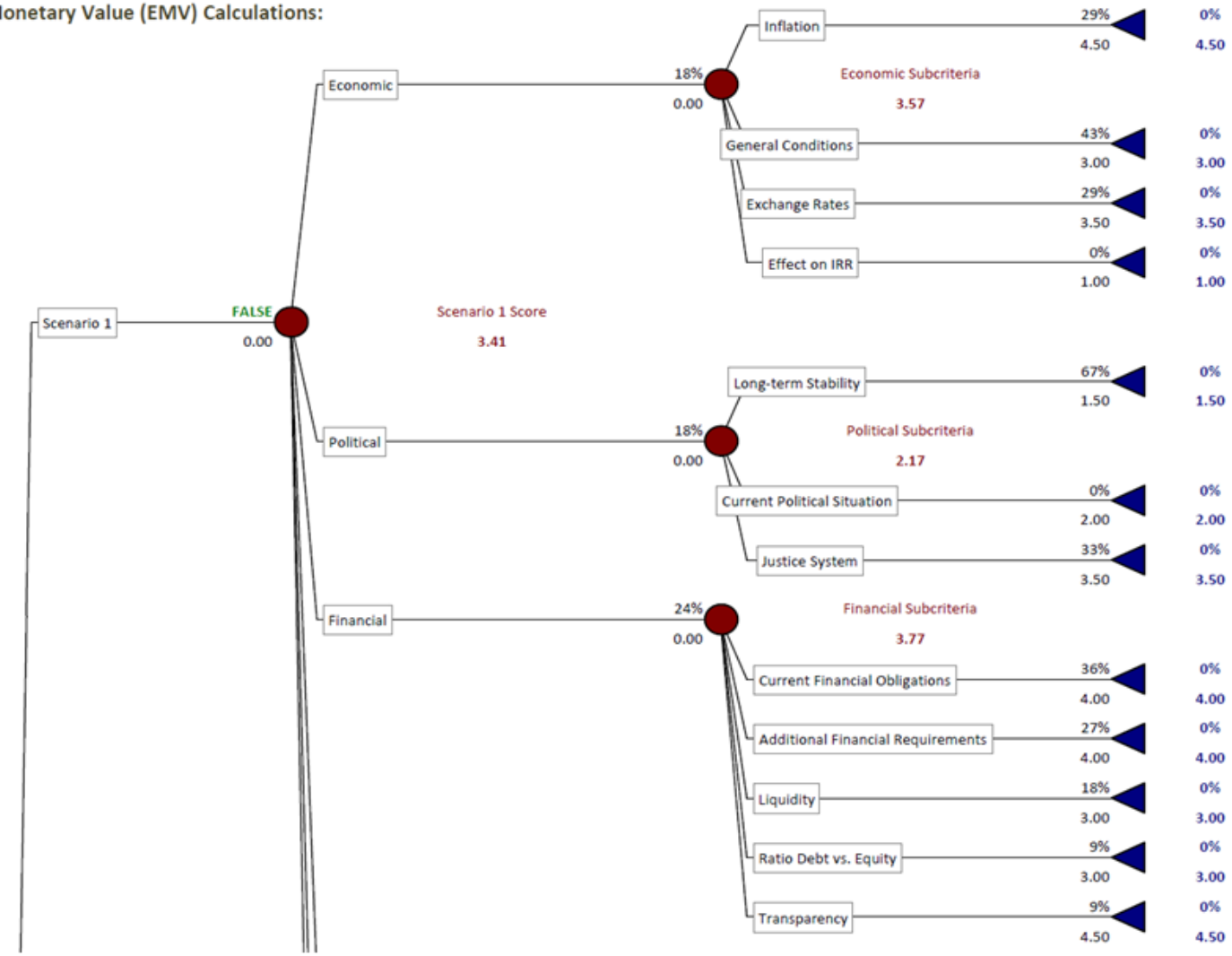


Model Screenshot 61: Reports Section (Cont.)

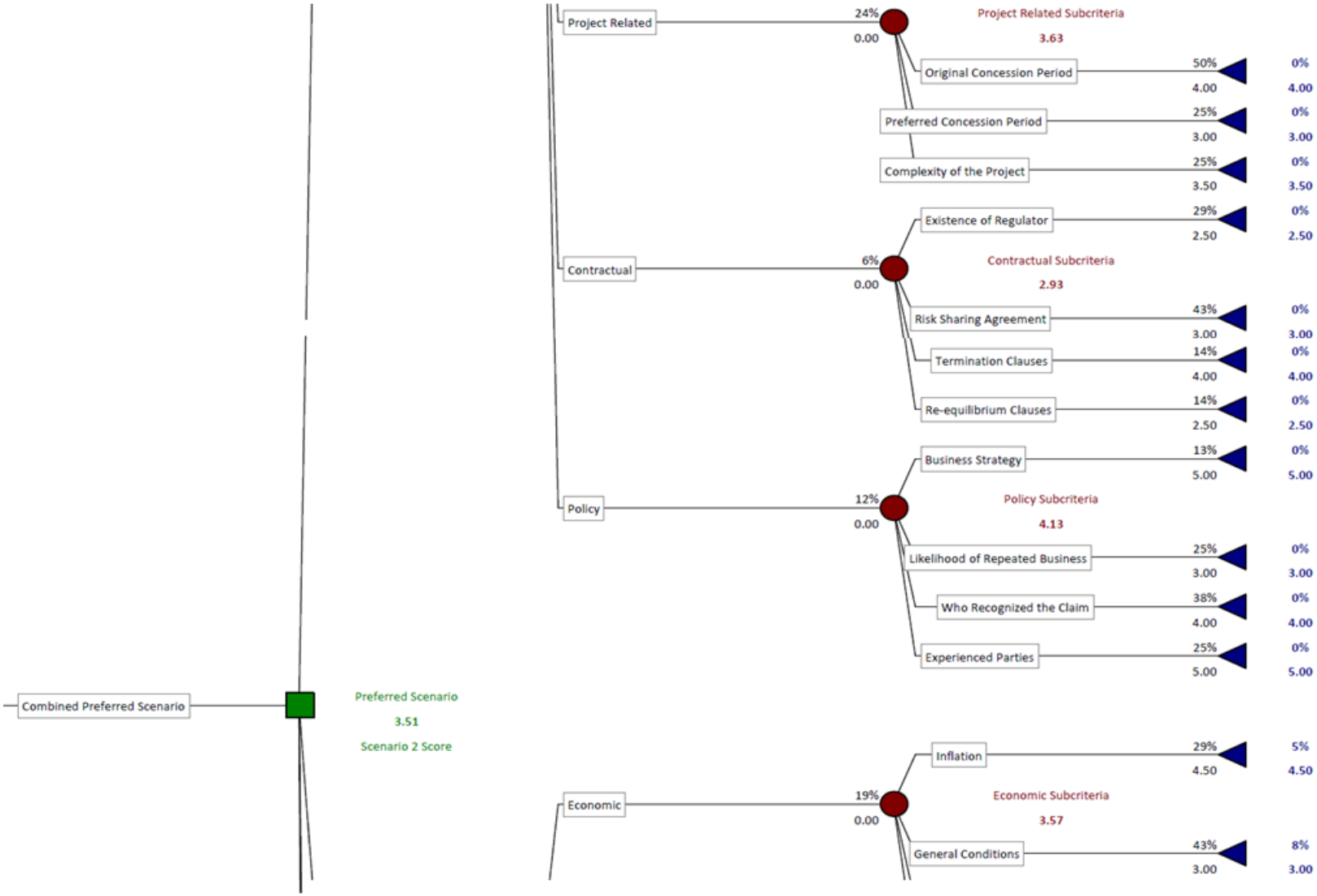


Model Screenshot 62: Reports Section (Cont.)

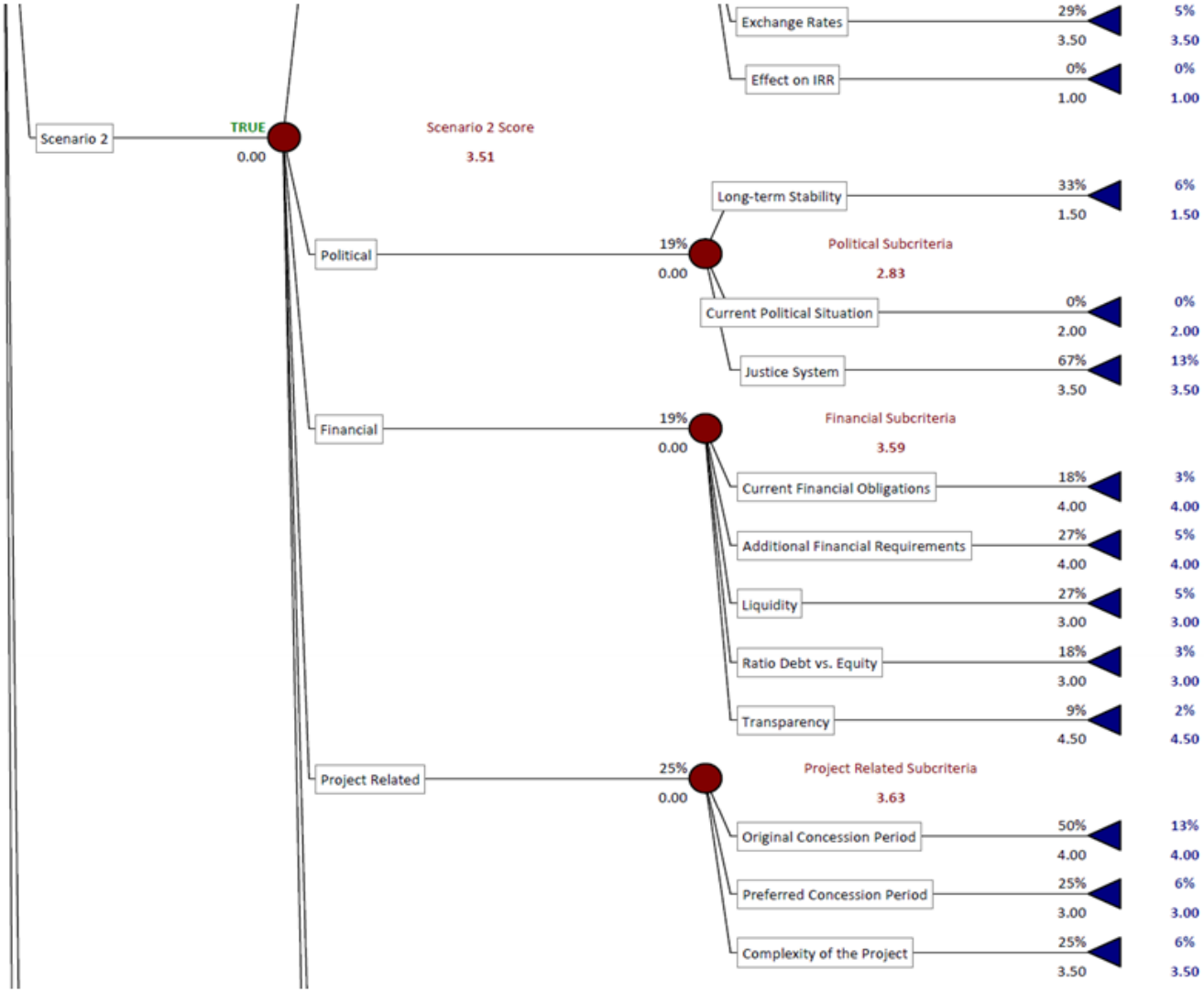
Combined Decision Tree and Expected Monetary Value (EMV) Calculations:



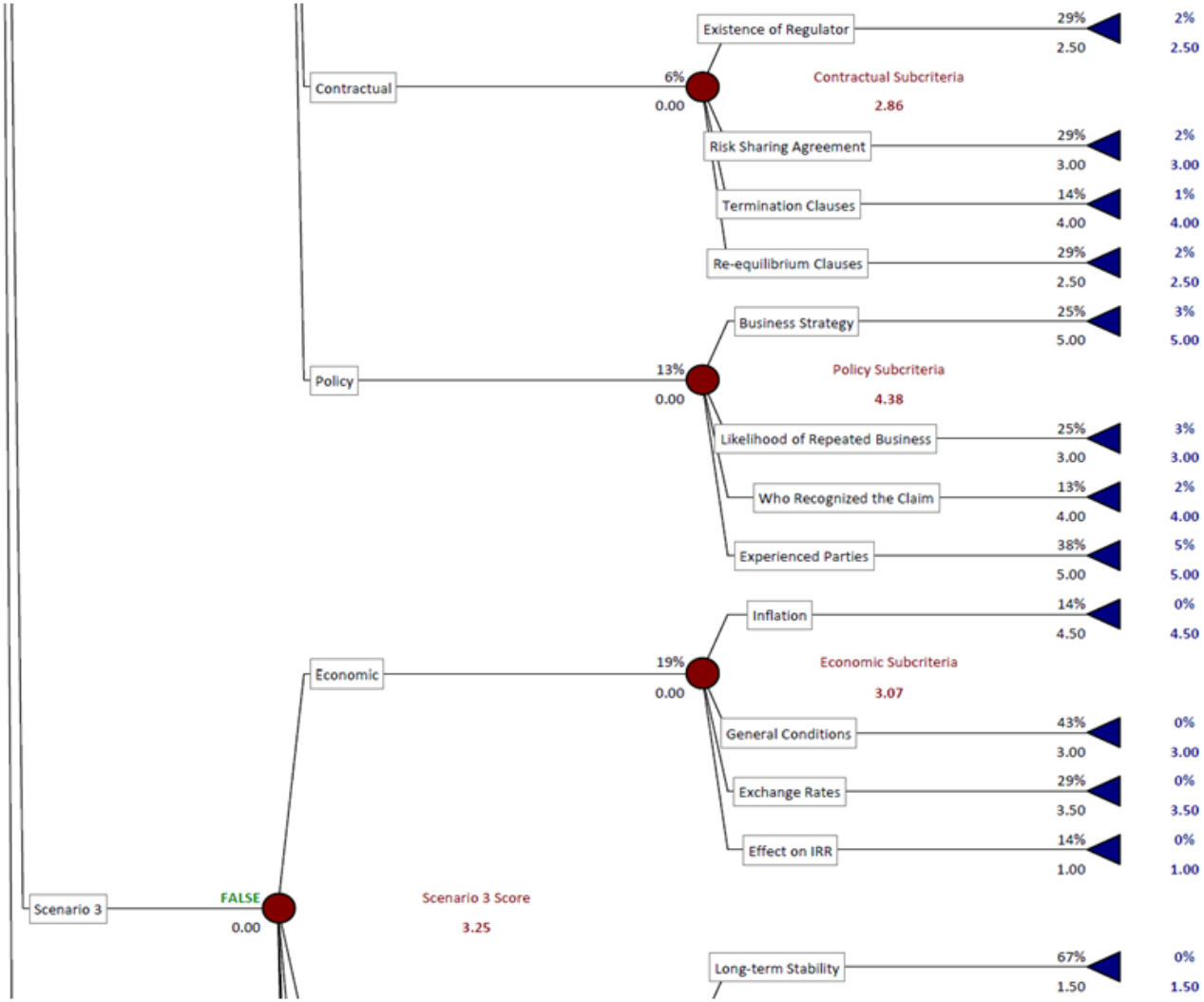
Model Screenshot 63: Reports Section (Cont.)



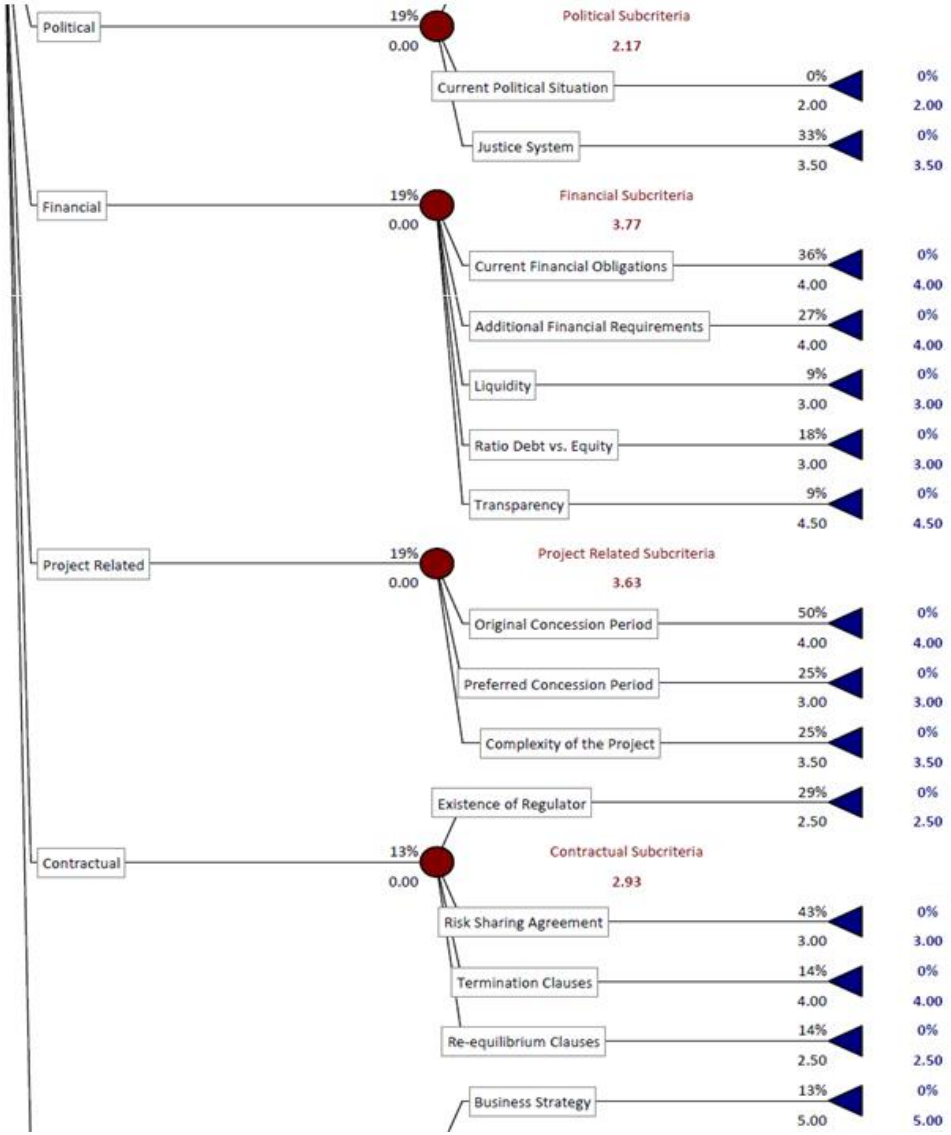
Model Screenshot 64: Reports Section (Cont.)



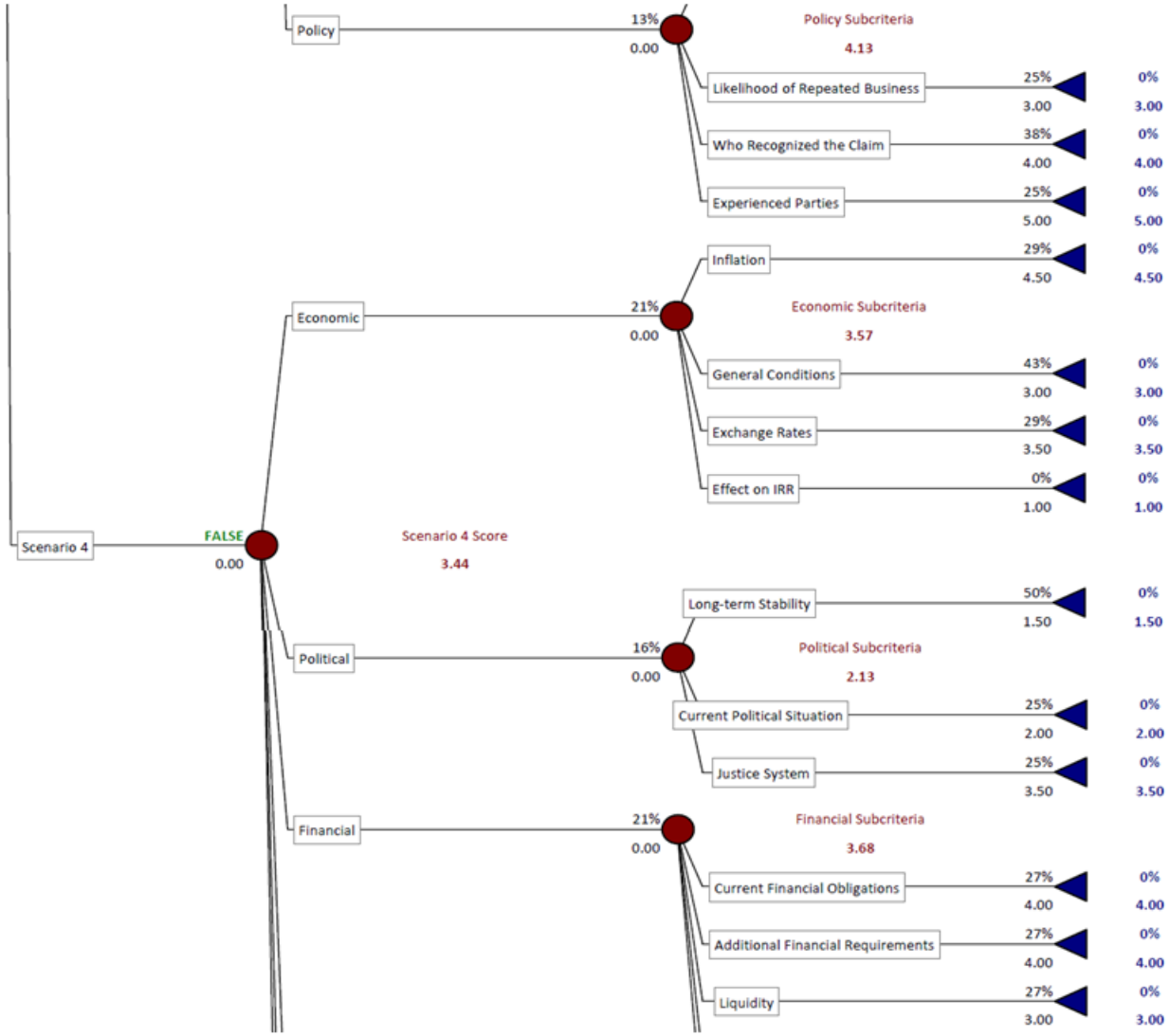
Model Screenshot 65: Reports Section (Cont.)



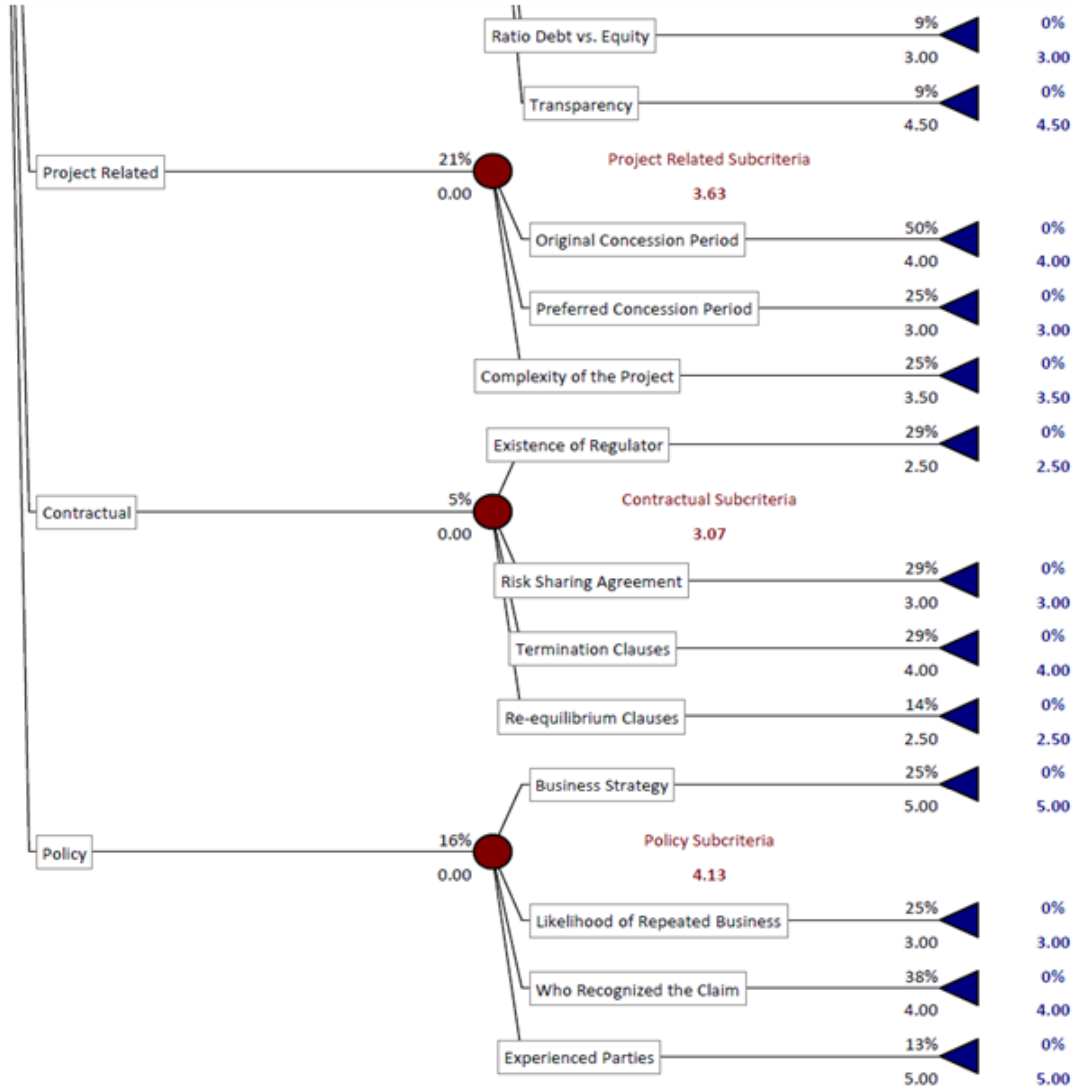
Model Screenshot 66: Reports Section (Cont.)



Model Screenshot 67: Reports Section (Cont.)



Model Screenshot 68: Reports Section (Cont.)



Model Screenshot 69: Reports Section (Cont.)

PrecisionTree Risk Profile - Probability Chart

Performed By: Amira Shalaby
Date: Sunday, May 25, 2014 3:30:46 PM
Model: Decision Tree 'Private Sector Preferred Scenario' in [Decission Support System v26.xlsm]Decision Tree (EMV) - Pr
Analysis: Choice Comparison for Node 'Preferred Scenario' (C66)

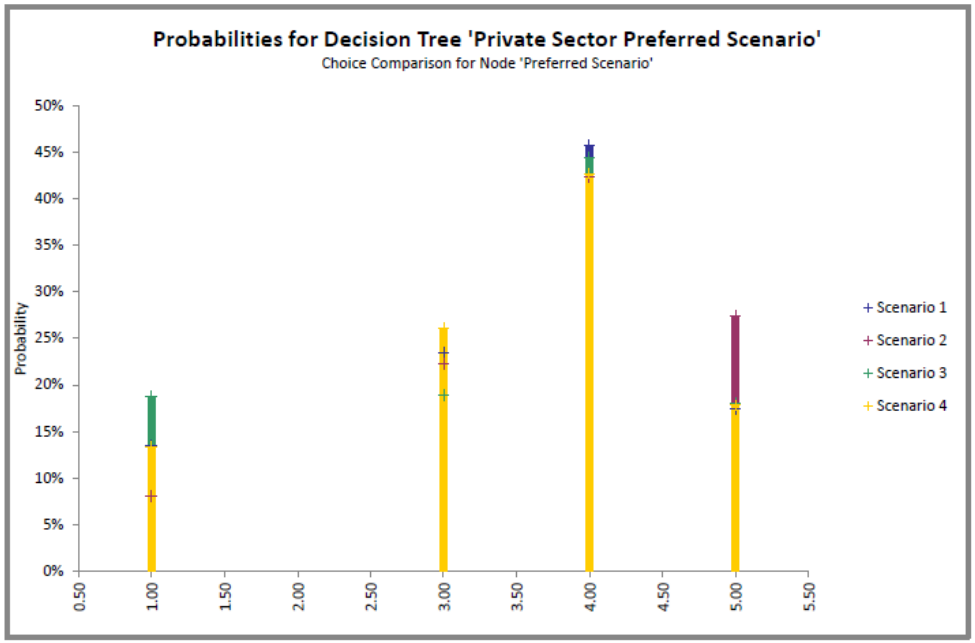


Chart Data

	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
	Value	Probability	Value	Probability	Value	Probability	Value	Probability
#1	1.00	13%	1.00	8%	1.00	19%	1.00	13%
#2	3.00	23%	3.00	22%	3.00	19%	3.00	26%
#3	4.00	46%	4.00	42%	4.00	44%	4.00	43%
#4	5.00	17%	5.00	27%	5.00	18%	5.00	18%

Continue

Model Screenshot 70: Reports Section (Cont.)

PrecisionTree RiskProfile - Cumulative Chart

Performed By: Amira Shalaby
Date: Sunday, May 25, 2014 3:30:48 PM
Model: Decision Tree 'Private Sector Preferred Scenario' in [Decission Support System v26.xlsm]Decision Tree (EMV) - Pr
Analysis: Choice Comparison for Node 'Preferred Scenario' (C66)

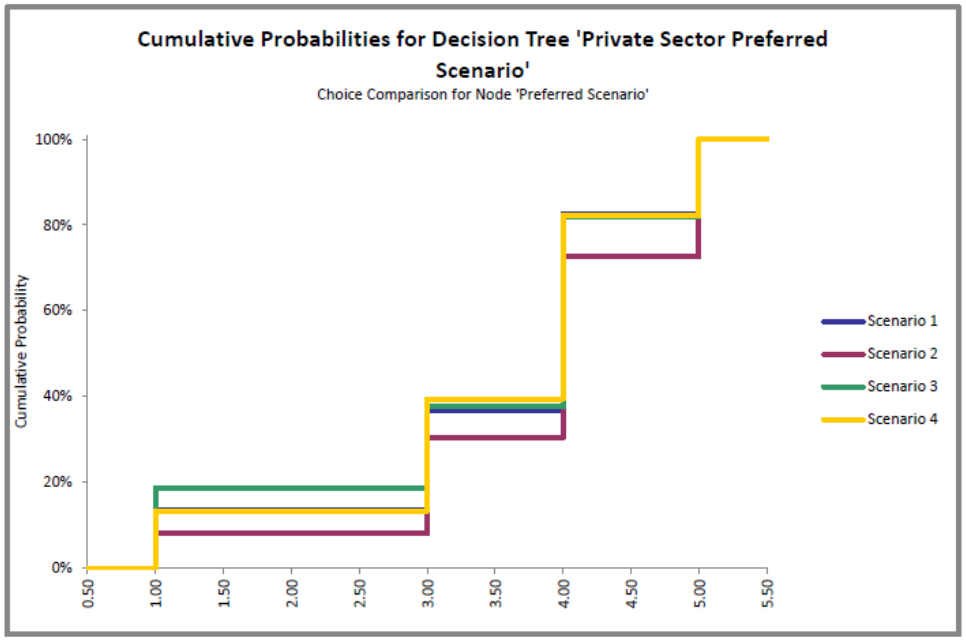


Chart Data

	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
	Value	Probability	Value	Probability	Value	Probability	Value	Probability
#1	-Infinity	0%	-Infinity	0%	-Infinity	0%	-Infinity	0%
#2	1.00	0%	1.00	0%	1.00	0%	1.00	0%
#3	1.00	13%	1.00	8%	1.00	19%	1.00	13%
#4	3.00	13%	3.00	8%	3.00	19%	3.00	13%
#5	3.00	37%	3.00	30%	3.00	38%	3.00	39%
#6	4.00	37%	4.00	30%	4.00	38%	4.00	39%
#7	4.00	83%	4.00	73%	4.00	82%	4.00	82%
#8	5.00	83%	5.00	73%	5.00	82%	5.00	82%
#9	5.00	100%	5.00	100%	5.00	100%	5.00	100%
#10	Infinity	100%	Infinity	100%	Infinity	100%	Infinity	100%

Continue

Model Screenshot 71: Reports Section (Cont.)

PrecisionTree Risk Profile - Statistical Summary

Performed By: Amira Shalaby
Date: Sunday, May 25, 2014 3:30:48 PM
Model: Decision Tree 'Private Sector Preferred Scenario' in [Decission Support System v26.xlsm]Decision Tree (EMV) - Pr
Analysis: Choice Comparison for Node 'Preferred Scenario' (C66)

Statistics	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Mean	3.54	3.81	3.43	3.52
Minimum	1.00	1.00	1.00	1.00
Maximum	5.00	5.00	5.00	5.00
Mode	4.00	4.00	4.00	4.00
Std. Deviation	1.19	1.09	1.32	1.19
Skewness	-0.9855	-1.1150	-0.8436	-0.9187
Kurtosis	3.2499	4.0348	2.5643	3.1620

Continue

PrecisionTree Policy Suggestion - Decision Table

Performed By: Amira Shalaby
Date: Sunday, May 25, 2014 3:42:36 PM
Model: Decision Tree 'Private Sector Preferred Scenario' in [Decission Support System v26.xlsm]Decision Tree (EMV) - Pr

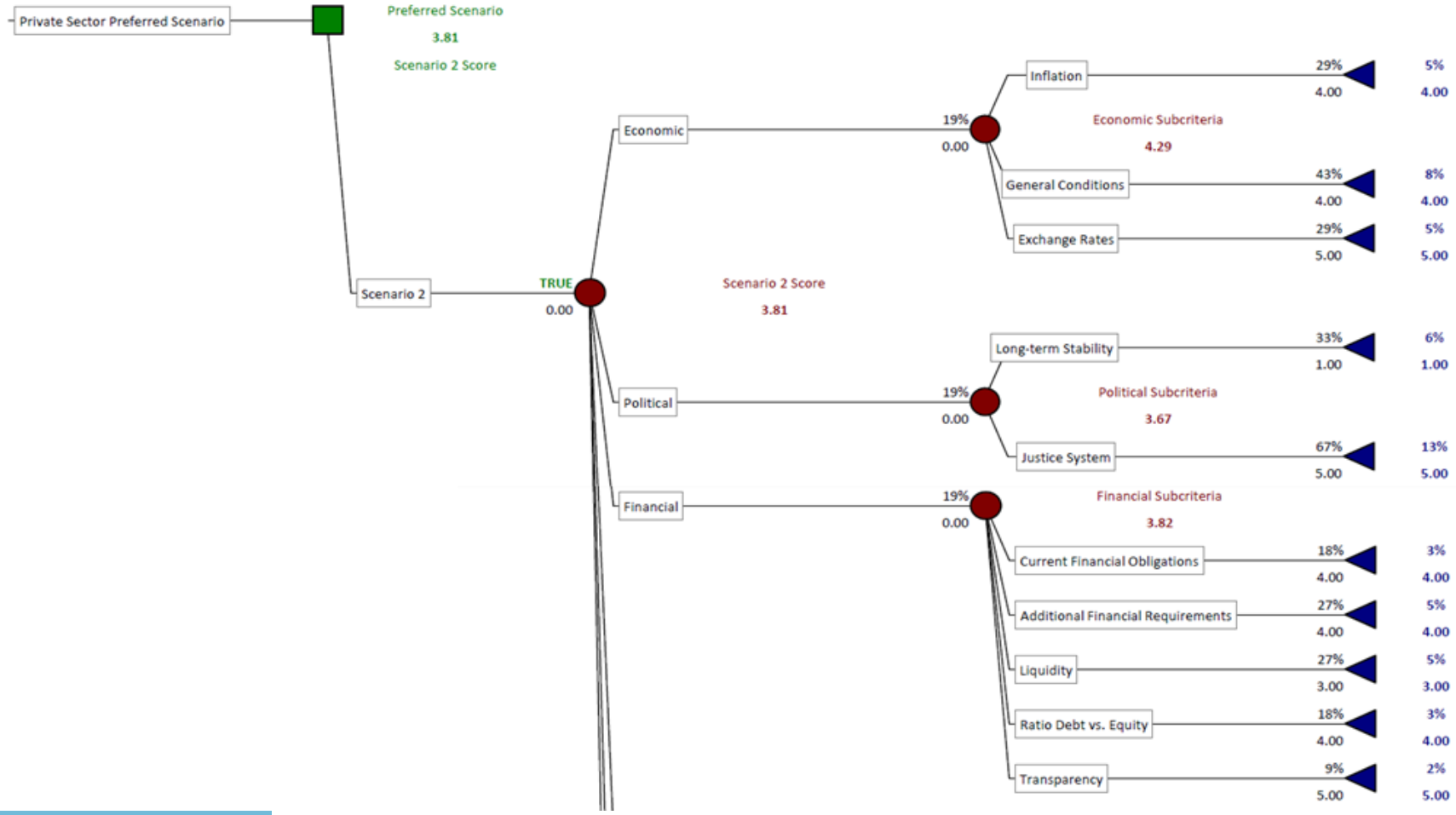
Decision	Optimal Choice	Arrival Probability	Benefit of Correct Choice
'Preferred Scenario' (C66)	Scenario 2	100%	0.38

Continue

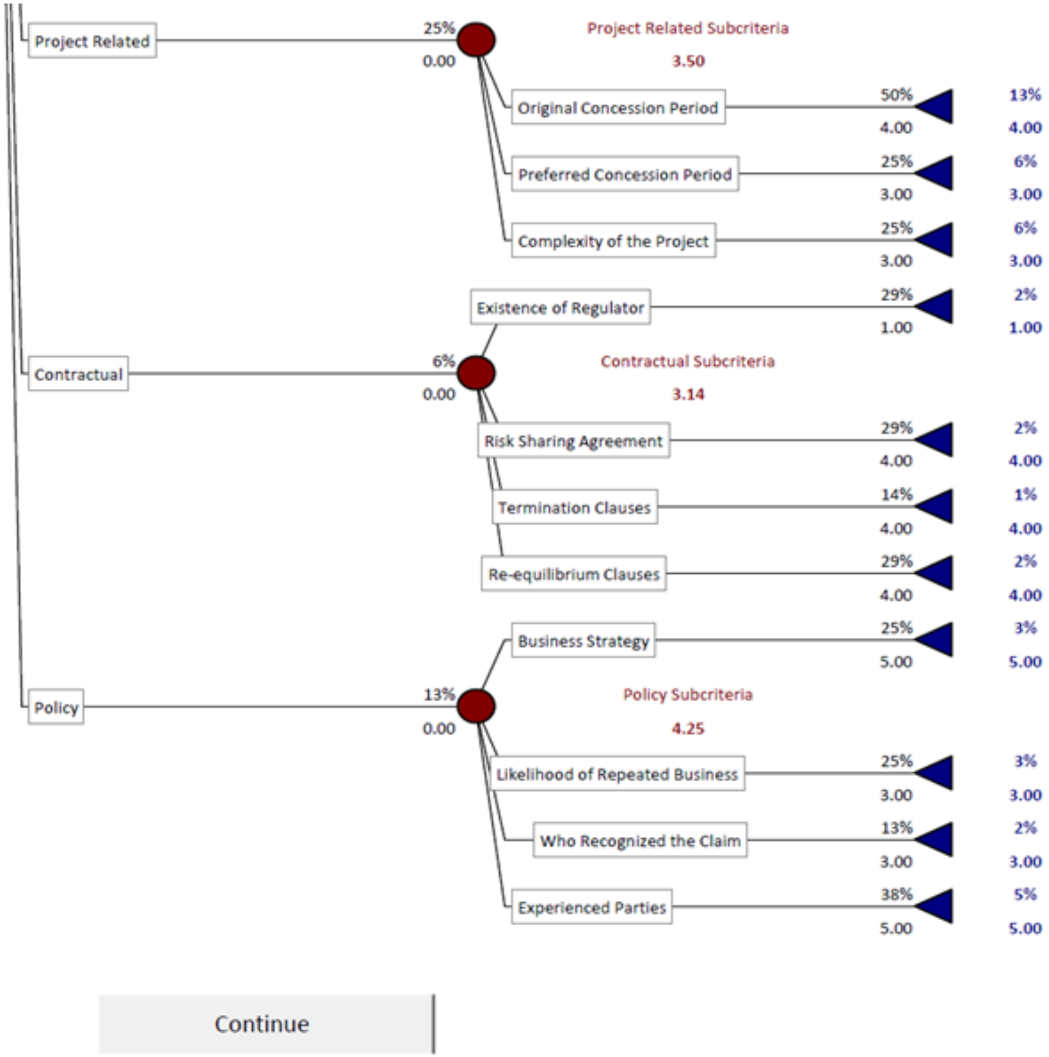
Model Screenshot 72: Reports Section (Cont.)

PrecisionTree Policy Suggestion - Optimal Decision Tree

Performed By: Amira Shalaby
Date: Sunday, May 25, 2014 3:42:36 PM
Model: Decision Tree 'Private Sector Preferred Scenario' in [Decission Support System v26.xlsm]Decision Tree (EMV) - Pr



Model Screenshot 73: Reports Section (Cont.)



Model Screenshot 74: Reports Section (Cont.)

PrecisionTree Risk Profile - Probability Chart

Performed By: Amira Shalaby
Date: Sunday, May 25, 2014 3:47:33 PM
Model: Decision Tree 'Public Sector Preferred Scenario' in [Decission Support System v26.xlsm]Decision Tree (EMV) - Pu
Analysis: Choice Comparison for Node 'Preferred Scenario' (C66)

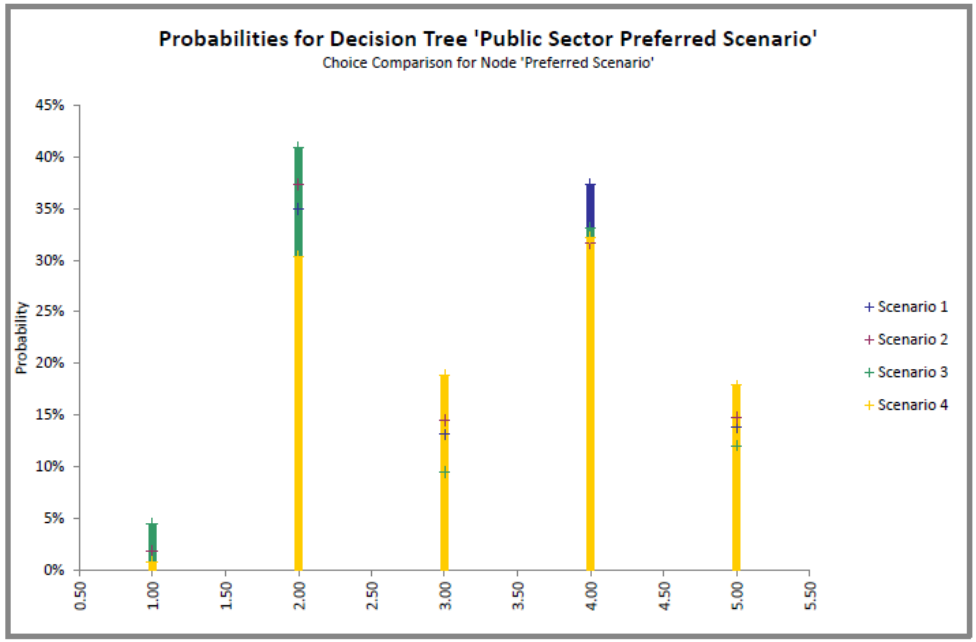


Chart Data

	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
	Value	Probability	Value	Probability	Value	Probability	Value	Probability
#1	1.00	1%	1.00	2%	1.00	4%	1.00	1%
#2	2.00	35%	2.00	37%	2.00	41%	2.00	30%
#3	3.00	13%	3.00	14%	3.00	10%	3.00	19%
#4	4.00	37%	4.00	32%	4.00	33%	4.00	32%
#5	5.00	14%	5.00	15%	5.00	12%	5.00	18%

Continue

Model Screenshot 75: Reports Section (Cont.)

PrecisionTree RiskProfile - Cumulative Chart

Performed By: Amira Shalaby
Date: Sunday, May 25, 2014 3:47:34 PM
Model: Decision Tree 'Public Sector Preferred Scenario' in [Decission Support System v26.xlsm]Decision Tree (EMV) - Pu
Analysis: Choice Comparison for Node 'Preferred Scenario' (C66)

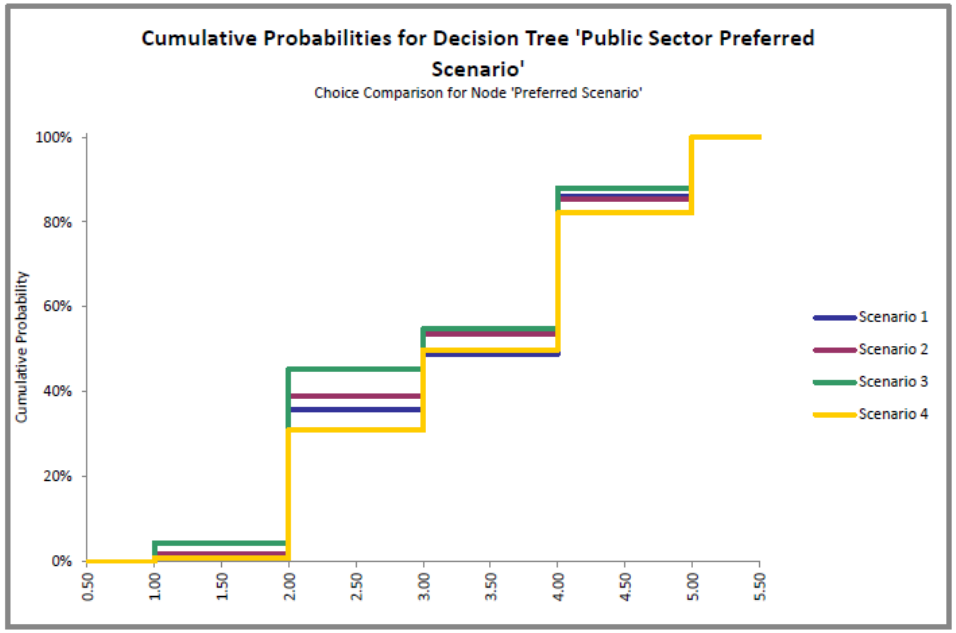


Chart Data

	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
	Value	Probability	Value	Probability	Value	Probability	Value	Probability
#1	-Infinity	0%	-Infinity	0%	-Infinity	0%	-Infinity	0%
#2	1.00	0%	1.00	0%	1.00	0%	1.00	0%
#3	1.00	1%	1.00	2%	1.00	4%	1.00	1%
#4	2.00	1%	2.00	2%	2.00	4%	2.00	1%
#5	2.00	36%	2.00	39%	2.00	45%	2.00	31%
#6	3.00	36%	3.00	39%	3.00	45%	3.00	31%
#7	3.00	49%	3.00	54%	3.00	55%	3.00	50%
#8	4.00	49%	4.00	54%	4.00	55%	4.00	50%
#9	4.00	86%	4.00	85%	4.00	88%	4.00	82%
#10	5.00	86%	5.00	85%	5.00	88%	5.00	82%
#11	5.00	100%	5.00	100%	5.00	100%	5.00	100%
#12	Infinity	100%	Infinity	100%	Infinity	100%	Infinity	100%

Continue

Model Screenshot 76: Reports Section (Cont.)

PrecisionTree Risk Profile - Statistical Summary

Performed By: Amira Shalaby
Date: Sunday, May 25, 2014 3:47:34 PM
Model: Decision Tree 'Public Sector Preferred Scenario' in [Decission Support System v26.xlsm]Decision Tree (EMV) - Pu
Analysis: Choice Comparison for Node 'Preferred Scenario' (C66)

Statistics	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Mean	3.28	3.20	3.07	3.36
Minimum	1.00	1.00	1.00	1.00
Maximum	5.00	5.00	5.00	5.00
Mode	4.00	2.00	2.00	4.00
Std. Deviation	1.11	1.14	1.18	1.11
Skewness	-0.0040	0.1177	0.1345	-0.0012
Kurtosis	1.6400	1.6714	1.6817	1.7061

Continue

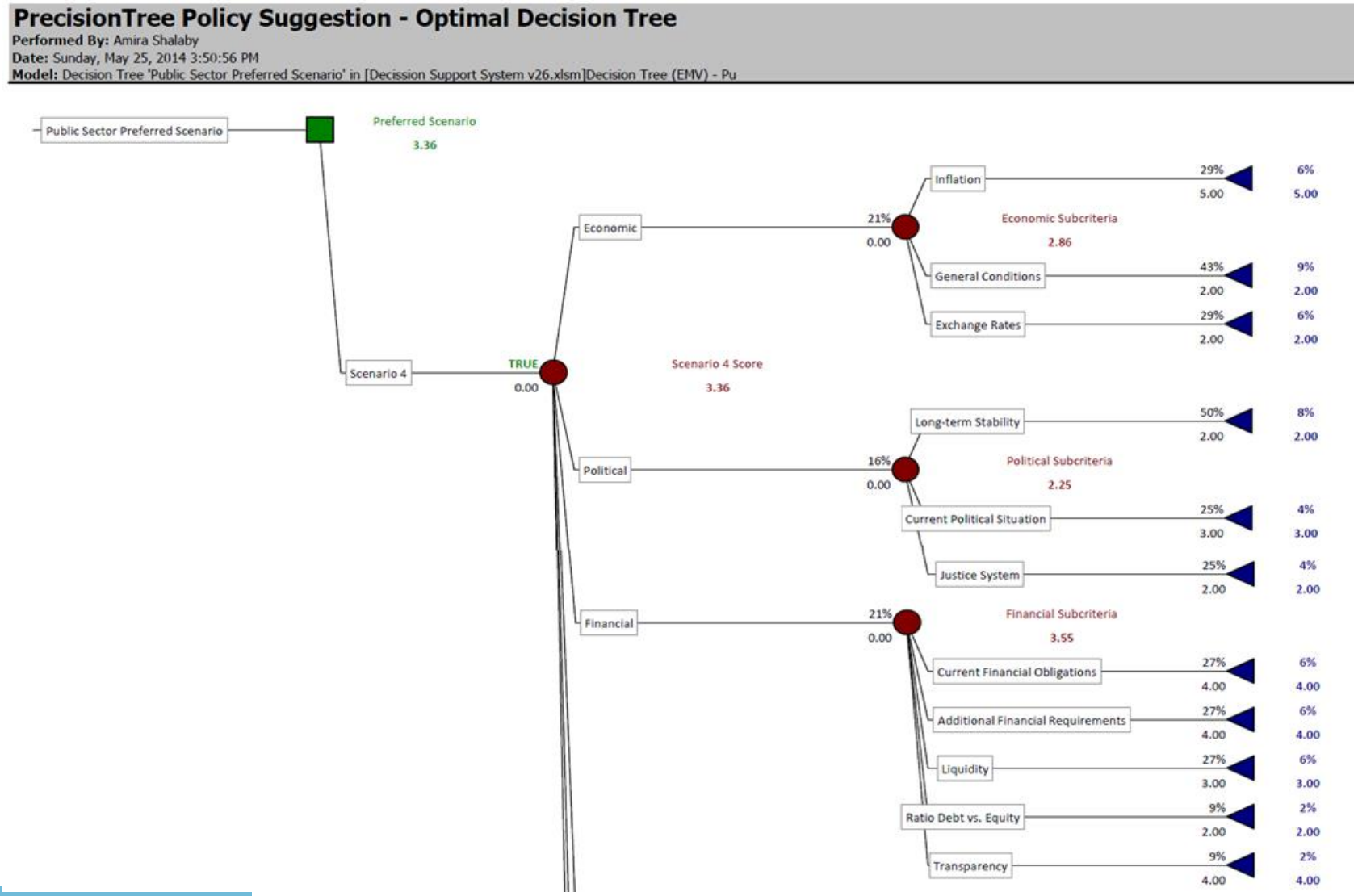
PrecisionTree Policy Suggestion - Decision Table

Performed By: Amira Shalaby
Date: Sunday, May 25, 2014 3:50:56 PM
Model: Decision Tree 'Public Sector Preferred Scenario' in [Decission Support System v26.xlsm]Decision Tree (EMV) - Pu

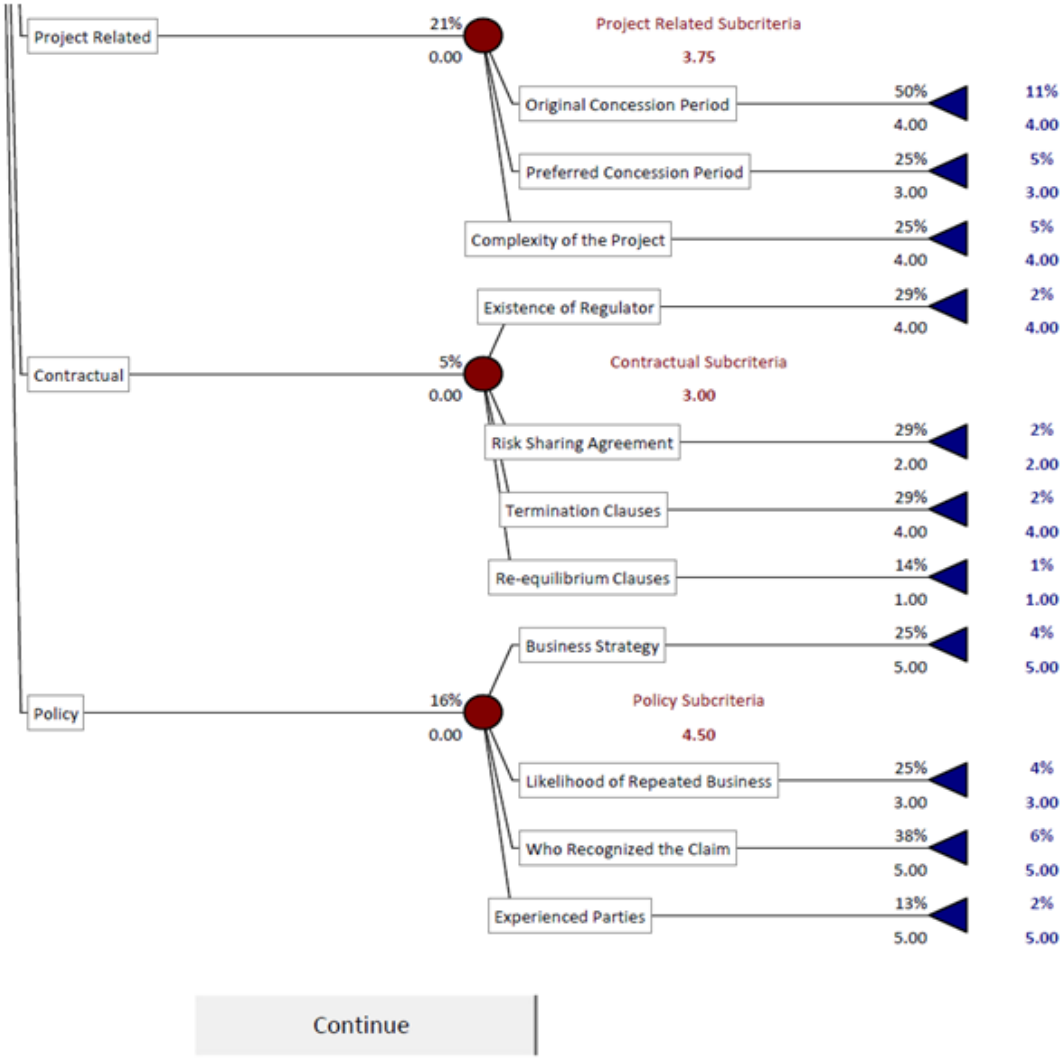
Decision	Optimal Choice	Arrival Probability	Benefit of Correct Choice
'Preferred Scenario' (C66)	Scenario 4	100%	0.29

Continue

Model Screenshot 77: Reports Section (Cont.)



Model Screenshot 78: Reports Section (Cont.)



Model Screenshot 79: Reports Section (Cont.)

PrecisionTree Risk Profile - Probability Chart

Performed By: Amira Shalaby
Date: Sunday, May 25, 2014 3:51:53 PM
Model: Decision Tree 'Combined Preferred Scenario' in [Decission Support System v26.xlsm]Decision Tree (EMV) - Combined
Analysis: Choice Comparison for Node 'Preferred Scenario' (C66)

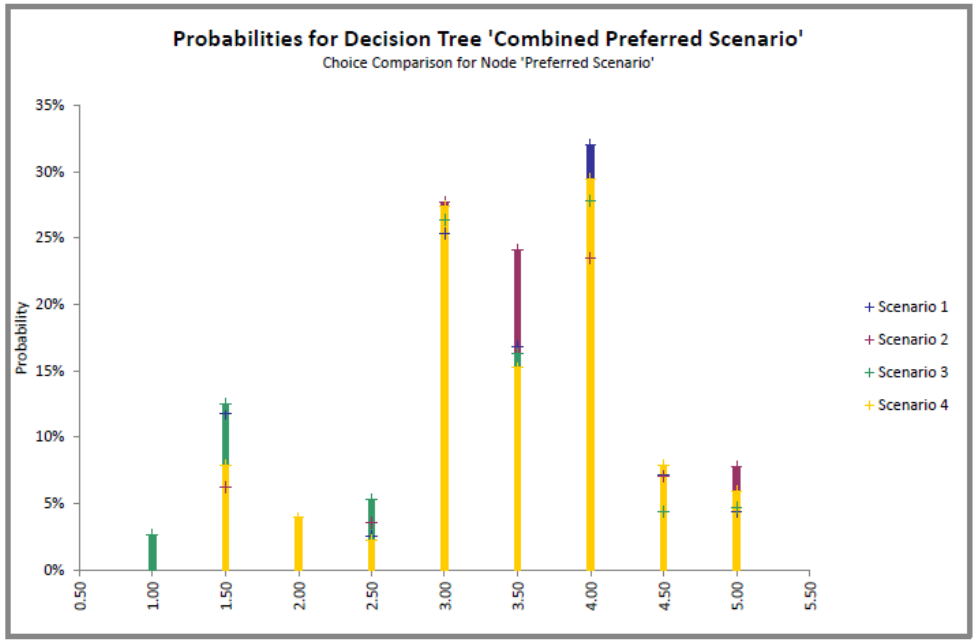


Chart Data

	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
	Value	Probability	Value	Probability	Value	Probability	Value	Probability
#1	1.50	12%	1.50	6%	1.00	3%	1.50	8%
#2	2.50	3%	2.50	4%	1.50	13%	2.00	4%
#3	3.00	25%	3.00	28%	2.50	5%	2.50	2%
#4	3.50	17%	3.50	24%	3.00	26%	3.00	27%
#5	4.00	32%	4.00	23%	3.50	16%	3.50	15%
#6	4.50	7%	4.50	7%	4.00	28%	4.00	29%
#7	5.00	4%	5.00	8%	4.50	4%	4.50	8%
#8					5.00	5%	5.00	6%

Continue

Model Screenshot 80: Reports Section (Cont.)

PrecisionTree RiskProfile - Cumulative Chart

Performed By: Amira Shalaby
Date: Sunday, May 25, 2014 3:51:53 PM
Model: Decision Tree 'Combined Preferred Scenario' in [Decission Support System v26.xlsm]Decision Tree (EMV) - Combined
Analysis: Choice Comparison for Node 'Preferred Scenario' (C66)

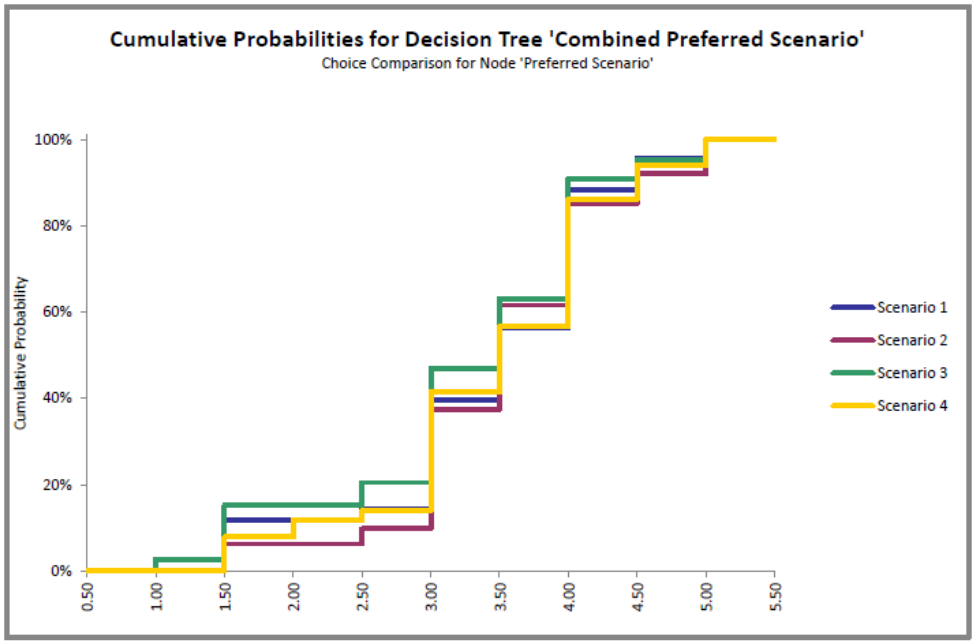


Chart Data

	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
	Value	Probability	Value	Probability	Value	Probability	Value	Probability
#1	-Infinity	0%	-Infinity	0%	-Infinity	0%	-Infinity	0%
#2	1.50	0%	1.50	0%	1.00	0%	1.50	0%
#3	1.50	12%	1.50	6%	1.00	3%	1.50	8%
#4	2.50	12%	2.50	6%	1.50	3%	2.00	8%
#5	2.50	14%	2.50	10%	1.50	15%	2.00	12%
#6	3.00	14%	3.00	10%	2.50	15%	2.50	12%
#7	3.00	40%	3.00	38%	2.50	21%	2.50	14%
#8	3.50	40%	3.50	38%	3.00	21%	3.00	14%
#9	3.50	56%	3.50	62%	3.00	47%	3.00	41%
#10	4.00	56%	4.00	62%	3.50	47%	3.50	41%
#11	4.00	88%	4.00	85%	3.50	63%	3.50	57%
#12	4.50	88%	4.50	85%	4.00	63%	4.00	57%
#13	4.50	96%	4.50	92%	4.00	91%	4.00	86%
#14	5.00	96%	5.00	92%	4.50	91%	4.50	86%
#15	5.00	100%	5.00	100%	4.50	95%	4.50	94%
#16	Infinity	100%	Infinity	100%	5.00	95%	5.00	94%
#17					5.00	100%	5.00	100%
#18					Infinity	100%	Infinity	100%

Continue

Model Screenshot 81: Reports Section (Cont.)

PrecisionTree Risk Profile - Statistical Summary

Performed By: Amira Shalaby
Date: Sunday, May 25, 2014 3:51:53 PM
Model: Decision Tree 'Combined Preferred Scenario' in [Decission Support System v26.xlsm]Decision Tree (EMV) - Combined
Analysis: Choice Comparison for Node 'Preferred Scenario' (C66)

Statistics	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Mean	3.41	3.51	3.25	3.44
Minimum	1.50	1.50	1.00	1.50
Maximum	5.00	5.00	5.00	5.00
Mode	4.00	3.00	4.00	4.00
Std. Deviation	0.90	0.81	0.97	0.88
Skewness	-0.7265	-0.4072	-0.5977	-0.5279
Kurtosis	3.1295	3.5319	2.8242	2.9635

Continue

PrecisionTree Policy Suggestion - Decision Table

Performed By: Amira Shalaby
Date: Sunday, May 25, 2014 3:52:43 PM
Model: Decision Tree 'Combined Preferred Scenario' in [Decission Support System v26.xlsm]Decision Tree (EMV) - Combined

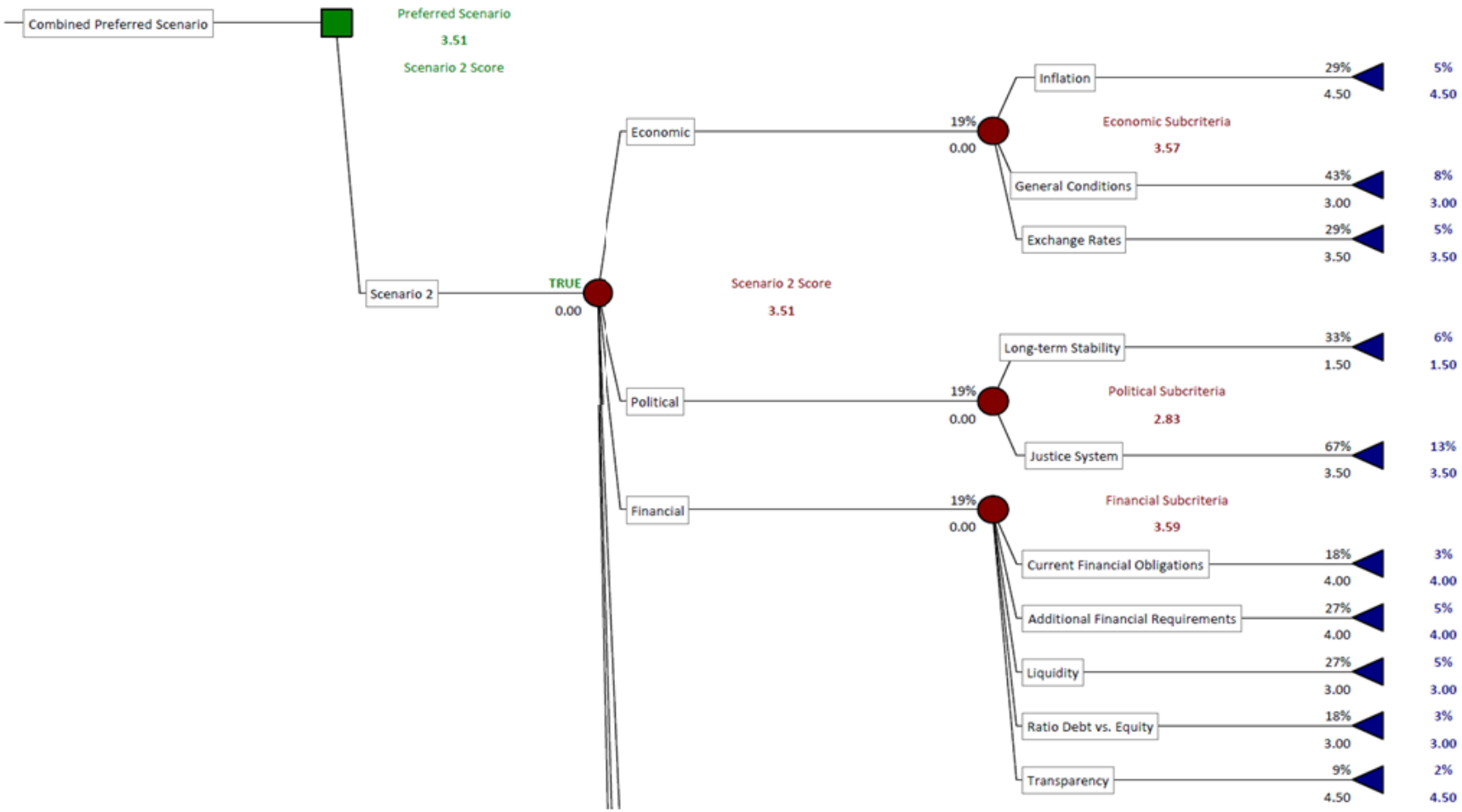
Decision	Optimal Choice	Arrival Probability	Benefit of Correct Choice
'Preferred Scenario' (C66)	Scenario 2	100%	0.25

Continue

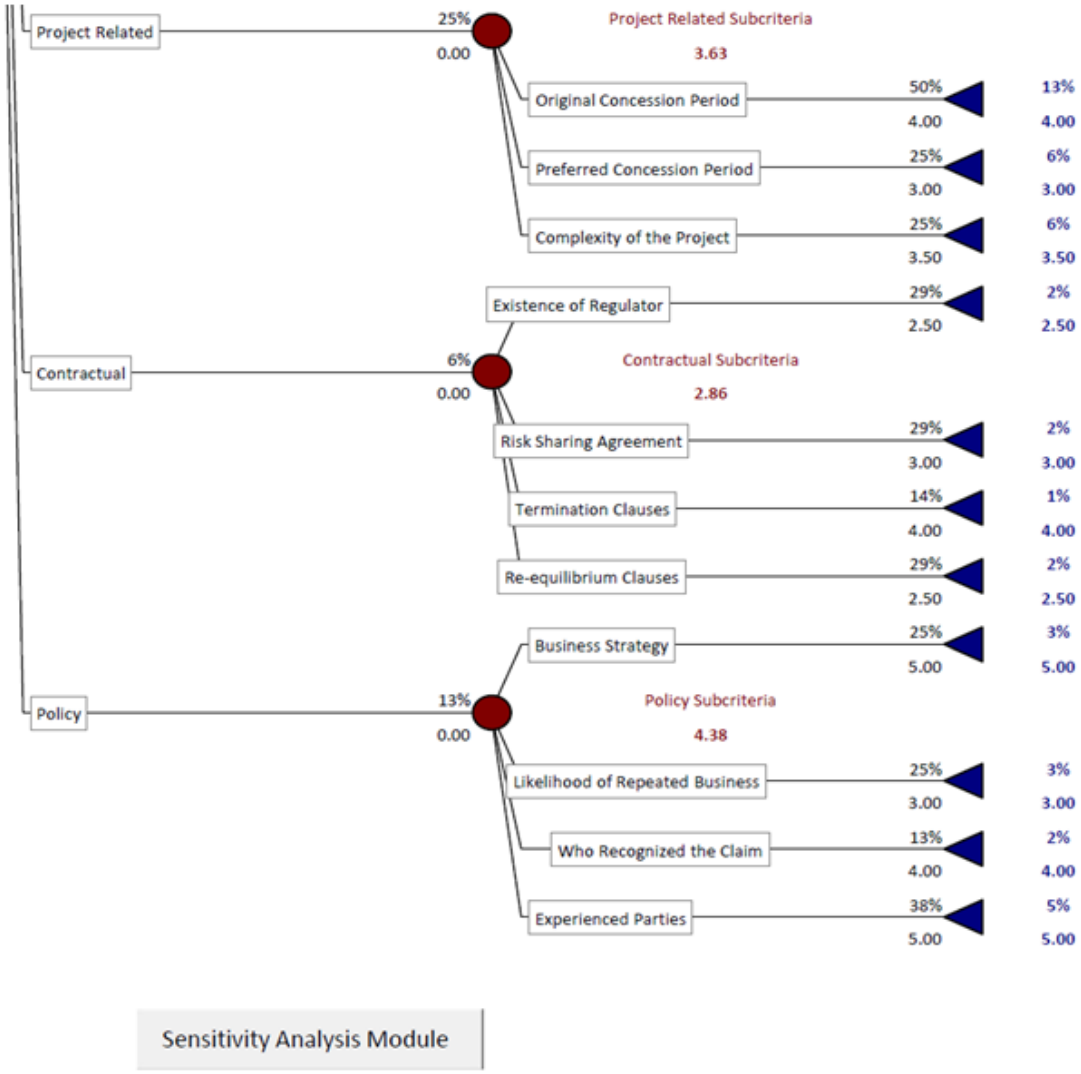
Model Screenshot 82: Reports Section (Cont.)

PrecisionTree Policy Suggestion - Optimal Decision Tree

Performed By: Amira Shalaby
Date: Sunday, May 25, 2014 3:52:43 PM
Model: Decision Tree 'Combined Preferred Scenario' in [Decission Support System v26.xlsm]Decision Tree (EMV) - Combined



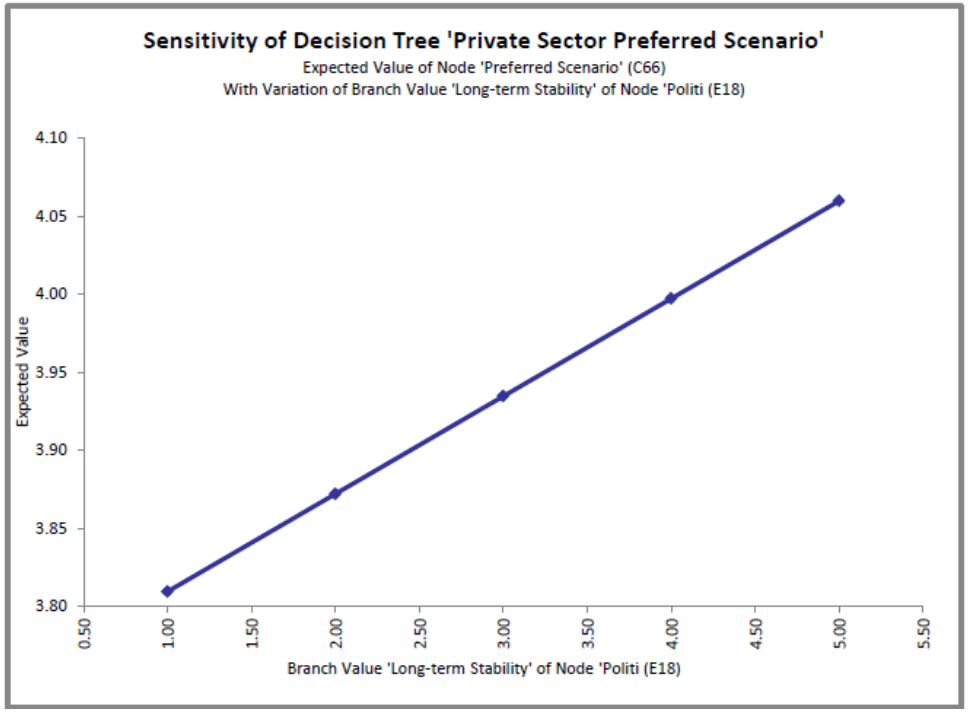
Model Screenshot 83: Reports Section (Cont.)



Model Screenshot 84: Reports Section (Cont.)

PrecisionTree Sensitivity Analysis - Sensitivity Graph

Performed By: Amira Shalaby
Date: Sunday, May 25, 2014 5:40:49 PM
Output: Decision Tree 'Private Sector Preferred Scenario' (Expected Value of Entire Model)
Input: Branch Value 'Long-term Stability' of Node 'Politi (E18)



Sensitivity Data

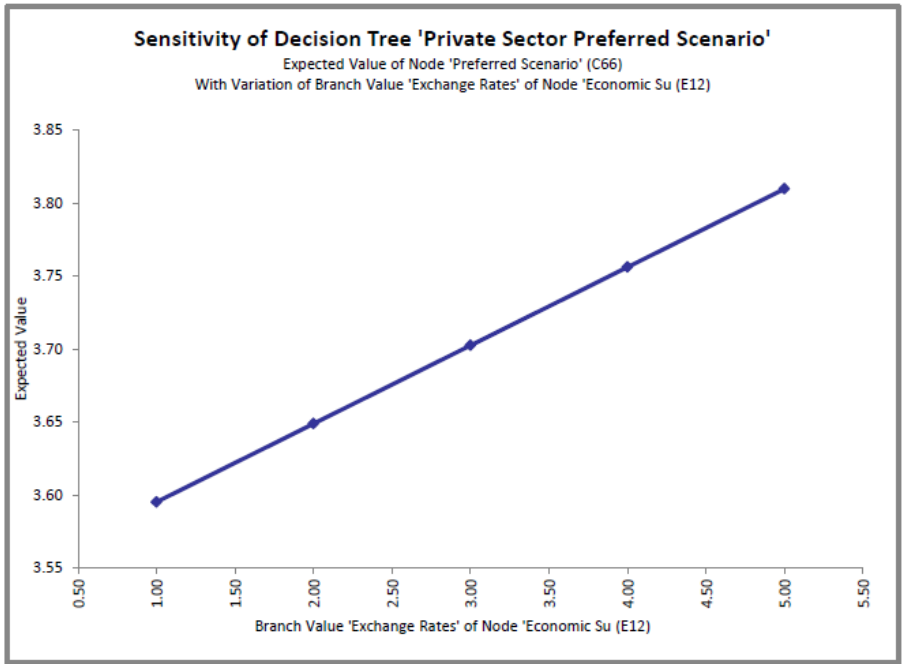
	Input		Output	
	Value	Change (%)	Value	Change (%)
#1	1.00	0.00%	3.81	0.00%
#2	2.00	100.00%	3.87	1.64%
#3	3.00	200.00%	3.93	3.28%
#4	4.00	300.00%	4.00	4.92%
#5	5.00	400.00%	4.06	6.56%

Continue

Model Screenshot 85: Reports Section (Cont.)

PrecisionTree Sensitivity Analysis - Sensitivity Graph

Performed By: Amira Shalaby
Date: Sunday, May 25, 2014 5:40:50 PM
Output: Decision Tree 'Private Sector Preferred Scenario' (Expected Value of Entire Model)
Input: Branch Value 'Exchange Rates' of Node 'Economic Su (E12)



Sensitivity Data

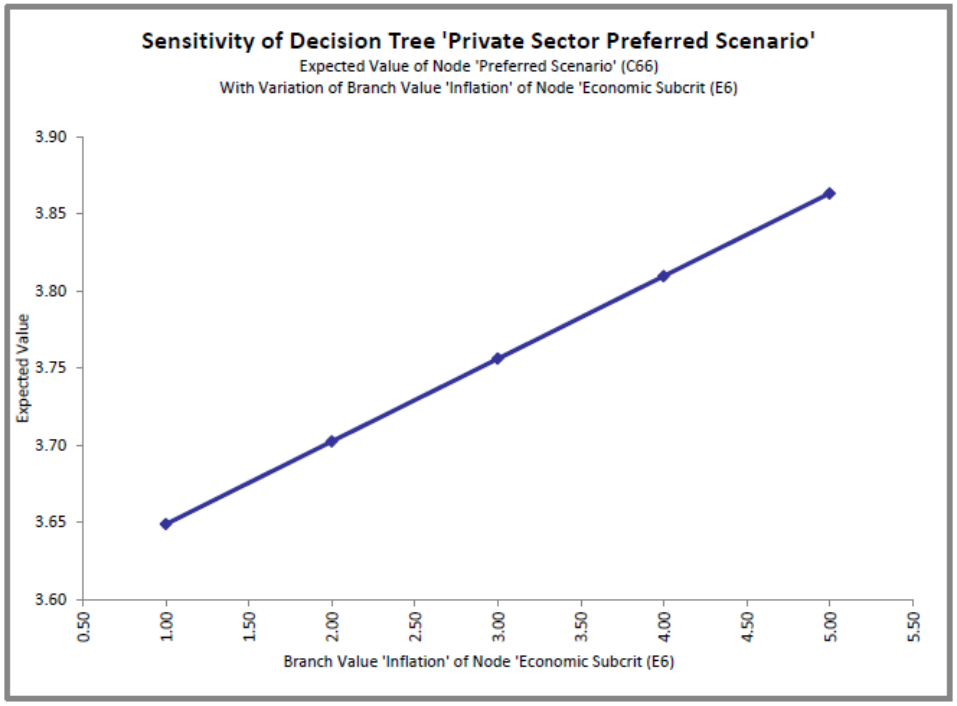
	Input		Output	
	Value	Change (%)	Value	Change (%)
#1	1.00	-80.00%	3.60	-5.62%
#2	2.00	-60.00%	3.65	-4.22%
#3	3.00	-40.00%	3.70	-2.81%
#4	4.00	-20.00%	3.76	-1.41%
#5	5.00	0.00%	3.81	0.00%

Continue

Model Screenshot 86: Reports Section (Cont.)

PrecisionTree Sensitivity Analysis - Sensitivity Graph

Performed By: Amira Shalaby
Date: Sunday, May 25, 2014 5:40:50 PM
Output: Decision Tree 'Private Sector Preferred Scenario' (Expected Value of Entire Model)
Input: Branch Value 'Inflation' of Node 'Economic Subcrit (E6)



Sensitivity Data

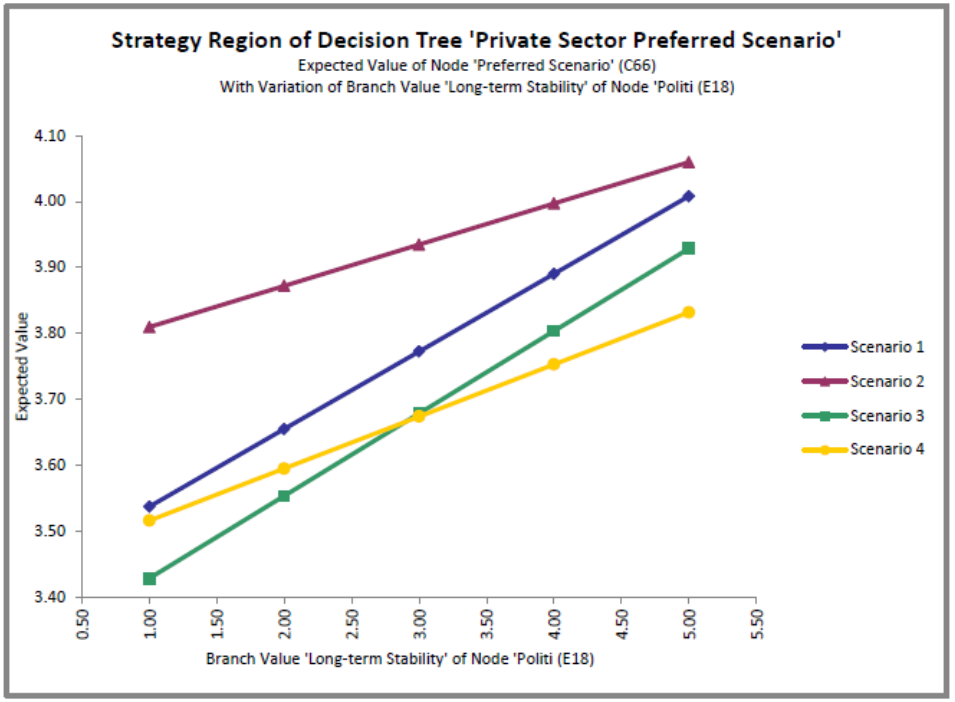
	Input		Output	
	Value	Change (%)	Value	Change (%)
#1	1.00	-75.00%	3.65	-4.22%
#2	2.00	-50.00%	3.70	-2.81%
#3	3.00	-25.00%	3.76	-1.41%
#4	4.00	0.00%	3.81	0.00%
#5	5.00	25.00%	3.86	1.41%

Continue

Model Screenshot 87: Reports Section (Cont.)

PrecisionTree Sensitivity Analysis - Strategy Region

Performed By: Amira Shalaby
Date: Sunday, May 25, 2014 5:40:50 PM
Output: Decision Tree 'Private Sector Preferred Scenario' (Expected Value of Entire Model)
Input: Branch Value 'Long-term Stability' of Node 'Politi (E18)



Strategy Region Data

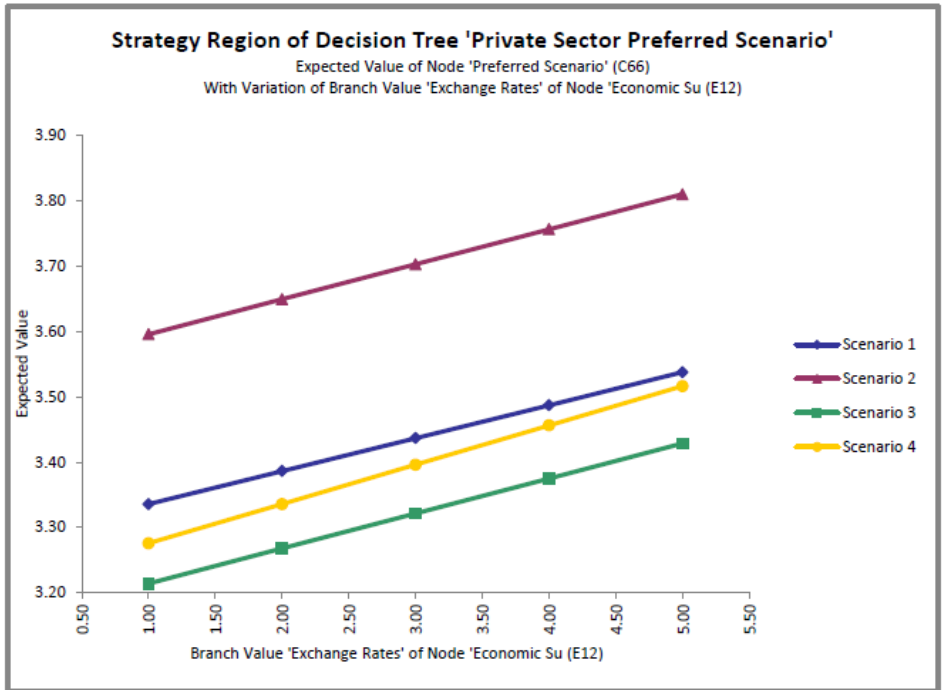
	Input		Scenario 1		Scenario 2		Scenario 3		Scenario 4	
	Value	Change (%)	Value	Change (%)	Value	Change (%)	Value	Change (%)	Value	Change (%)
#1	1.00	0.00%	3.54	-7.15%	3.81	0.00%	3.43	-10.00%	3.52	-7.70%
#2	2.00	100.00%	3.66	-4.06%	3.87	1.64%	3.55	-6.72%	3.60	-5.63%
#3	3.00	200.00%	3.77	-0.97%	3.93	3.28%	3.68	-3.44%	3.67	-3.56%
#4	4.00	300.00%	3.89	2.12%	4.00	4.92%	3.80	-0.16%	3.75	-1.49%
#5	5.00	400.00%	4.01	5.21%	4.06	6.56%	3.93	3.12%	3.83	0.59%

Continue

Model Screenshot 88: Reports Section (Cont.)

PrecisionTree Sensitivity Analysis - Strategy Region

Performed By: Amira Shalaby
Date: Sunday, May 25, 2014 5:40:51 PM
Output: Decision Tree 'Private Sector Preferred Scenario' (Expected Value of Entire Model)
Input: Branch Value 'Exchange Rates' of Node 'Economic Su (E12)



Strategy Region Data

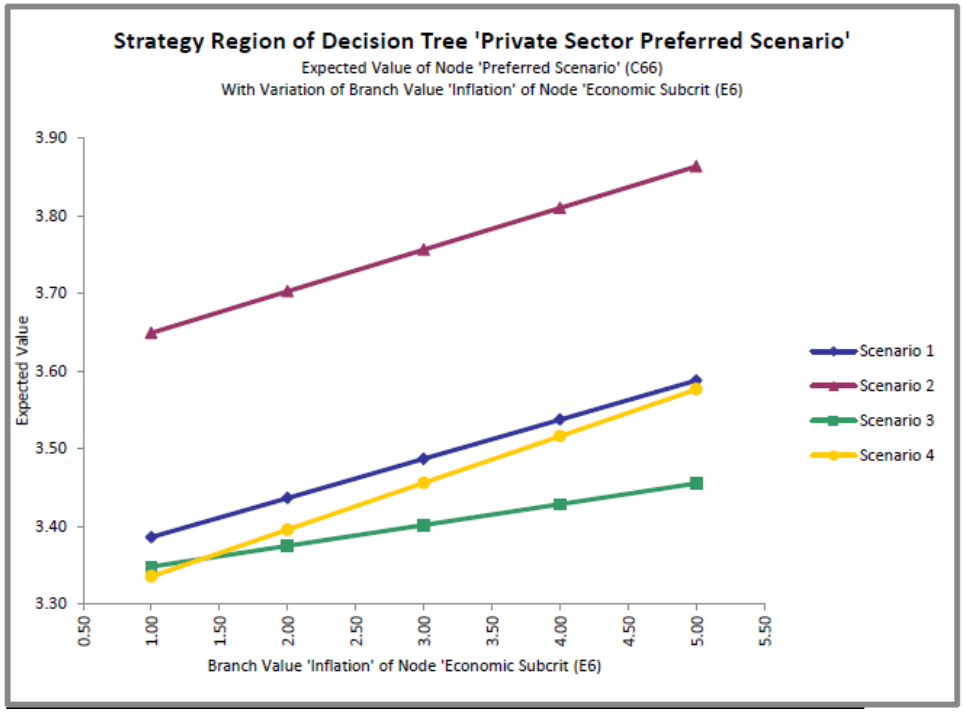
	Input		Scenario 1		Scenario 2		Scenario 3		Scenario 4	
	Value	Change (%)	Value	Change (%)	Value	Change (%)	Value	Change (%)	Value	Change (%)
#1	1.00	-80.00%	3.34	-12.44%	3.60	-5.62%	3.21	-15.63%	3.28	-14.02%
#2	2.00	-60.00%	3.39	-11.12%	3.65	-4.22%	3.27	-14.22%	3.34	-12.44%
#3	3.00	-40.00%	3.44	-9.79%	3.70	-2.81%	3.32	-12.82%	3.40	-10.86%
#4	4.00	-20.00%	3.49	-8.47%	3.76	-1.41%	3.38	-11.41%	3.46	-9.28%
#5	5.00	0.00%	3.54	-7.15%	3.81	0.00%	3.43	-10.00%	3.52	-7.70%

Continue

Model Screenshot 89: Reports Section (Cont.)

PrecisionTree Sensitivity Analysis - Strategy Region

Performed By: Amira Shalaby
Date: Sunday, May 25, 2014 5:40:51 PM
Output: Decision Tree 'Private Sector Preferred Scenario' (Expected Value of Entire Model)
Input: Branch Value 'Inflation' of Node 'Economic Subcrit (E6)



Strategy Region Data

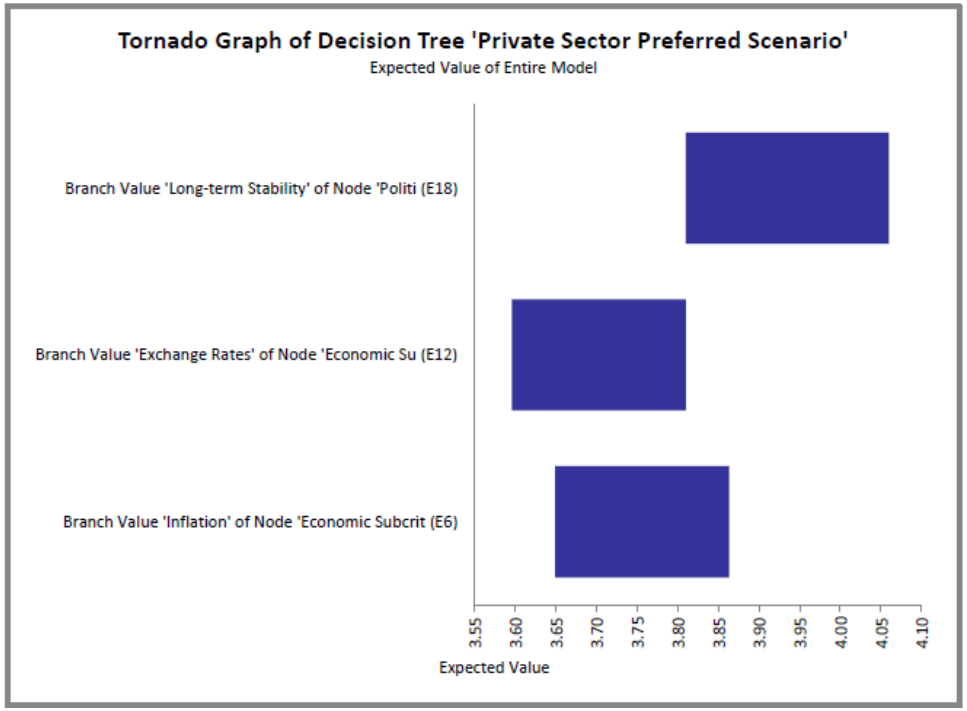
	Input		Scenario 1		Scenario 2		Scenario 3		Scenario 4	
	Value	Change (%)	Value	Change (%)	Value	Change (%)	Value	Change (%)	Value	Change (%)
#1	1.00	-75.00%	3.39	-11.12%	3.65	-4.22%	3.35	-12.11%	3.34	-12.44%
#2	2.00	-50.00%	3.44	-9.79%	3.70	-2.81%	3.38	-11.41%	3.40	-10.86%
#3	3.00	-25.00%	3.49	-8.47%	3.76	-1.41%	3.40	-10.71%	3.46	-9.28%
#4	4.00	0.00%	3.54	-7.15%	3.81	0.00%	3.43	-10.00%	3.52	-7.70%
#5	5.00	25.00%	3.59	-5.82%	3.86	1.41%	3.46	-9.30%	3.58	-6.12%

Continue

Model Screenshot 90: Reports Section (Cont.)

PrecisionTree Sensitivity Analysis - Tornado Graph

Performed By: Amira Shalaby
Date: Sunday, May 25, 2014 5:40:51 PM
Output: Decision Tree 'Private Sector Preferred Scenario' (Expected Value of Entire Model)



Tornado Graph Data

Decision Tree 'Private Sector Preferred Scenario' (Expected Value of Entire Model)

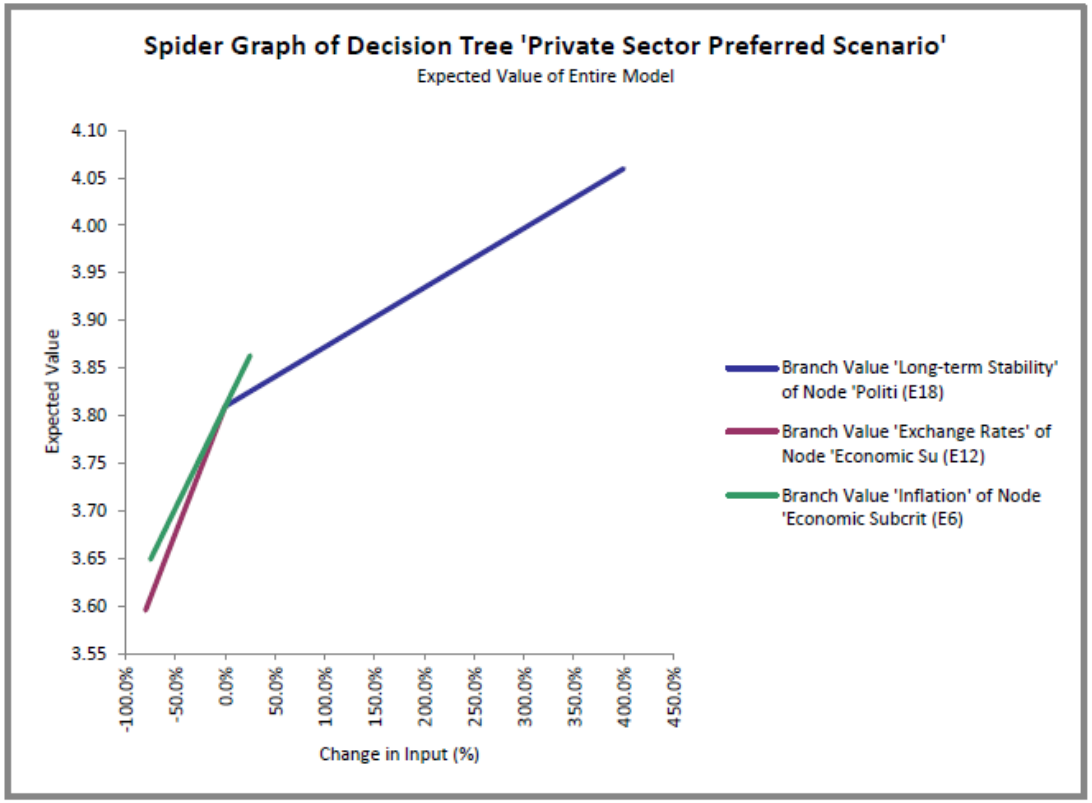
			Minimum			Maximum		
			Output		Input	Output		Input
Rank	Input Name	Cell	Value	Change (%)	Value	Value	Change (%)	Value
1	Branch Value 'Long-term Stability' of Node 'Politi (E18)	E18	3.81	0.00%	1	4.06	6.56%	5
2	Branch Value 'Exchange Rates' of Node 'Economic Su (E12)	E12	3.60	-5.62%	1	3.81	0.00%	5
3	Branch Value 'Inflation' of Node 'Economic Subcrit (E6)	E6	3.65	-4.22%	1	3.86	1.41%	5

Continue

Model Screenshot 91: Reports Section (Cont.)

PrecisionTree Sensitivity Analysis - Spider Graph

Performed By: Amira Shalaby
Date: Sunday, May 25, 2014 5:40:52 PM
Output: Decision Tree 'Private Sector Preferred Scenario' (Expected Value of Entire Model)



Model Screenshot 92: Reports Section (Cont.)

Spider Graph Data

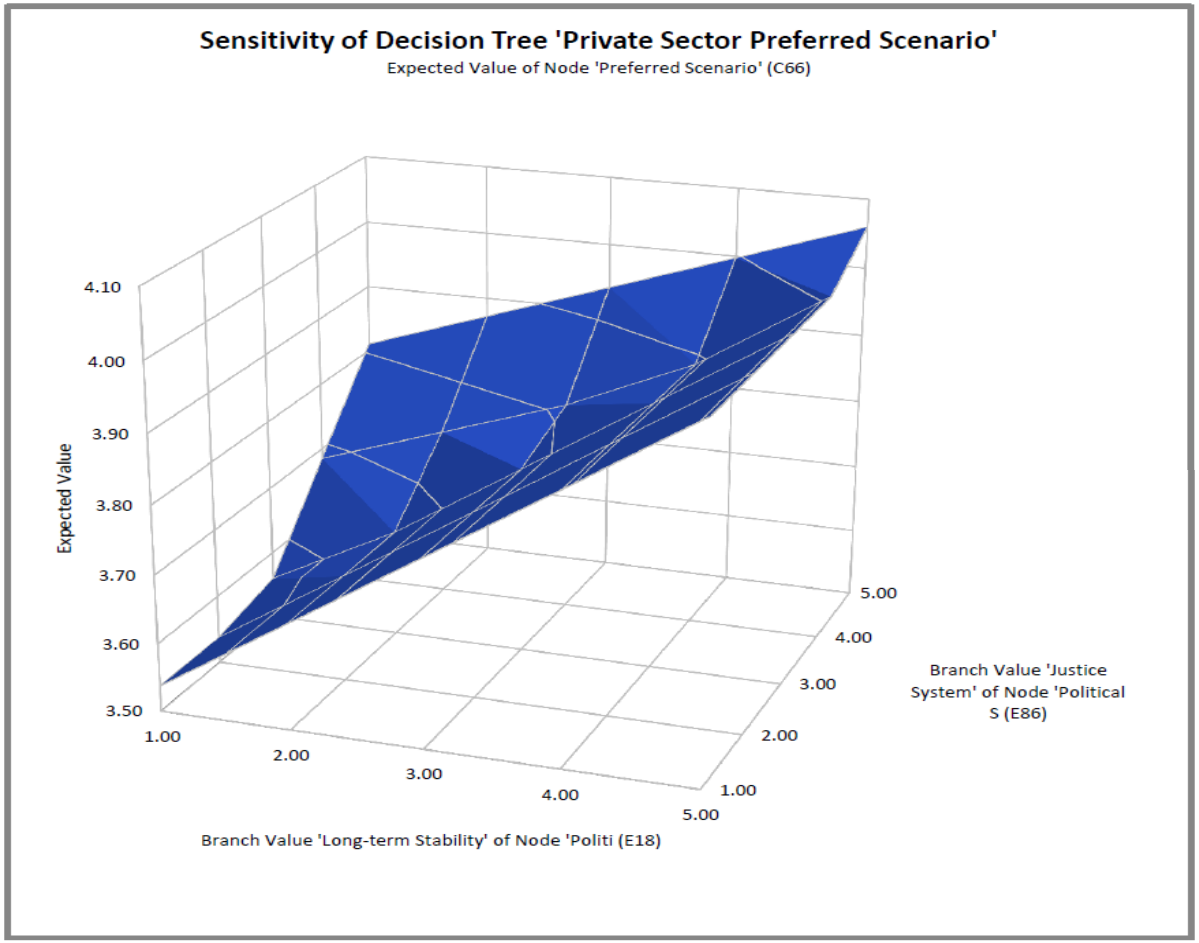
Decision Tree 'Private Sector Preferred Scenario' (Expected Value of Entire Model)

			Input Variation			Output Variation		
Input Name	**Cell**	**Step**	**Value**	**Change**	**Change (%)**	**Value**	**Change**	**Change (%)**
Branch Value 'Long-term Stability' of Node 'Politi (E18)	E18	1	1	0	0.00%	3.809659091	0	0.00%
		2	2	1	100.00%	3.872159091	0.0625	1.64%
		3	3	2	200.00%	3.934659091	0.125	3.28%
		4	4	3	300.00%	3.997159091	0.1875	4.92%
		5	5	4	400.00%	4.059659091	0.25	6.56%
Branch Value 'Exchange Rates' of Node 'Economic Su (E12)	E12	1	1	-4	-80.00%	3.595373377	-0.214285714	-5.62%
		2	2	-3	-60.00%	3.648944805	-0.160714286	-4.22%
		3	3	-2	-40.00%	3.702516234	-0.107142857	-2.81%
		4	4	-1	-20.00%	3.756087662	-0.053571429	-1.41%
		5	5	0	0.00%	3.809659091	0	0.00%
Branch Value 'Inflation' of Node 'Economic Subcrit (E6)	E6	1	1	-3	-75.00%	3.648944805	-0.160714286	-4.22%
		2	2	-2	-50.00%	3.702516234	-0.107142857	-2.81%
		3	3	-1	-25.00%	3.756087662	-0.053571429	-1.41%
		4	4	0	0.00%	3.809659091	0	0.00%
		5	5	1	25.00%	3.863230519	0.053571429	1.41%

Model Screenshot 93: Reports Section (Cont.)

PrecisionTree Sensitivity Analysis - Sensitivity Graph (2-Way)

Performed By: Amira Shalaby
Date: Thursday, July 03, 2014 12:02:54 PM
Output: Decision Tree 'Private Sector Preferred Scenario' (Expected Value of Entire Model)
Input X: Branch Value 'Long-term Stability' of Node 'Politi (E18)
Input Y: Branch Value 'Justice System' of Node 'Political S (E86)



Model Screenshot 94: Reports Section (Cont.)

Two-Way Sensitivity Data of Decision Tree 'Private Sector Preferred Scenario' (Expected Value of Entire Model)

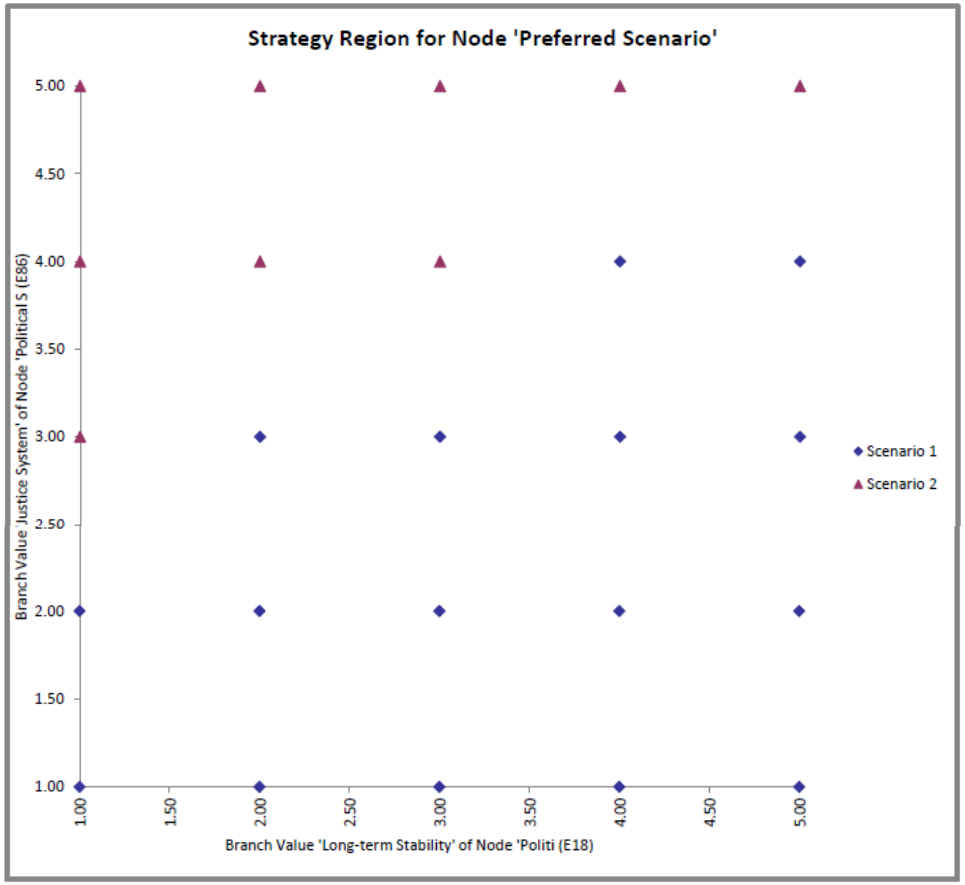
With Variation of Branch Value 'Long-term Stability' of Node 'Politi (E18) and Branch Value 'Justice System' of Node 'Political S (E86)

		Branch Value 'Long-term Stability' of Node 'Politi (E18)				
		1.00	2.00	3.00	4.00	5.00
Branch Value 'Justice System' of Node 'Political S (E86)	1.00	3.54	3.66	3.77	3.89	4.01
	2.00	3.54	3.66	3.77	3.89	4.01
	3.00	3.56	3.66	3.77	3.89	4.01
	4.00	3.68	3.75	3.81	3.89	4.01
	5.00	3.81	3.87	3.93	4.00	4.06

Model Screenshot 95: Reports Section (Cont.)

PrecisionTree Sensitivity Analysis - Strategy Region (2-Way)

Performed By: Amira Shalaby
Date: Thursday, July 03, 2014 12:02:55 PM
Node: 'Preferred Scenario' (C66)
Input #1: Branch Value 'Long-term Stability' of Node 'Politi (E18)
Input #2: Branch Value 'Justice System' of Node 'Political S (E86)



Model Screenshot 96: Reports Section (Cont.)

Strategy Region Chart Data			
Scenario 1		Scenario 2	
Branch Value 'Long-term Stability' of Node 'Politi (E18)	Branch Value 'Justice System' of Node 'Political S (E86)	Branch Value 'Long-term Stability' of Node 'Politi (E18)	Branch Value 'Justice System' of Node 'Political S (E86)
1.00	1.00	1.00	3.00
1.00	2.00	1.00	4.00
2.00	1.00	1.00	5.00
2.00	2.00	2.00	4.00
2.00	3.00	2.00	5.00
3.00	1.00	3.00	4.00
3.00	2.00	3.00	5.00
3.00	3.00	4.00	5.00
4.00	1.00	5.00	5.00
4.00	2.00		
4.00	3.00		
4.00	4.00		
5.00	1.00		
5.00	2.00		
5.00	3.00		
5.00	4.00		

Model End