Asset Management Decision Making Using Data Analytics

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CONTENTS

- First provide an overview of the fundamentals of decision making and problem solving
- Discuss the types of methods available for decision making and introduces the concept of decision support systems (DSS) and multiobjective programming
- Describe the selected method - composite programming
- Example: Development of a Knowledge Based – Decision Support System for private sector participation in water utilities

Decision making differs fundamentally from problem solving

- A problem occurs when something is not behaving as it should: something is deviating from the norm; something goes wrong

- Problem solving is a systematic approach to overcoming obstacles and/or problems in the management process

- Steps for problem solving:
  - Recognizing a problem exists and defining it
  - Generating a range of solutions
  - Evaluating the possible solutions and choosing the best one
  - Implementing the solution and evaluating its effectiveness in solving the problem

Quick solutions

- With straightforward, common problems it is common sense to try a series of quick and tested solutions starting with the most simple or cheapest before moving on to those that take longer or cost more

- With problems of greater complexity it may not be so easy, or indeed advisable, to try quick solutions

Decision making is a process

- Decision making is the process of choosing between alternative courses of action
- Decision making may take place at an individual or organizational level
- The process may involve establishing objectives, gathering relevant information, identifying alternatives, setting criteria for the decision, and selecting the best option

Decision theory can be used to assist the process of decision making

- The nature of the decision-making process within an organization is influenced by its culture and structure, and a number of theoretical methods have been developed
- Specific techniques used in decision making include heuristics and decision trees
- Computer systems designed to assist managerial decision making are known as decision support systems (DSS)

Decision Support Systems and multiobjective programming

- A DSS is an interactive computer based support system that helps decision makers utilize data and models to solve unstructured problems
- Multiobjective programming deals with problems involving several objectives that are noncommensurate and conflicting with each other
- Among the objective functions involved, there is no single one whose importance is overwhelming dominant over all others
- Under this circumstance, the ideological theme of optimality in the single-objective context is no longer appropriate
- The solution to a multiobjective problem is a best compromisable solution, according to the decision maker’s preference, among the objectives and the options to the problem

Compromise programming

- Classical compromise programming is a multiobjective decision analysis technique used to identify the best compromise solution from a set of solutions by some measure of distance
- The measure of distance, referred to as a distance metric, determines the closeness of a particular solution to a general infeasible (ideal) solution
- Therefore, obtaining a compromise solution is analogous to obtaining a solution that is as close as practically possible to the ideal solution

Bárdossy modified compromise programming to form composite programming

- Composite programming is a methodology that deals with problems of hierarchical nature (i.e., when certain criteria contain a number of sub criteria)

- This method meets the important aspects of a good tool: consideration of all relevant aspects of decision making and methodological transparency

The principle of composite programming may be explained as follows

- An alternative Ai is characterised by a specific selection of values for each one of the n objectives
- The ideal situation is characterised by the maximum possible value for each of the n objectives
- The ranking, or value, that the alternative will represent is the “distance” of the alternative from the ideal situation
- This distance is calculated like the physical Pythagoric distance, in a space with n-dimensions, where the ideal situation is represented by a point with the co-ordinates [max1, max2, …,maxn] and the alternative by a point of co-ordinates [Ai1, Ai2, …, Ain]

Composite programming gives the possibility of grouping

- In particular, composite programming gives the possibility of grouping some objectives in indicators that will in a second step be grouped together to give a final evaluation of the alternative
- The comparison between alternatives can than be done on different levels: either comparing the total evaluation factor or comparing the values of the group indicators
- In the process of grouping, the objectives are given a weight, according to their importance in the total evaluation, and every group is characterised by a compensation factor, which shows the degree of “compensability” between indicators
- A high value of the compensation factor means that the objectives grouped cannot compensate each other; for a good performance of the group indicator, is required a good performance of each of the indicators

APPLYING MATHEMATICS TO DECISION MAKING USING COMPOSITE PROGRAMMING

The value of the indicators are normalized using the formula:

$$n_{i,j} = \frac{z_{i,j} - w_j}{b_j - w_j}$$

$n_{I,j}$ = normalized value
$z_{I,j}$ = indicator value
w_j = worse value
b_j = best value
If $z_{I,j} < w_j \Rightarrow n_{I,j} = 0$
If $z_{I,j} > b_j \Rightarrow n_{I,j} = 1$

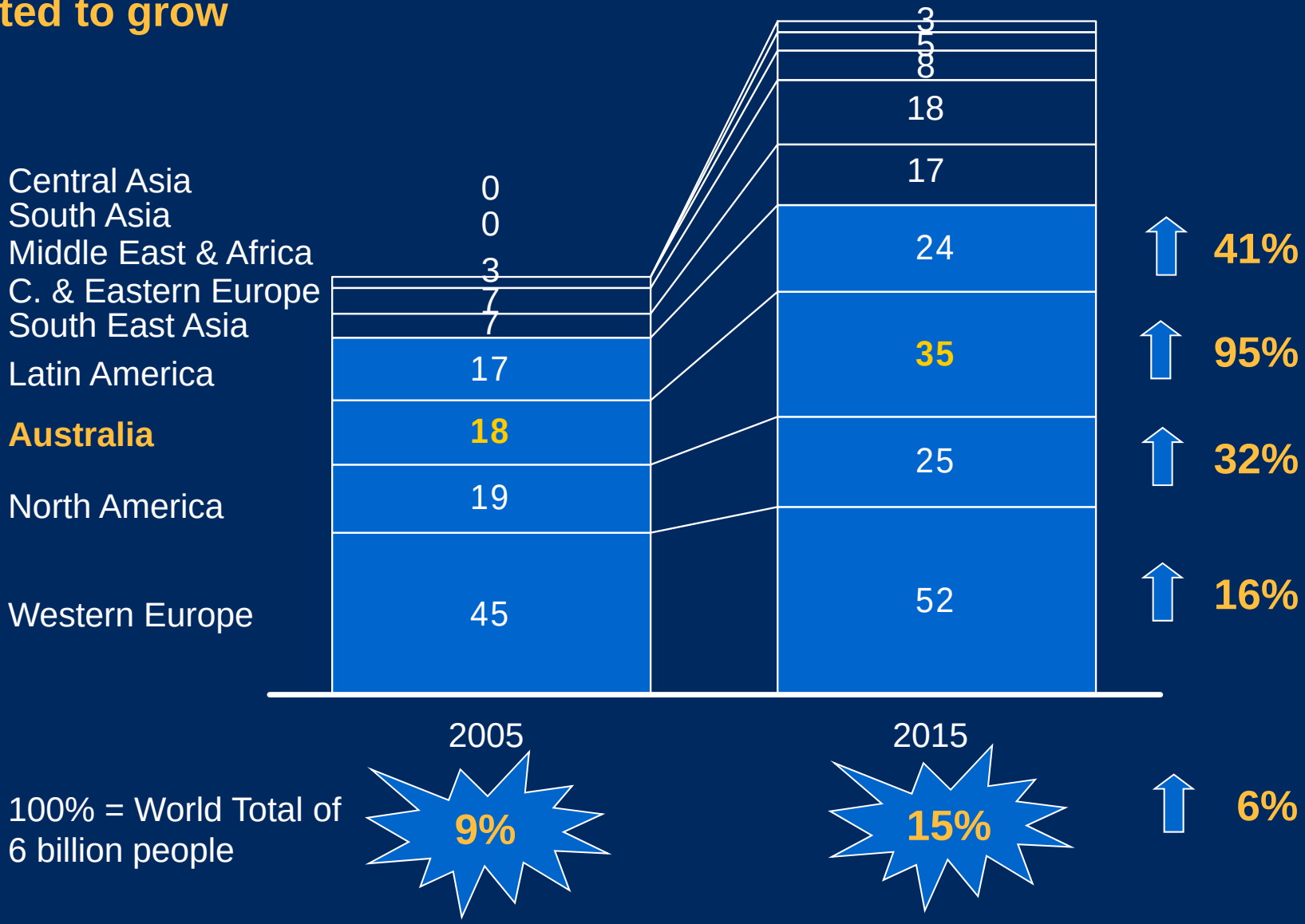
The normalized indicators are then grouped in *I* groups and each group is formed by the aggregation of J_i indicators. The value I_i for the group *I* is calculated as follows:

$$I_i = 1 - \left[\sum_{j=1}^{J} \alpha_j \left(1 - n_{i,j}\right)^{p_i} \right]^{1/p_i}$$

α_j = weighting factor of the indicator j in group i
$n_{I,j}$ = normalized value of the indicator $z_{I,j}$
p_i = compensation factor within groups

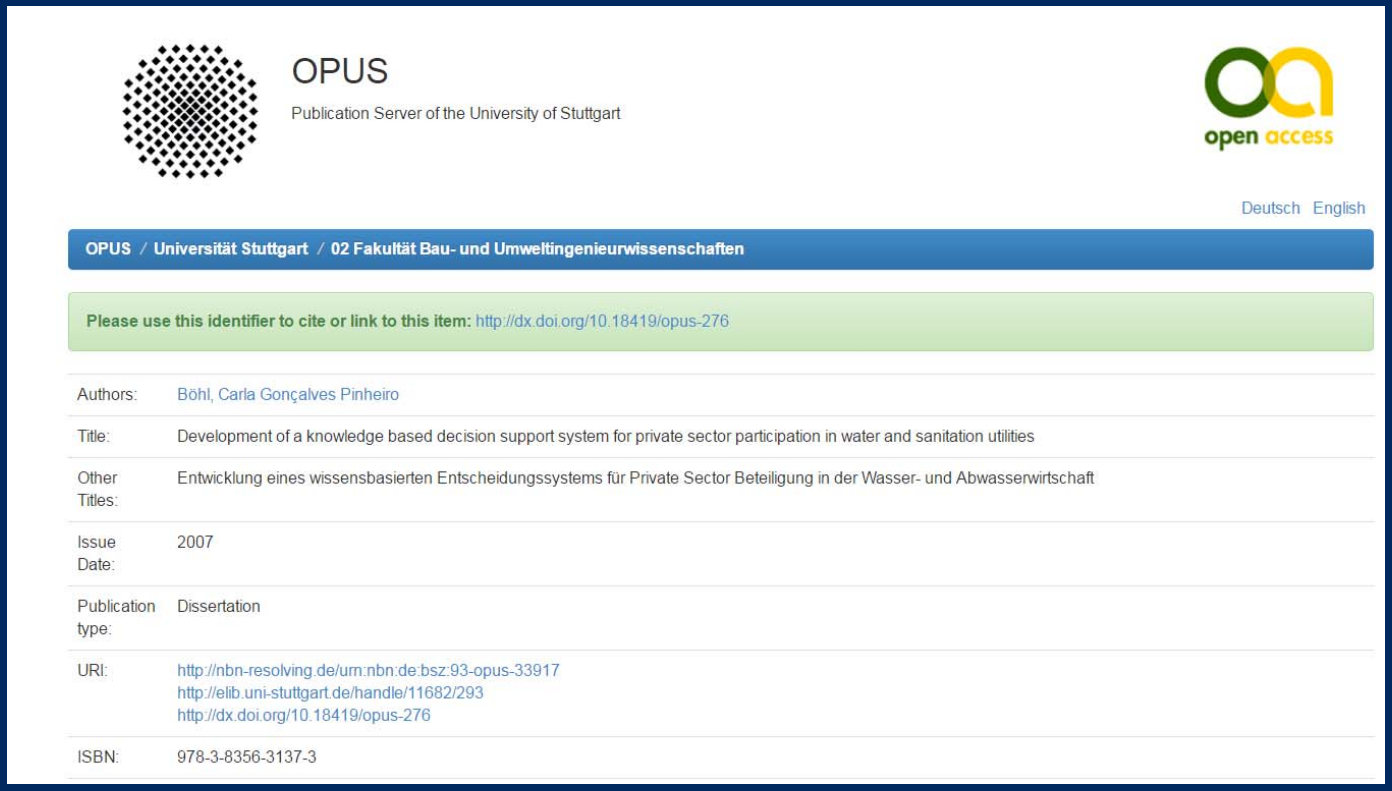
Water Industry

Tthe percentage (%) of population served by private sector was expected to grow



Source: Global Water Intelligence

Development of a knowledge based decision support system for private sector participation in water utilities



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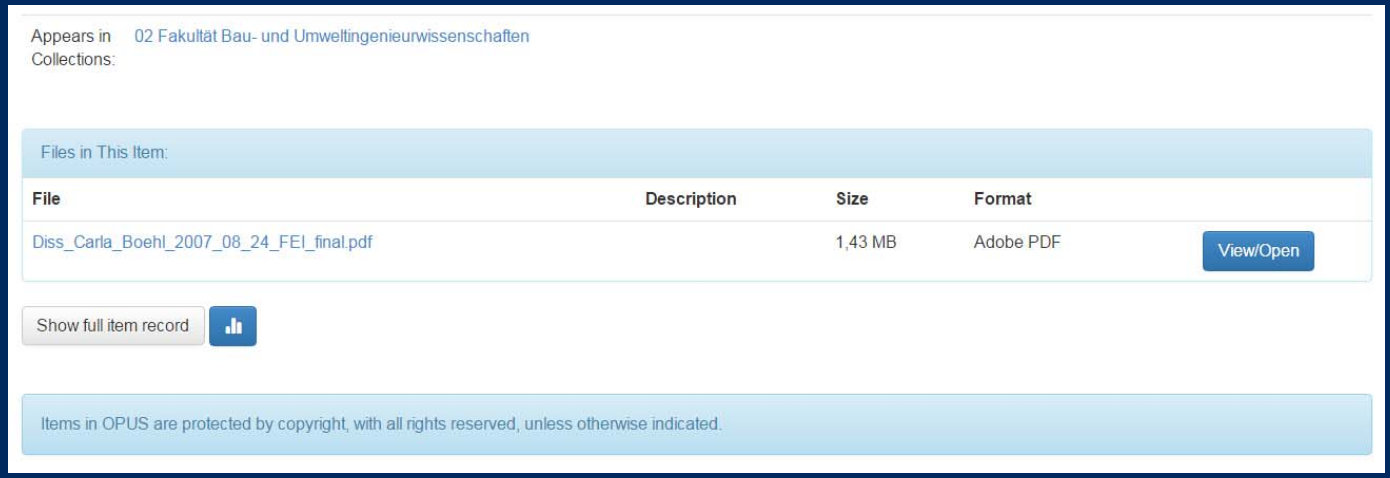

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KBDSS - ABSTRACT

This research's message is simple: Governments can turn to the private sector for help in developing and delivering water and sanitation services

- Different approaches can be adapted to varying degrees and, when well designed, these arrangements can bring improvements in the quality, availability, and cost-effectiveness of services
- This research explains the core principles, and demonstrates the practical way to select an option for private sector participation.
- The knowledge based decision support system (KB-DSS) is designed for utility managers to use as they begin to look for a private partner
- The model points out which kind of private sector alternative best meets their objectives
- It then provides the development of the KB-DSS step-by-step and applies the model to the special cases of a Western European country (Portugal) and an African archipelago (Cape Verde)

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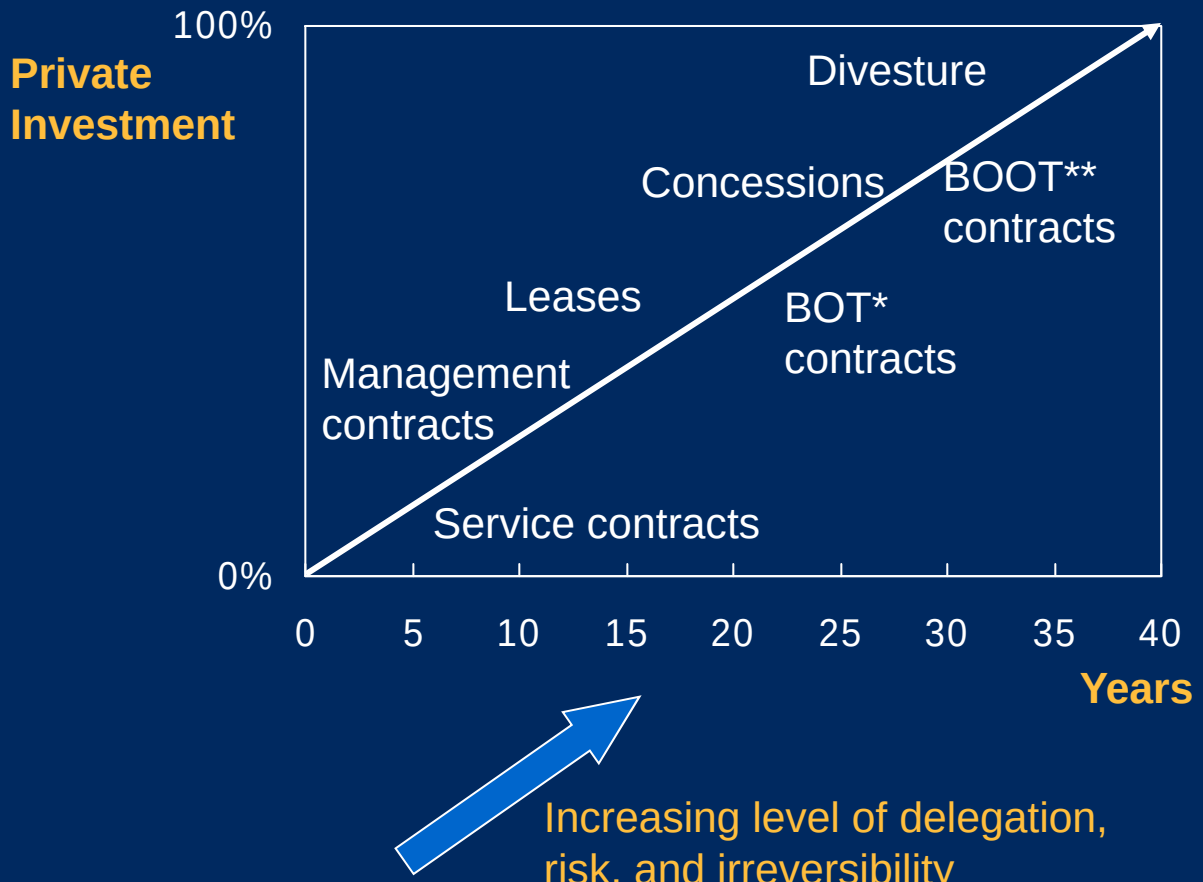
Selection of Alternatives

Various models exist for private sector participation



* BOT: Build, Operate, Transfer

** BOOT: Build, Own, Operate, Transfer

Source: Adapted from World Bank (1997), Toolkit 1

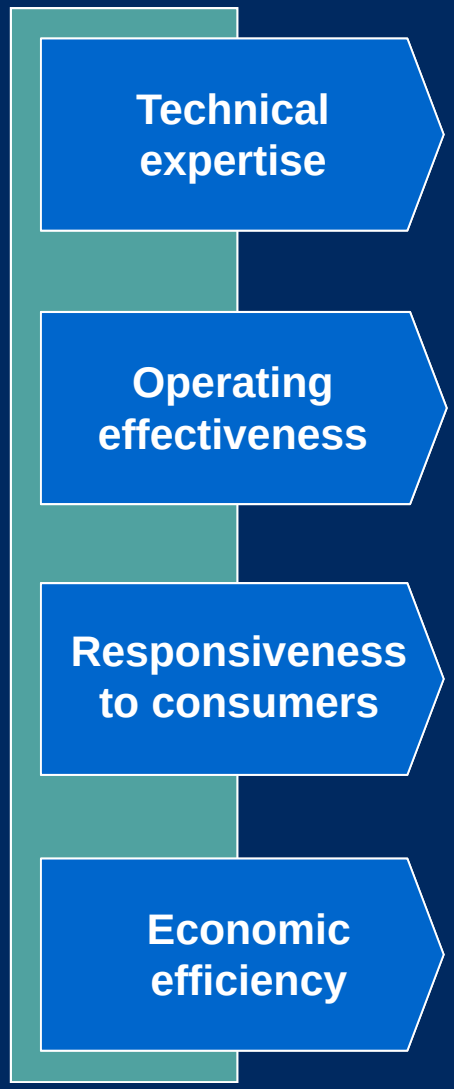
Selection of Objectives

So what are water suppliers worried about?

- Bring technical expertise
- Inject investment
- Improve operating effectiveness
- Managerial expertise
- More responsive to consumers‘ needs
- Insulate from political intervention
- Achieve economic efficiency

FOR EACH OF THE OBJECTIVES A GROUP OF KPI'S WAS IDENTIFIED AS WELL AS THEIR BEST AND WORST VALUES

(1/2)



Key Performance Indicators

- Difference between water abstracted and water distributed
- Difference between water distributed and water consumed
- Wastewater treatment
- Unaccounted for water
- Water and sanitation complaints
- Water quality monitoring
- Water and sanitation coverage
- Continuity of service
- Number of system failures
- Delay obtaining a connection
- Tariffs
- Revenues
- Collection Period
- Working Ratio
- Debt Service Ratio

FOR EACH OF THE OBJECTIVES A GROUP OF KPI'S WAS IDENTIFIED AS WELL AS THEIR BEST AND WORST VALUES

(2/2)

Key Performance Indicators

- Investment
- Net Fixed Assets
- Indebtness level

- Metering level
- Unit operating costs
- Staffing
- Labor Costs
- Skills and education
- Labor Regulations
- Absenteeism
- Training

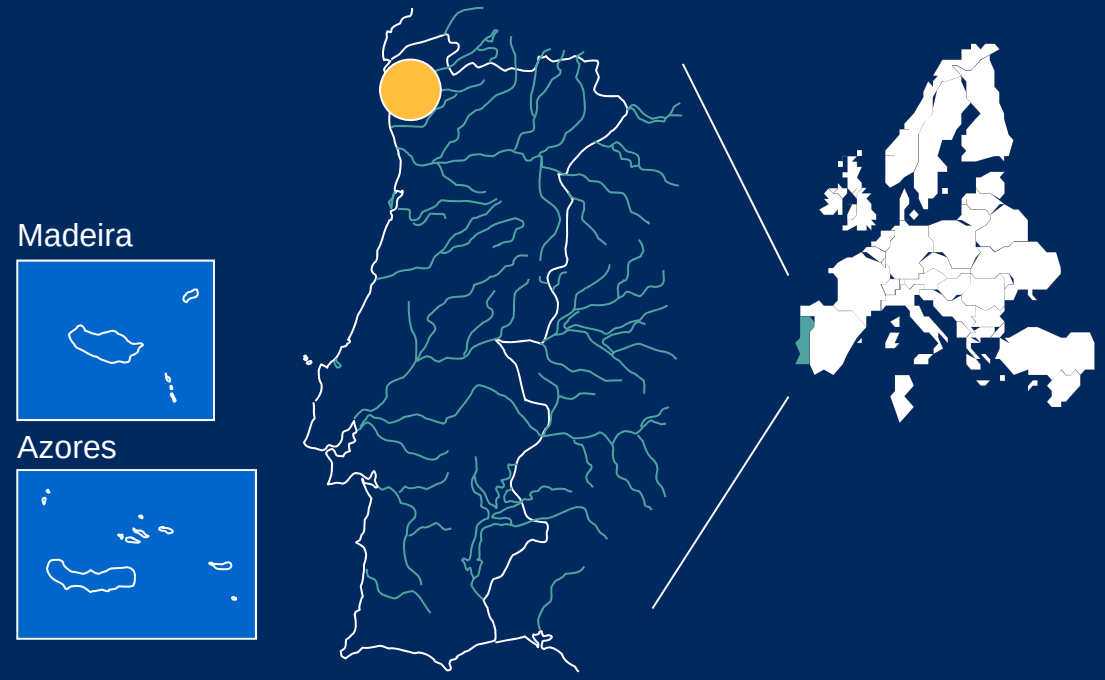
- Political appointees
- Corruption
- Regulation requirements
- Licensing and permits
- Competitiveness
- Economic freedom
- Crime
- Capacity building

SCHEME USED TO VISUALIZE THE GROUPS, WEIGHTS AND COMPENSATION FACTORS USED IN COMPOSITE PROGRAMMING

Table 6.37 Groups, weights and compensation factors used for the KB-DSS

KPI	α	p	Level 1	α	p	Level 2	α	p	Level 3	α	p	Level 4
1	0,40	1	Supply-Demand	0,70	3	Technical Expertise	0,20	2	Technical capacity	0,35	3	Total Evaluation
2	0,60											
3				0,30								
4				0,50								
5	0,50	1	Performance	0,30	4	Operational Efficiency	0,30					
6	0,50											
7				0,20								
8	0,50	2	Coverage	0,40	1	Responsiveness to Consumers	0,5					
9	0,50											
10	0,70	3	Quality of service	0,60								
11	0,20											
12	0,10											
13	0,40	3	Billing & Collection	0,50	3	Economic Efficiency	0,40	1	Financial capacity	0,25		
14	0,30											
15	0,30											
16	0,60	1	Financial ratios	0,50								
17	0,40											
18				0,50	2	Investment	0,60					
19				0,40								
20				0,10								
21				0,20	6	Managerial Expertise	0,50	4	Managerial capacity	0,4		
22	0,40	6	Staff & Cost	0,30								
23	0,30											
24	0,30											
25	0,30	7	People management	0,50								
26	0,10											
27	0,25											
28	0,35											
29				0,10	3	Insulation from political intervention	0,50					
30				0,10								
31	0,50	1	Bureaucracy	0,10								
32	0,50											
33	0,30	2	Rankings	0,20								
34	0,70											
35				0,10								
36				0,40								

THE MUNICIPALIZED SERVICES OF VIANA DO CASTELO (SMSBVC) IS THE LARGEST UTILITY IN THE MINHO-LIMA RIVER BASINS



- A multi-municipal company was created to build necessary infrastructure for intake and water and wastewater treatment
- Using Cohesion Funds from the European Union (65%)

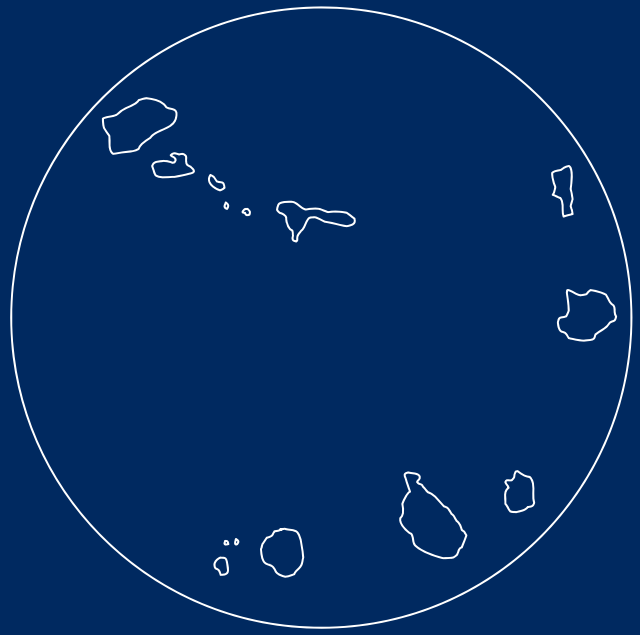
Source: *Águas do Minho e Lima* (2004), SMSBVC (1998 and 2004)

SERVICE CONTRACTS ARE THE MOST APPROPRIATE FORM OF PSP FOR THE MUNICIPALIZED SERVICES OF VIANA DO CASTELO

Table 7.1 KB-DSS ordered results for SMSBVC, Portugal in 1998 and 2004

SMSBVC, Portugal 1998			SMSBVC, Portugal 2004		
A1	Service contract	0,38	A1	Service contract	0,44
A4	Lease	0,35	A5	BOT	0,34
A3	Manag. contract fixed fee	0,33	A3	Manag. contract fixed fee	0,32
A7	Divesture	0,32	A4	Lease	0,31
A2	Management contract	0,32	A7	Divesture	0,30
A6	Concession	0,31	A2	Management contract	0,29
A5	BOT	0,31	A6	Concession	0,29

CAPE VERDE IS ONE OF AFRICA‘S SMALLEST TERRITORIES AND HAS POOR WATER RESOURCES



- Cape Verde has frequent droughts and serious water shortages and can produce only 15% of its food
- The economy is dominated by services which accounted 73% of GDP; agriculture and fishing employ much of the population but account for only 11% of the GDP

Source: Reuters Foundation (2006), AQUASTAT (2005), EIU (2005)

THE PRIVATE SECTOR MECHANISM BRINGING HIGHER RESPONSIVENESS TO CAPE VERDE GOVERNMENT OBJECTIVES WOULD BE A DIVESTURE OR ASSET SALE

Table 7.2 KB-DSS ordered results for Electra, Cape Verde in 1998 and 2003

Electra, Cape Verde 1998			Electra, Cape Verde 2003		
A7	Divesture	0,40	A7	Divesture	0,42
A6	Concession	0,39	A6	Concession	0,40
A4	Lease	0,39	A5	BOT	0,38
A3	Manag. contract fixed fee	0,33	A4	Lease	0,30
A2	Management contract	0,30	A1	Service contract	0,26
A5	BOT	0,29	A3	Manag. contract fixed fee	0,25
A1	Service contract	0,25	A2	Management contract	0,20

Summary

- The knowledge base decision support system (KB-DSS) that has been developed trough this research represents a standardized procedure for analysing the problems of asset-intensive companies
- The ease with which it can be used makes it attractive, and allows the user to gain a broad understanding of the current situation of the company in focus – technically, financially and from a management perspective
- The same methodology can be applied for decision-making in asset management

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Obrigado.
Thanks for listening!

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