

Designing Informatics Systems Using Economic Models Defined by Excel Spreadsheets

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The development of informatics system within multi-disciplinary teams requires the use of the computer as a working tool of all the team members. One of the mostly used informatics instruments for implementing economic and financial models is Excel. A spreadsheet can be used both as a computing engine and data base within an informatics system. In order to create a proper interface as well as other instruments designed as user-centered applications, different programming technologies should be developed in order to insure the interoperability between the applications.

Keywords: *interoperability, generic spreadsheets, design of informatics systems, templates.*

Introduction

The technology of components has the advantage of constructions of independent modules, used for a variety of applications as well as to communicate with other applications or peripherals. The data base represents an efficient way of storing and manipulating data, meaning actualizing, finding or displaying the needed information. In order to implement economic models, a set of objects and/or specific procedures need to be defined. Even if there are evident similarities between the programming languages to the natural languages, for non-specialists in informatics is hard to implement an economic model using a formal language.

As a result, a viable and efficient alternative for implementing economic models is represented by Excel. Working with spreadsheets is well known for non-specialists, and, as a consequence, can be used as a common instrument for team work. The development of informatics systems based on such implementations has to deal with solving the interoperability issues between the applications.

2. Generic spreadsheets

The generic programming concept is a concept well known and tackled among the program developers given its large efficiency in the programming process. Implementing generic programming concepts refers to defining templates of functions or classes in C++ or to define objectual data types starting from a class situated in the top of the hierarchy, for example the Object in C#.

A spreadsheet is used both for data storage and computing engine, given the fact that by applying the formulae on the cells containing the primary data as input parameters the needed results are obtained.

When the model needs to be implemented for several entities, the solution is to develop several worksheets in the same workbook, one for each entity. The storage of several worksheets is made in order to store the specific data corresponding to each entity, while the calculation sequence is kept the same. The entities can be defined as administrative units such as: county, development region or country, hence a workbook needs to be defined for each administrative unit.

Based on all these aspects, a solution is that the informatics system to keep only one worksheet, corresponding to a generic entity. The *generic worksheet* will have only the role of computing engine and will not act as a data base.

The basic structure of the generic worksheet consists in several cells organized to store the data on three levels:

- Input parameters
- Intermediate data
- Output data

3. An economic model implemented by Excel Spreadsheet

Romania's accession to the European Union implies our country's alignment to all the European norms, including environmental ones. Romania closed the negotiation for Chapter 22 – Environment on November

2004, assuming several investments to be done in order to insure the required quality of the environment.

The following informatics application is done in order to estimate the compliance cost for the LCP (Large Combustion Plants) Directive. The LCP directive¹ refers to the control of the pollution from large combustion plants that burn various kind of fossil fuels (coal, diesel oil etc.) and are causing polluting emissions essentially in terms of SO_x, NO_x and Particulate Matters (PM).

The investments required to comply to the LCP Directive requirements – as well as the other costs (O&M, Administrative) are made in order to limit the emissions of certain pollutants into the air from large combustion plants (LCPs) and attain an environmental performance in compliance with EU policy and Romania's participation to the EU air quality improvement policy.

As general parameters the model refers to inflation rate, nominal and real discount rates, real GDP growth rate.

The specific parameters refers to the type of boilers used in the LCP units as well as the values of the Operation and Maintenance costs calculated for each type of pollution reduction measures.

Four groups of core costs elements are necessary in order to insure equipment investments, sustainable operation and replacement. These four cost series are:

a) The investment costs (CAPEX) needed to develop the required environmental equipments and facilities in line with the approved implementation plans of each underlying directive. These costs are expressed as time series of incremental yearly new investment required up to the end of the agreed transition period (if any) of the respective directive(s) underlying the investments.

b) The re-investment costs required over time to replace and refurbish the depreciating facilities and equipment so as to maintain over time the quality and performance of the envi-

ronmental services produced by the initial investments. Due to the relatively high average lifetime of the equipments (around 20 years) and the short period of time taken into account in this analysis, the re-investment cost are not taken into account.

c) The operating and maintenance (O&M) costs essential to deliver the environmental improvement services made available through the investments and sustain their operative capacity. The O&M costs are calculated as a percentage of the investments, as follows: 6% for DeNO_x, 4% for DeSO₂, 1% for PM.

d) The administrative costs needed to plan, orchestrate, finance, monitor and enforce the implementation and sustainable operation of the investments. These costs are not important compared to the investments themselves but their enabling role and impact are critical to bring about success.

The total costs are calculated as a sum of the four types of costs:

TC = CAPEX + Reinvestment + O&M + Administrative
The output is presented as a present value of each cost flow, based on a discount rate (r) that is taken in the model from the input parameters:

$$PVC_{ij} = C_{0j} + \frac{C_{1j}}{(1+r)} + \frac{C_{2j}}{(1+r)^2} + \dots + \frac{C_{nj}}{(1+r)^n} ,$$

for each type of cost $j = 1, 4$ (investment, re-investment, O&M and administrative) and the timeframe $i = 2004, 2050$.

The calculation is made also for each three of the major owners of the LCP units: Ministry of Economy and Trade (MET), Ministry of Administration and Interior (MAI) and Others.

The final results are presented for three years and several discounting rates options.

The whole Spreadsheet is presented in figure 1.

¹ Directive 2001/80/EC on the limitation of emissions of certain pollutants into the air from large combustion plants (LCPs)

	A	B	C	D	E	F	G	H	I	J	K	L	M	
1	General parameters			Specific parameters										
2	Inflation rate	%	3.0%		Operation & Maintenance costs as % of CAPEX	DeNOx	0.1		Type of boiler Owner	C	CAI	CAF		
3	Nominal discount rate	%	7.1%			DeSO2	0.0		MET		MAI	Other		
4	Real discount rate	%	4.0%			EF	0.0							
5	GDP real growth rate	%				Monitoring	0.0							
6	Average lifetime	years	20											
7	Intermediate calculation													
8	Known Source Capex							2,005	2,006	2,007	2,008	2,009	2,010	2,011
9	Type of boiler	C	DeNOx	€ thou						1,000.0		2,500.0		
10	Power of boiler(s)	533	DeSO2	€ thou										
11	No of boilers	3	EF	€ thou										4,000.0
12			Monitoring	€ thou										
13			Capex boiler type C	€ thou		0.0	0.0	0.0	1,000.0	0.0	2,500.0	4,000.0		
24	Total		DeNOx	€ thou		0.0	3,090.0	6,365.4	4,458.3	0.0	2,898.2	656.7		
25	Power of boiler(s)	1389	DeSO2	€ thou		0.0	0.0	0.0	0.0	0.0	0.0	656.7		
26	No of boilers	11	EF	€ thou		0.0	0.0	0.0	0.0	0.0	0.0	4,776.2		
27			Monitoring	€ thou		0.0	0.0	0.0	0.0	0.0	0.0	0.0		
28	Known Source Capex			Current prices		0.0	3,000.0	6,000.0	4,080.0	0.0	2,500.0	5,100.0		
30	Estimate Source O&M			% of investment										
31			DeNOx	6.0%	€ thou	0.0	185.4	572.9	857.6	883.3	1,083.7	1,155.6		
32			DeSO2	4.0%	€ thou	0.0	0.0	0.0	0.0	0.0	0.0	26.3		
33			EF	1.0%	€ thou	0.0	0.0	0.0	0.0	0.0	0.0	47.8		
34			Monitoring	1.0%	€ thou	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
35				Current prices		0.0	180.0	540.0	784.8	784.8	934.8	1,029.8		
37	Final results													
38	Discount rate	3.5%	7.1%	11.2%	3.5%	7.1%	11.2%	3.5%	7.1%	11.2%				
39	Investment	61,306	54,629	48,897	421,806	326,872	258,137	421,806	326,872	258,137				
40	O&M	2,596	2,314	2,072	123,293	85,781	61,180	693,313	274,043	134,309				
41	Replacement	0	0	0	0	0	0	1,027,711	339,425	131,847				
42	Administrative	358	333	312	1,043	828	677	3,306	1,575	967				
43	Total	64,259	57,277	51,280	546,142	413,481	319,993	2,146,135	941,915	525,260				

Figure 1. The implementation of LCP Directive in Excel

The Spreadsheet is a generic one because it can be used for any administrative unit. Figure 1 presents several ranges for store various categories of parameters.

4. The architecture of the informatics system

The generic spreadsheet is generating the results based on the input parameters. As a result, it is required to identify the cells containing the input parameters and to store them in a data base. For example, the table *lcp_param* from the data base is containing the input parameters under the following form:

key	atribute ₁	atribute ₂	...	atribute _n
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where, *key* is an identification of the administrative unit and *atribute_i* identifies an input parameter.

The generation of the results for a given entity is based on isolating the corresponding input parameters:

```
select * from lcp_param where key = syent
```

where, *syent* represents the symbol of the entity.

The interconnection with the spreadsheets is based on specialised software components, which depend on the *Microsoft Office*

version. For example, the component *Microsoft Excel 11.0 Object Library* has to be added to the project in order to insure the communication with *Excel* from the *MSOffice 2003* software package. The *Visual Basic* code sequency used for loading the parameters from the data base into the spreadsheet is:

- create an instance for a new *Excel* application:
Set exapp = New Excel.Application
- open a *xls* file (*lcp.xls*):
Set exwb =
exapp.Workbooks.Open("lcp.xls")
- access a sheet (*lcp*) from the *xls* file:
Set exsh = exwb.Worksheets("lcp")
- load a cell *e8* with the value from the first field from a *RecordSet* object (*rs*) mapped on the table that store the input parameters:
exsh.Range("e8").Value = rs.Fields(1)
- close *xls* file:
exwb.Close False
- close the instance of the *Excel* application:
exapp.Quit

After all the input parameters are loaded, the final results can be extracted from the excel worksheet cells and they can be displayed under different forms (tables, graphs, on the digital maps and so on).

The architecture of the informatics system is presented in the figure 2:

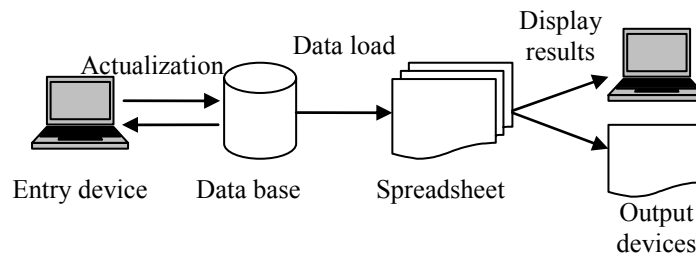


Figure 2. The architecture of the informatics system

5. Conclusions

The development of the informatics systems that are using informational entities presented in different forms requires to make use of several techniques and components in order to insure their interoperability. The main limit of this procedure is the slower execution speed of the application, due to the interoperability.

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