TITLE OF THESIS

THE SIGNIFICANCE OF IMPLEMENTING A WELL ORGANIZED PROJECT SELECTION METHODOLOGY USING MULTI-CRITERIA ANALYSIS

By

Siskos V. Dimitrios

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RESUME

Siskos Dimitris is currently employed by Express Publishing Corporate Company in Athens, Greece. The company is in the business of writing and publishing of English educational books. He belongs to the Financial – Accounting Department of the company. He is responsible for the accounting management, financial reports formation and the economic audits of the organization.

In addition to these, he participates in the financial monitoring and controlling of the projects contracts. His department is, also, authorized to keep in touch with the customer of each project or contract, informing them about all relevant project details. Project management principles have great application in his nature of work.

Dedicated to my family

THE SIGNIFICANCE OF IMPLEMENTING A WELL ORGANIZED PROJECT SELECTION METHODOLOGY USING MULTI-CRITERIA ANALYSIS

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Abstract — The decision of an optimum project portfolio selection in the area of project management, is frequently encountered in the business environment. On a purely organizational level (assuming minimal internal political considerations), this decision must take into account the uncertainties in the calculation of many criteria as the expected revenue from the investment, profitability, resource availability, labor skills, perspectives and know how. This survey addresses the above questions using an adequate software tool, and provides the methodological framework for the modeling of such business decisions; furthermore, it demonstrates the feasibility and the reliability of the proposed approach and corroborates its findings with a realistic example. The research will be oriented to the concept of an article by Reyck et al (2005) that recommend not ‘‘doing projects right’’ but ‘‘doing the right projects’’.

Keywords — Project Portfolio, Uncertainty, Decision, Optimization, Risk Management, Monte Carlo Simulation, Crystal Ball

Results and Discussion — In the present paper, we have demonstrated the feasibility of using a multicriteria forecasting and risk analysis program to complement management decisions in projects where the product life cycle needs to be carefully examined and evaluated. The analysis and the estimation of the uncertainties may be executed not only at the beginning of a project, but also in its middle stages. As projects develop, uncertainties become reality and decisions obtain specific values. But in the beginning of such projects, there are multiple uncertainties, possible scenarios and lack of accurate information. This is exactly where the Crystal Ball software allows the management team to take the initial and most important decisions in conditions of relative safety, as a properly built model offers huge amount of information about the variables that affect the project. The presented model proposes a multicriteria process which incorporates the uncertainty in the criteria variables of running a project portfolio so as to select its optimal one.

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CHAPTER 1 INTRODUCTION

1.1 NATURE OF THE STUDY

A great numerous of multiple projects is being implemented all over the world. Many of them fail to meet success because they proved to be inappropriate for the organizations which undertake them. Unfortunately when that fact becomes apprehensible from the project directors, it is usually too late. Most of these organizations finally, are compelled to withdraw from project implementation. Consequently, they often result in the difficult position to pay penalties for non conformance with the contract's terms.

Stakeholders for this thesis include the upper level management who desire profit maximization, project managers in companies who lead the projects, the sponsors that expect return of their investment and the team members of the project teams. This thesis will provide a strategy to those who are responsible for projects selection so as to:

- Improve project selection methodologies.
- Identify corresponding criteria that influence the selection of the "right" projects.
- Adopt the concept that rejecting the improper projects and undertaking only the proper ones maximizes profit.
- Address the impact that a new project has on the whole company's project portfolio.

The author believes that the root cause of project failures, not only in his company but generally, is their selection of projects. Through this research he will try to

provide a methodology on how to develop successfully project selection processes to a wide range of projects. Upon completion of this thesis, the author will be able to present solutions to projects selection departments or to project directors or to whoever is responsible for project evaluation and selection within organizations. The outcome for the organizations will be to reducing the waste of money and time on improper projects and ensuring profitable allocation of recourses to “the right ones”.

The purpose of this study is to consider the value of Project Portfolio Management (PPM). The author expects through research, surveys, and questionnaires this thesis will provide a booklet to all managers with ways of how to select the right projects which will be truly executable and profitable for the organization. This paper will also demonstrate the usefulness of creating a new project selection model.

1.2 RELATION TO THE PROGRAM OF STUDY

PM 501 - Introduction to Project Management

The professor recommended ways in order to improve projects selection methodologies. The instructor provided multiple ways of evaluating factors that influence the final project choice. In addition, a short presentation of PPM is being made analyzing its significance.

PM 504 - Project Planning and Control

The course showed some of the control and planning symptoms that occur when improper projects are undertaken. Generally, the course works as a consultant to the decision makers so as to think and act proactively.

PM 508 - Project Risks and Decisions

This course provided techniques in order to determine and mitigate the uncertain situations which might occur though projects. Moreover, it also suggested tools so as to improve the decision making processes. This course's documents can be easily related to this research thesis because both aims are to increase the rate of positive decisions.

PM 505 – Systems Concepts and Thinking in Project Management

Systemic theory used to describe the interacting or interrelating groups of activities/parts which, when taken together, form a new whole. Such kind of systemic thinking is a fundamental requirement in order to meet project selection multicriteria view.

PM 507 – Project Financial Management

This course identifies the two different groups of indices in project selection process: the quantitative and the qualitative indices. Moreover, it introduces multicriteria analysis and the way is related to the selection procedures. Financial indicators are usually the major criteria for selecting projects in most organizations.

Project Management and the tools that it provides can help organizations which face similar problems with project selection to handle them. Selecting the right projects is a great advantage that few companies enjoy. The ones do will remain healthy and will ensure their longevity.

1.3 DEFINITION OF TERMS

What is a project? A *project* can be defined as "a complex effort, usually less than three years in duration, made up of interrelated tasks, performed by

various organizations, with a well-defined objective, schedule, and budget" (Archibald, Russell D., 1992).

What is project portfolio? A *project portfolio* is a group of projects that are carried out under the sponsorship or management of a particular organization. These projects call for scarce resources (people, finances, time, quality and so forth) available from the organization or the sponsor, since there are usually not enough resources to accomplish every proposed project which meets the organization's minimum requirements on certain criteria such as potential profitability, feasibility, perspectives and so forth.

What is project portfolio selection? *Project portfolio selection* is the process related to selecting a portfolio, from available list of project proposals, which apparently meets the organization's stated objectives in a desirable manner without exceeding available resources or violating other constraints.

Acronyms used in the study:

MCA - Multicriteria Analysis

PPM - Project Portfolio Management

Project Portfolio Process (PPP) - Link of the organization’s projects directly to the goals and strategy of the organization

ROI - Return on Investment

SWOT analysis - Strengths, weaknesses, opportunities, threats

CB - Crystal Ball

OptQuest – Optimum Quest

CHAPTER 2 PROBLEM STATEMENT

2.1 OVERVIEW

In today's complex business environment, organizations sometimes undertake precarious or improper projects. Lack of a systematic project selection methology results in failure to successfully control and complete projects.

Most of the organizations that take on projects find themselves in an incredibly competitive environment. Their attempt to be constantly profitable for the shareholders endangers their existence as an entity. Acting under such pressure, it is difficult to reject some projects that might prove to be inappropriate for them.

Consequently, it is very hard not only to efficiently implement them but also to have control of all factors that affect on them. Thus completing them on time, in budget and with the desired quality becomes an overoptimistic expectation. In many circumstances, some of the companies in such a position are obliged to withdraw from the projects' implementation.

2.2 THE STAKEHOLDERS OF THE PROBLEM

Project success is a matter of concern for many people who get involved directly by the time of the kick off contract signature.

Customers become more and more demanding by asking organizations to deliver products on schedule, at the minimum cost and maximum quality. Potential omitting in the above usual conditions actually effects in legal problems or great penalties to the companies that were proved insufficient of completing the projects according to the terms of the contract or the product's specifications.

Sponsors desire a high return and fast payback of their investment. Thus, they become very disappointed if some things go wrong during the projects. In that case they demand compensation from organizations.

So far the author involved only the external stakeholders with the problem. In parallel with them, great concern of the problem is, also, shown by the people inside the organization.

Internal discipline and stability among the employees of the corporation may be weakened when improper projects are being undertaken. In many cases, the skills and the cumulative experience of the staff do not meet project requirements. Consequently reworking becomes necessary and results in a great waste of money and time. Conflicts may also, be produced through these messy conditions.

Project Directors usually have to select projects from a pool which includes many similar ones. Afterwards, they become responsible for managing a portfolio with many projects inside the organization. Therefore, the project selections processes are a very crucial business part.

2.3 RATIONALE

NP Archer and F Ghasemzadeh (1999) reported that “project portfolio selection and the associated activity of managing selected projects throughout their life cycles are important activities in many organizations, since project management approaches are so commonly used in many industries for activities such as research and development of new products, implementing new systems and processes in manufacturing, information systems, contracting engineering and construction projects. But there are usually more projects available for selection than can be undertaken within the physical and financial constraints of a firm, so choices must be made in making up a suitable project portfolio.” (p. 207)

A project selection methodology would be very useful for organizations to evaluate the corresponding criteria before the final undertaking of similar projects. In this case a lot of the above mentioned symptoms would be avoided and companies would be healthier.

The author expects this project management research will generate an appropriate recommendation to eliminate or minimize the occurrence of the problem. The research will be oriented to the concept of an article by Reyck et al (2005) that recommends not ‘‘doing projects right’’ but ‘‘doing the right projects’’.

CHAPTER 3 REVIEW OF LITERATURE

3.1 OVERVIEW

This literature review summarizes the research done regarding the implementation of a project selection methodology. The basic literature scope is to categorize the existing data, to combine it with project management tools and techniques, and to strongly support the intended solution.

Therefore, the literature review is organized into three sections: the importance of a capable project selection system, identification of the variables affecting projects selection, and recommended solution through project management strategies.

The importance of a capable project selection system

Harvey A. Levine (2002) underlines the necessity of project portfolio management.

"Executives have come to realize that *projects* are the basis for future profitability of the firm. Hence, there is a growing interest on the part of executives in how projects are managed. They are precipitating an increased demand for more standardization and automation of project management. But what they are asking for is different from the requests from traditional project management sources.

And what they are calling this emerging project management protocol has also changed. It is no longer just project management, or even enterprise project management. It is now called Project Portfolio Management."

In addition, he claims that Project Portfolio Management (PPM) is the bridge between traditional operations management and project management. For organizations that will be depending on project success for success of the overall

enterprise, a well-structured bridge, built on a good foundation, is the preferred way to overcome the traditional gap between operations and projects management.

The pre-conditions that organizations should take into account, when adopting PPM approaches are analyzed in an article by Bert De Reyck et al. (2005). Specifically, this article divides those pre-conditions into three parts:

1. Organizational strategy
2. Business leader's involvement
3. Team skills

Identification of the variables affecting projects selection

This section is concerned with the specific factors and variables that affect project selection as outlined by Jack R. Meredith and Samuel J. Mantel (2005). Firstly, they define the importance of the decision-aiding models telling that "We need such models because they abstract the relevant issues about a problem from a plethora of detail in which the problem is embedded."

They broadly identify proper project selection needs and criteria of selecting the appropriate decision model. Their proposed criteria are:

1. Realism
2. Capability
3. Flexibility
4. Ease of use
5. Cost
6. Easy computerization

The two existing types of project selection models mentioned are: nonnumeric and numeric models. Nonnumeric model is being constituted by:

- The Sacred Row

- The Operating Necessity
- The Competitive Necessity
- The Product Line Extension
- Comparative Benefit Model

Numeric model is being constituted by:

Profitability	Scoring
Payback Period	Unweighted 0-1 Factor Model
Average Rate of Return	Unweighted 0-1 Factor Scoring Model
Discounted Cash Flow	
Internal Rate of Return	

Recommended solution through project management strategies

In the book Crystal Ball® 7.2 (2005), there are some useful strategies that could guide a lot of companies into selecting the optimal project. Furthermore, Jack R. Meredith and Samuel J. Mantel (2005) referred to the firms' lack of project selection methodologies according to a survey which report showing that "none of the respondent firms used mathematical programming techniques for project selection or resource allocation."

Also they recommended project tools and techniques in order the managers to decide successfully what project to prioritize or avoid. Specifically, they referred "we strongly favor weighted scoring models for three fundamental reasons. First, they allow the multiple objectives of all organizations to be reflected in the important decision about which projects will be supported and which will be rejected. Second, scoring models are easily adapted to changes in managerial philosophy or changes in the environment. Third, they do not suffer from the bias toward the short run that is inherent in profitability models that discount future cash flows."

3.2 CONCLUSION

There are indications in the literature that the implementation of a strategic project selection methodology could lead to the generation of a model which will be a credible consultant for the Directors of the projects. This has provided a focal point for the study and a basis for the problem to be investigated.

CHAPTER 4 METHODOLOGIES AND PROCEDURES

4.1 INTRODUCTION

In order to complete this Thesis Project, the methodology that the author will use is a mixture approaches.

Data analysis

In this stage, information will be collected using multiple sources. In addition, questionnaire will also be used in order to provide realistic results. This stage's mission is also, to provide the results of the above mentioned surveys.

Evaluation

After collecting the proper elements, the evaluation of the data collected will be presented. An innovating approach of the problem will be introduced.

Development

As long as the author has addressed most of the criteria that influence projects selection methodologies and prioritized them per project, the next step is to develop a recommendation.

The below figure depicts the systemic thinking which problems like that require so as to gradually result in a effective solution.

Data analysis

Problem confirmation – The questionnaire – The results

Evaluation

Multidimensional approach of the problem

Introducing Multi-Criteria Analysis – Data collection

Development

Connection between the problem and MCA

The Monte Carlo simulation and the Crystal Ball software

Deploy the problem, enhance it with MCA steps and simulate using Crystal Ball software

Figure 1

4.2 PROBLEM CONFIRMATION

4.2.1 THE QUESTIONNAIRE

According to survey made by the author (see Appendix A for a detailed discussion) which performed through questionnaires, among remarkable Managers, Directors and Academic Professors all related to project selection activities, the above problem was proved to be quite substantial in project management world.

The purpose of this survey was:

1. To find out if the problem is actually considered being a fact
2. To determine the project selection criteria which eventually being used from the organizations
3. To discern and range project failures according to project management "*golden triangle*"
4. To rank project selection criteria according to different nature of the projects

The questionnaire is related to project selection processes. It is being constituted from 7 questions each one requires filling a gap or selecting a preferred answer. At the end of that form, it is being asked if the person who participates in the survey would desire to have feedback of the results.

4.2.2 THE RESULTS

The questionnaire created in order the author to approach market's trends and moreover, to confirm that the mentioned problem is real. The questionnaire is divided into seven questions related to project management.

The results were classified and are now briefly shown below:

1. What are the 5 most significant reasons that influence your organization in order to select one project against to another?

Type of criterion	**Total Percentage**	**Business Area**			
		Constructing	Services	Co-Financed (EU)	Academic
Profitability	70%	30%	20%	20%	-
Perspectives	50%	20%	10%	10%	10%
Resource availability	60%	30%	10%	10%	10%
Know How	40%	10%	-	10%	20%
Company strategy	10%	-	-	10%	-
Added value	20%	10%	-	-	10%
Relativity	10%	-	-	-	10%
Labor skills	30%	20%	-	10%	-
Added value	20%	10	-	-	10%
Scientific research attitudes	10%	-	-	-	10%

Table 1

The answers for the 1st question show off some important elements for the survey. First of all, criterion "profitability" is the most important factor for all the types of

business areas, except for the academic one. The next more important factors are "resource availability", "perspectives", "know how" and "labor skills".

2. How many projects per year are getting failed to meet cost, schedule or performance (even if they were considered to be successful)? (Please give an approximate percentage for each one)

Type of specification	**Business Area**			
	Constructing	Services	Co-Financed (EU)	Academic
Cost	22,50%	51%	10%	20%
Schedule	22,50%	2,5%	10%	45%
Performance	16,25%	6,5%	0%	20%

Table 2

As shown in the above answer table, constructing projects face problems mainly in the cost and schedule area. Services projects have more difficulties in meeting cost specification. EU projects face cost and schedules problems. Finally, academic projects find it difficult to meet schedule.

3. What is mainly the most usual specification, which most projects in your company fail to meet? (Please underline the preferable)

Type of specification	**Business Area**			
	Constructing	Services	Co-Financed (EU)	Academic
Cost	v	v	v	
Schedule	v		v	v
Performance				
Other	v			

Table 3

This table depicts with "v" the main reasons why organizations in many different business areas fail to implement successful projects.

4. Does your company use any kind of software or other kind of facility so as to optimize projects selection ability? If yes, please name it. (Optional)

Type of software	Business Area			
	Constructing	Services	Co-Financed (EU)	Academic
Excel	25%	50%	25%	50%
Ms Project	50%		25%	25%
Other	12,5%	50%		
Nothing	12,5%		50%	25%

Table 4

The table informs readers what type of software are being used so as to improve project selection methodology inside the organizations. It is quite remarkable to say that most of them don't use project oriented software, as to prefer to create their own models in "excel" application. One other interesting result is that the business area which has the biggest diversity in using software facilities is the constructing one. Finally, there is a big enough percentage per almost each category showing that many organizations doesn't even use a facility to optimize project selection methodology. That fact shows that in many cases, the selection of projects happens empirical or even randomly.

5. Do you think that your organization counts all of the potential criteria that might influence project success?

Type of answer	Business Area			
	Constructing	Services	Co-Financed (EU)	Academic
Yes	50%	50%	50%	
No	25%	20%	40%	100%
Not sure	25%	30%	10%	

Table 5

This report shows the need for a new way of approaching project portfolio selectionism. All business areas include a percentage of people which are not satisfied with theirs organization project selection methodology. Moreover this table confirms

problem statement and shows that there is a lot of market space for this survey and its results.

6. Please rate from 1 to 5 the below project selection criteria according to your company policy. (1=Lowest of concern, 5=maximum of concern).

Type of criterion	**Rate**	**Business Area**			
		Constructing	Services	Co-Financed (EU)	Academic
Labor Skills	1	25%			
	2				
	3	50%		100%	
	4				
	5	25%	100%		100%
Relativity to company's profile	1				
	2		50%		
	3	25%		50%	
	4	50%		50%	100%
	5	25%	50%		
Competition	-				50%
	1	50%			
	2			50%	
	3	50%	50%	50%	50%
	4		50%		
	5				
Profit	1				100%
	2				
	3				
	4	25%		100%	
	5	75%			
Reputation	-	25%			
	1				
	2		50%	50%	50%
	3	25%	50%		50%
	4				
	5	50%		50%	
Maintain customer relationships	-				50%
	1				
	2	25%		50%	50%
	3	25%	50%		
	4	50%	50%	50%	

	5				
Impact on project portfolio	-	25%			
	1				
	2	25%	50%		
	3	25%	50%	50%	50%
	4				50%
	5	25%		50%	

Table 5

7. Have you ever rejected a profitable project because you considered it to be very risky for your company or irrelevant to your business field?

Type of answer	**Business Area**			
	Constructing	Services	Co-Financed (EU)	Academic
Yes	75%	100%	50%	100%
No	25%		50%	

Table 6

Risk is a great factor influencing all of human's activities. Projects are a kind of activities which include a lot of risk, and in many times is unknown. This report is interesting because it shows that many managers in organizations take into account risk data and don't hesitate to reject projects that considered being very risky for their firm.

4.2.2 DISCUSSION OF THE RESULTS

Summarizing the results, it can be arisen that there is a big enough market gap between project portfolio selection and the way it could be applied so as to bring in effective outcomes for the organization. People working on projects selection methodologies are ready to embrace a new methodology which to approach the problem realistically, to incorporate risk wherever is needed and exact workable recommendations.

This questionnaire's results guided author to make an attempt to combine information, knowledge and market trends so as the output be a credible "friend" for the decision managers or anyone who is related to project portfolio selection decisions.

4.3 MULTIDIMENSIONAL APPROACH OF THE PROBLEM

History has shown that projects throughout the world fail to meet the most common criteria, even if they are considered to be successful. Traditional methods of project evaluation such as benefit-cost analysis focus mainly on the financial rewards of projects and do not sufficiently consider multicriteria and risk evaluations in an integrated framework. According to that incontestable fact which confirmed throughout questionnaire's report made by the author, and analyzed in previous chapter, the problem of project portfolio selection is not a linear one. Since now the most common criterion which used so as the decision makers to select the appropriate projects, was the finance one without interrelating it to many others that probably had similar weighting factor to the final choice.

There are many criteria which influence selectionism of the "right projects" apart from finances ones such as labor skills, resource availability, perspectives, and so forth. All of them should be quantified counting in parallel all the appropriate risk ambiguities.

Consequently, it is easily understandable that project portfolio selection is a multi-dimensional problem and that should be the base to bank on.

4.4 INTRODUCING MCA – DATA COLLECTION

4.4.1 DESCRIPTION OF THE TECHNIQUE

In a situation which the directors have to evaluate firstly and finally to select some projects rejecting some others, multiple criteria are involved. Confusion can easily arise if a logical, well-structured decision-making process is not followed. Development of an objective and systematic methodology that could address the multicriteria nature of the projects and also deal with their risks and rewards is necessary for both private and public agencies. Multi-Criteria Analysis (MCA) is a decision-making tool developed for such complex problems.

Multicriteria analysis made its first appearance in the 1960s as a decision-making tool. By using that technique, several criteria can be taken into account simultaneously in a complex situation. The method is designed to help decision-makers to integrate the different options, reflecting many alternative opinions of the actors concerned, into a prospective or retrospective framework. Participation of the decision-makers in the process is a central part of the approach. The results are usually directed at providing operational advice or recommendations for future activities.

4.4.2 PURPOSE OF THE TECHNIQUE

The technique’s purpose is to structure and combine the different assessments to be taken into account in decision-making, whereby decision-making is made up of multiple choices and the treatment given to each of them influences the final decision in proportion to the individual weighting factor. It is usually used to synthesize the opinions expressed, in order to determine the priority structures, to analyze conflictual

situations, or to formulate recommendations or operational advice. Some of the various MCA applications are given below:

- Makes recommendations on the process of budgeting, either while the program is underway or during the preparation of it. The main decisions in this respect are taken at the measures level. When the results indicate that measures judged to be the least successful, then re-examination of them becomes necessary. Probable recommendation is either reducing the budgets or re-organizing the whole process so as to enhance effectiveness. In opposite, recommendations can also be made to increase the budgets of those measures ranked as being the best.
- Selects the best practice, by identifying the areas of success and the most effective measures of the program..
- Provides feedback on project selection methods. An appropriate use of multicriteria analysis method can deploy the correct evaluation criteria; their precise definition and their weighting constitute. This work makes it possible to formulate a clear, complete and coherent description of the intentions and priorities of every project portfolio. It is then possible to use these results to spread clear messages to the senior managers of the measures and their future possible acts
- Enhances the project selection process. Transferring criteria, scoring scales and weightings to the project selection system are some of the basic practices which MCA applies, considering that this system is also organized on the basis of scoring-weighting. By basing the selection of projects on the same logic as the evaluation of measures, the chances of stimulating and funding projects which contribute effectively to the program priorities are increased.

4.4.3 THE STEPS IN MCA

The main steps involved in multicriteria analysis can be broken down into several phases described chronologically below. It is possible to repeat the phases and thus to make corrections.

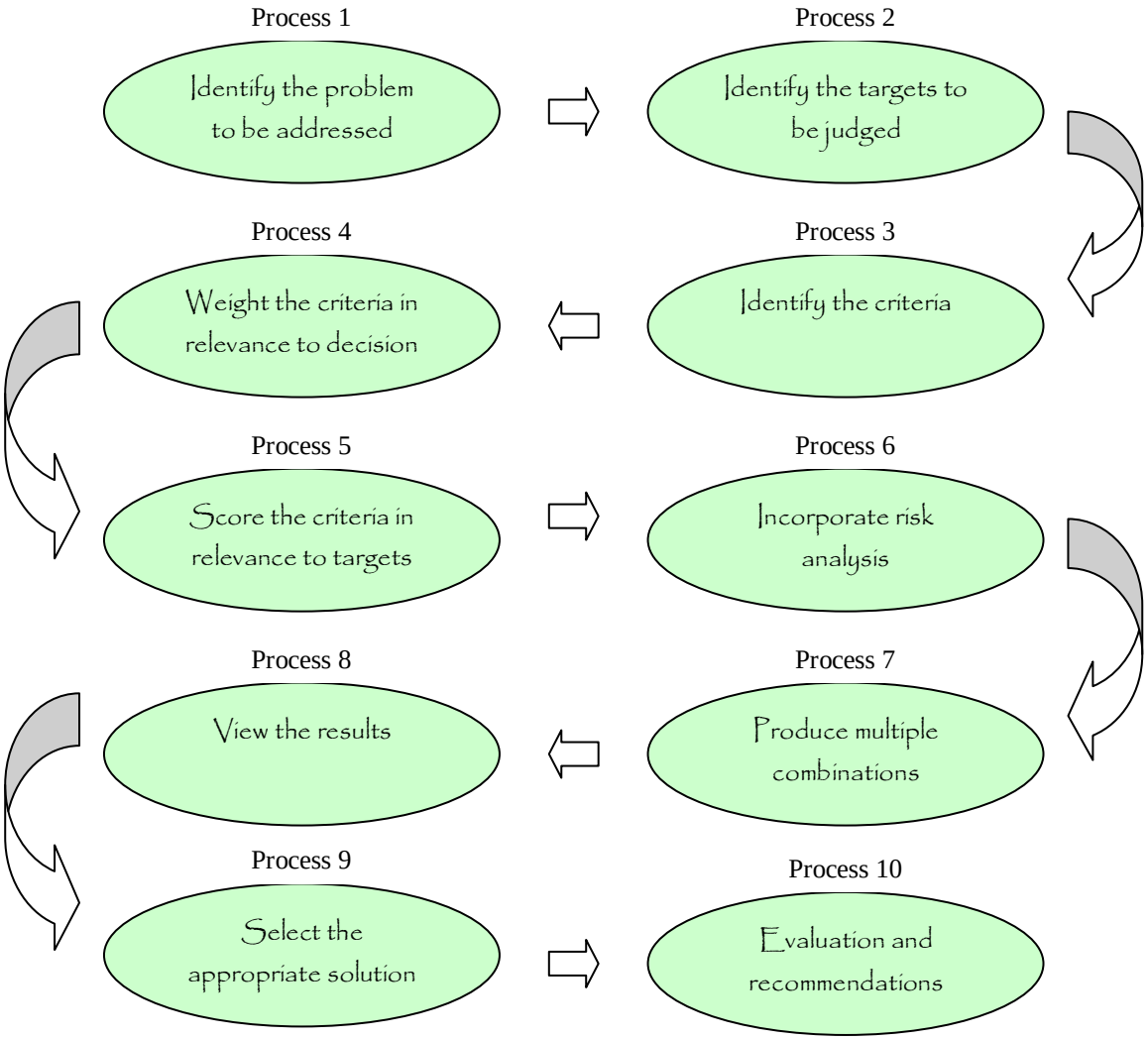

Figure 2

4.5 CONNECTION BETWEEN THE PROBLEM AND MCA

The project selection problem is being covered by many adjacent criteria which happen to influence those crucial decisions. Most of the organizations that find themselves in a position which have to select some projects against to others make their decision depending just on financial data. That means the criteria they count the decision process on, are usually some of the above:

Expected Revenue

Profitability

Return on Investment

Despite the fact that financial objectives are the main factors which motivate organizations so as to undertake projects, in many circumstances that fact becomes the root cause of the problems that arise during their implementation. There are many others criteria which since they get quantified, can feed the project selection decision with crucial information about the applicability scoring of each project. The final and the most crucial criterion remains the finances, but this time it is embedded by the impact of others significant criteria.

In *figure 3*, there is a widely report which shows the correlation between the problem and MCA:

MCA PROCESS		PROJECT PORTFOLIO SELECTION
Identify the problem to be addressed	Stage 1	The initial stage requires a clear identification of the problem. The problem is which projects to select so as to have the maximum of utility.
Identify the targets to be judged	Stage 2	The targets are all of the candidate projects which are possibly executable.
Identify the criteria	Stage 3	The criteria include all of the parameters which seem to influence the projects success.

Weight the criteria in relevance to decision	Stage 4	In that stage the manager has to weight the criteria according to how much each one influences his decision.
Score the criteria in relevance to targets	Stage 5	The decision maker scores the criteria per project according to the extent each one satisfies decision percentage.
Incorporate risk analysis	Stage 6	The criteria percentages per project need to be covered by the appropriate risk distribution in order to eliminate risk uncertainty.
Produce multiple combinations	Stage 7	In that stage the manager runs continuous simulations giving different value to each project criteria percentage according to individual risk deviation.
Select the appropriate solution	Stage 8	This step is to select the "right" projects finding the optimal solution.
View the results	Stage 9	The pre-final step is to view the generated reports and evaluate the situation in a most realistic view.
Evaluation and recommendations	Stage 10	Finally, evaluations and recommendations are about to take place comparing the results before

		and after applying the MCA process.

Figure 3

4.6 THE MONTE CARLO SIMULATION AND THE CRYSTAL BALL SOFTWARE

4.6.1 BRIEF REVIEW

Future estimates are not facts but statements of probability about how things will turn out. Because estimates are probabilistic assessments, costs may actually be very different than estimated even by seasoned professional estimators. The reasons are often causes that are outside the control of the manager, but may also be endemic to the estimating process, or the corporate culture. A risk estimating method is available that provides more accurate estimates. The method is based on Monte Carlo simulation.

Uncertainty about a situation can often indicate risk. Almost any change, good or bad, poses some risk. A typical analysis usually reveals numerous potential risk areas: overtime costs, results if geological survey, personnel fluctuations, changing labour costs, government approvals and so forth. Once the risks are identified, a model can help quantify the risks. Quantifying risk means putting a price on risk, to help decide whether a risk is worth taking. Traditionally, spreadsheet analysis tried to capture this uncertainty in one of three ways: Point estimates, Range estimates, and What-if scenarios. There are several ways to perform a risk analysis, but one method involves building a spreadsheet model, which can be very helpful in identifying where the risk might be, since cells with formulas and cell references identify causal relationships among variables.

One of the drawbacks of conventional spreadsheet models, however, is that only one value can be entered in a cell at a time. This is where Monte Carlo Simulation and

Crystal Ball (CB) S/W come in. A model is a spreadsheet that has taken the leap from being a data organizer to an analysis tool. A model represents a process with combinations of data, formulas, and functions. As one adds cells that help better understand and analyze data, the data spreadsheet becomes a spreadsheet model. CB helps define those uncertain variables in a whole new way: by defining the cell with a range or a set of values. One type of spreadsheet simulation is **Monte Carlo simulation**, which randomly generates values for uncertain variables over and over to simulate a model. Simulation refers to any analytical method meant to imitate a real-life system, especially when other analyses are too mathematically complex or too difficult to reproduce. Without simulation, a spreadsheet model will only reveal a single outcome, generally the most likely or average scenario. Spreadsheet risk analysis uses both a spreadsheet model and simulation to automatically analyze the effect of varying inputs on outputs of the modelled system.

For each uncertain variable (one that has a range of possible values), one may define the possible values with a probability distribution. The type of distribution that is selected is based on the conditions surrounding that variable. With CB, these equations are automatically calculated; CB can fit a distribution to any historical data that one might have. A simulation calculates multiple scenarios of a model by repeatedly sampling values from the probability distributions for the uncertain variables and using those values for the cell. During a single trial, CB randomly selects a value from the defined possibilities (the range and shape of the distribution) for each uncertain variable and then recalculates the spreadsheet. The probability distributions that describe the uncertainty surrounding specific input variables are referred to in CB as "assumptions".

4.6.1 SIMULATION USING OPTQUEST

In cases, such the selection of the optimal project portfolio, where there are multiple possible solutions Crystal Ball offers a powerful tool in order to simplify the final decision. This tool is called Optquest (Quest of the optimal solution) and requires that at least one simulation of the model is run. In the present paper the target is to find the optimal projects combination.

4.7 DEPLOY THE PROBLEM, ENHANCE IT WITH MCA STEPS AND SIMULATE USING CRYSTAL BALL SOFTWARE

4.7.1 INCORPORATING MCA STEPS

In order to, realistically, approach the problem the author has to make an assumption. This shall be the basis to our survey.

MCA / STEP 1 – What is the problem?

Summary

The R&D group of a Greek construction company has identified eight possible projects. Combining knowledge from different departments within the company, the management has computed: **(1)** the expected revenue for each project if it is successful, **(2)** the multiple and different criteria which their score impacts success, **(3)** the estimated weighted project score for each project, and **(4)** the initial investment required for each project. Using these figures, the finance manager has computed the expected return and the expected profit for each project. Unfortunately, the available budget is only $2.0 million, and selecting all projects would require a total initial investment of $2.8 million. Thus, the problem is to determine which projects to select to maximize the total expected profit while staying within the budget limitation.

Complicating this decision is the fact that the expected revenue and all of criteria rates are highly uncertain. As shown in *figure 4* below:

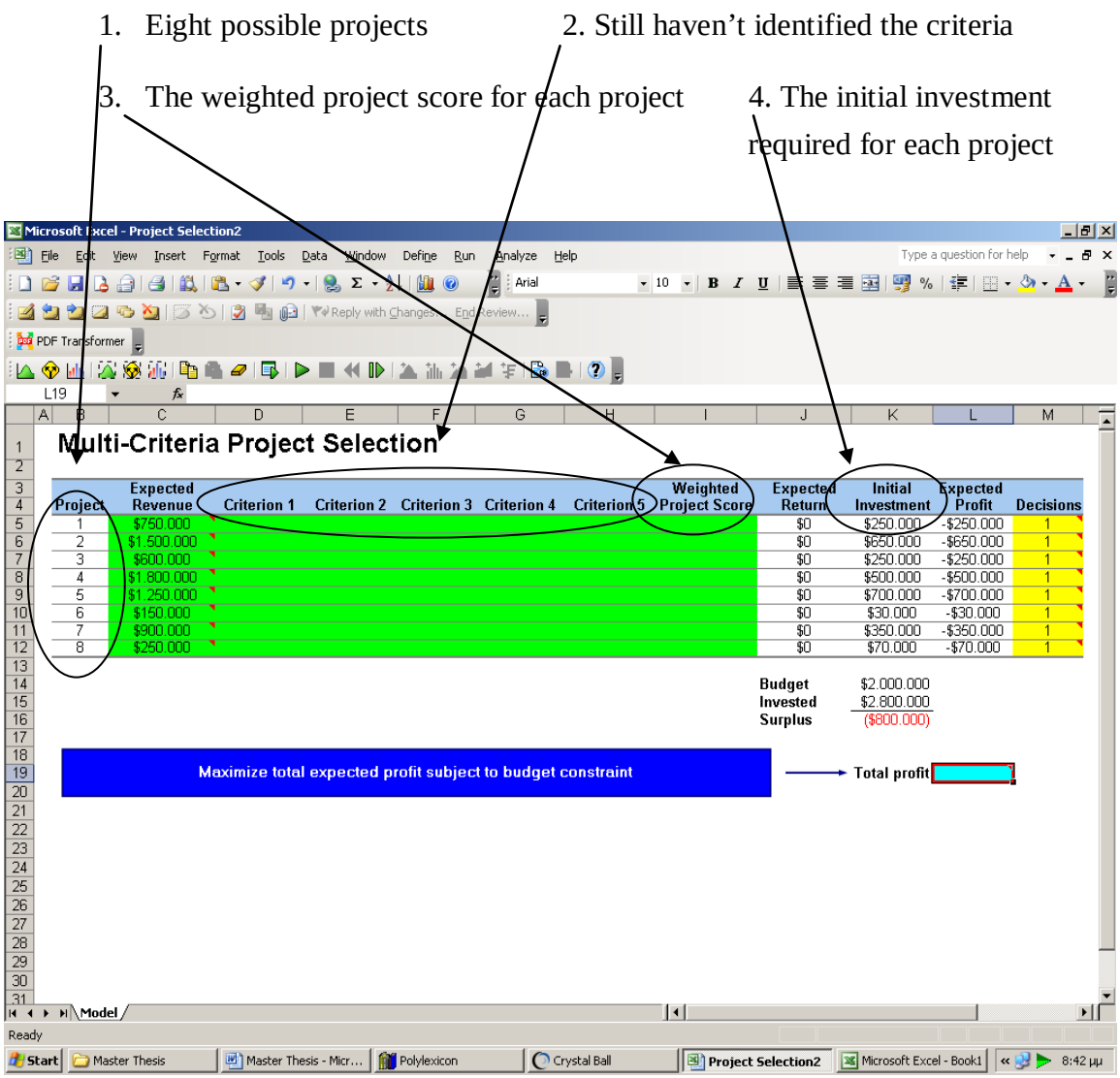

Figure 4

MCA / STEP 2 – How many are the candidate projects to execute and how will the manager decide?

The decision

The CEO or the related manager has to evaluate the eight projects, resulting into which projects to invest. Thus he has to take a crucial decision. That decision needs to be separated to some criteria. Each of them influences the decision. The manager then must compound with organization's top management level, about weighting the

criteria in relation to the decision. This usually depends on the desired outcome which organizations expect by implementing these projects.

MCA / STEP 3 – Identifying the criteria

There are too many criteria influencing a decision so as the manager to be able to deploy and count each of them. The next stage is to decide on how to compare different options' contribution to meeting the objectives. The above fact requires the selection of criteria to reflect performance in meeting the objectives. Each criterion must be measurable, which means that it must be possible to assess how well a particular project is expected to perform in relation to the criterion.

Based on the questionnaire's results and according literature, the most important criteria which firms count most when selecting a project portfolio are:

Profitability – Without doubt, project selection decisions are being based primarily on the degree to which of the organization's financial goal is met. Profitability remains one of the most fundamental criteria for the firms, which guide many of them into all their decisions.

Labor Skills – However profitable a project might be basic requirement in order to approach success is the ability and the group of skills which the available personnel hold. Not all kinds of projects are suitable for the employees of the company. Before naming a candidate project as executable one, the decision maker must firstly consider the project's requirements in regard to labor skills.

Competition – Living and acting in an extremely competitive business environment, it would be crucial mistake to ignore competitors' movements. Many times organizations change dramatically theirs strategy in order to follow the antagonists' one. Thus, it is obvious that competition trends influence some times positively project portfolio selection processes and some others negatively.

Reputation – Occasionally, many firms proceed in a set of actions not because they might prove to be profitable but to be famous inside the market they act. Positive reputation is a comparative advantage for the organizations. Rational managing leads many times to lucrative and furthers more long-term outcomes.

Feasibility – Not calling rare the phenomenon of many organizations to withdraw from project execution as a result of not being capable to meet the required specifications. Consequently, they result to pay penalties for non conformance to the contract's terms. Thus, when a firm employ feasibility to a category of projects it also, acquires credibility among the market.

Resource Availability **–** One of the most essential elements constituting project success is resource availability. Since projects ensure the means which can provide stability and security, it is very common the whole venture to lead to a success. Getting closer to reality, organizations find it more and more difficult to find recourses, especially the physical ones which are continuously being reduced.

Know How **–** Having knowledge of the way a project needs to be implemented is a great advantage for the company that undertakes it. Substantially the "know how" criterion influences many others as long as it is considered to be one of the most crucial decisions for the organization. Moreover, it can also prevent the selection of a project that there is lack of knowledge inside the organization.

Perspectives **–** Project portfolio selectionism does not depend only in criteria which might value to firm directly. In many cases, the managers take decisions which result in the long run. Such kind of criteria is the "perspectives" that project could return to organization. "Perspectives" might include opening of a new market, undertaking more projects in the future and further more.

Relativity **–** Not every project is related to company's profile, policy or others business characteristics. Projects which do not fulfill some of the above criteria are

being characterized as irregular and consequently they are being rejected from the company's portfolio. Relativity refers more to credibility that an organization desires to release, than to technical issues.

Scientific research attitudes – Organizations in the local area like universities, research centers as R&D departments in the private sector, usually consider scientific perspective as one of the main factors so as to undertake projects. In the last years, there is a trend which guides more and more organizations so as to prefer projects which improve their scientific background.

All of the above mentioned criteria depend mostly on the project type. There are many different types of projects as construction projects, R&D projects, co-financed (EU) projects, academic projects and projects which provide services. As long as the people who filled in the questionnaire come from different business areas, it is easy for the author to score each of the above criteria according to theirs significance to the different types of projects. The scoring scale is between 0 (minimum of significance) and 5 (maximum of significance).

No	**Type of project**	Constructing	R&D	Co-Financed (EU)	Services	Academic
	Criteria					
1	Profitability	5	2	3	4	4
2	Labor Skills	4	4	4	4	4
3	Competition	3	4	2	3	3
4	Reputation	3	3	2	4	3
5	Feasibility	3	5	3	3	4
6	Resource Availability	4	3	3	2	3

7	Know How	5	1	3	3	5
8	Perspectives	4	5	3	3	2
9	Relativity	3	3	3	3	2
10	Scientific research attitudes	1	5	1	1	1

Table 7

MCA / STEP 4 – Weight the criteria in relevance to decision

As mentioned before, the company will undertake a constructing project. Thus, the column that concern management mostly is the first one (constructing projects). The criteria which will guide to the decision should be those with the maximum of scoring. Evaluating data from *figure 7*, the five most significant criteria that influence people inside the constructing company so as to select projects portfolio, are the below:

(This decision holds a weighting factor per criterion which affects it separately)

Criteria	**Weighting factor**
1. Profitability	40%
2. Resource availability	10%
3. Labor skills	20%
4. Perspectives	20%
5. Know how	10%

Thus, a new table is added in the decision model firstly shown in *figure 4*. In *figure 5*, the new table (*The decision*) is easily seen.

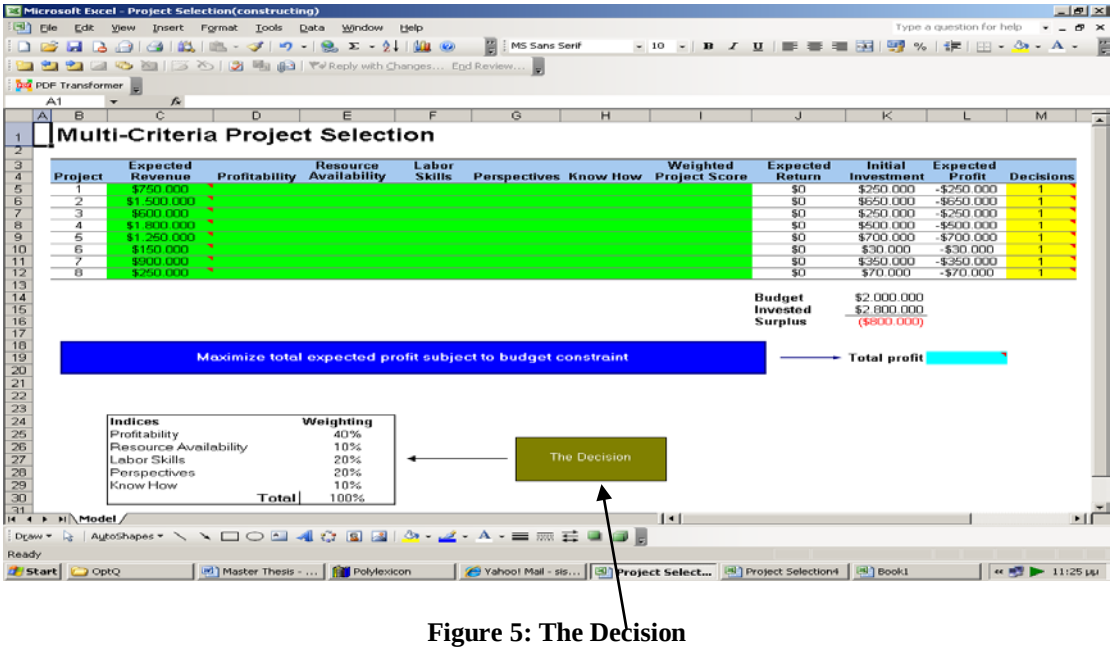

Figure 5: The Decision

The weighting factor is not a constant number, but it can be altered according to the organization policy. For example, the upper level management is able to score each criterion differently considering firstly the impact that each one of them hold in the final decision. Based on *figure 5*, the author gave to "profitability" weighting factor the maximum score.

MCA / STEP 5 – Score the criteria in relevance to projects

The next step is about scoring each criterion in relevance to projects. Every criterion is being satisfied in a different percentage to every project. Thus, the decision maker fills the green cells with the estimated number of criterion satisfaction. The cells D5-D12 refer to profitability, E5-E12 refer to resource availability, F5-F12 refer to labor skills, G5-G12 refer to perspectives, H5-12 refer to know how. The percentage which the manager gives to each one of the criteria are based on the percentage he previously gave to the criteria in relevance to decision. For example, if he gives for the "profitability" criterion in cell D5 a percentage of 50%, it will be correlated to the percentage of 40% in cell E25, which means that in Project 1 the

criterion “profitability”, satisfies the 50% of the 40% of his decision. Thus, his decision is fulfilled 20% until now.

Filling the cells, the manager can easily figure out that the column titled “Weighted Project Score” is automatically getting completed too. That column calculates the total project score in relevance to decision. The percentage given shows in what extent every project satisfies the decision. For example, the calculation that runs “behind” I5 cell is: D5*E24+E5*E25+F5*E26+G5*E27+H5*E28.

Similarly, the manager completes all cells with the estimated percentages as shown in *figure 6* below.

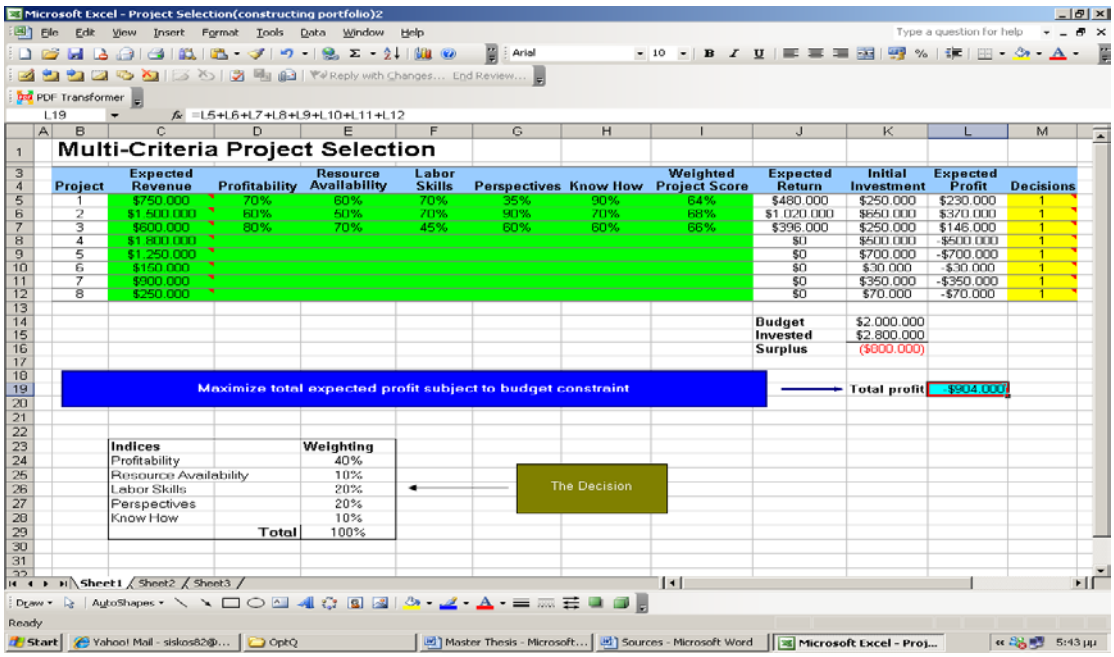

Figure 6

The next column named “expected return” depicts the “expected revenue” placed in column C, but this time it is multiplied by the specific “weighted project score” of each project placed in column I. For example, J5 = $750.000 * 64% = $480.000. When the manager fills all cells in column J, then the column “expected profit” will calculate automatically: expected return (J5) – initial investment (K5). Finally, all the above calculations end in cell L19, which forecasts the “Total profit” if organization selects all projects. All the above are shown in *figure 7* below:

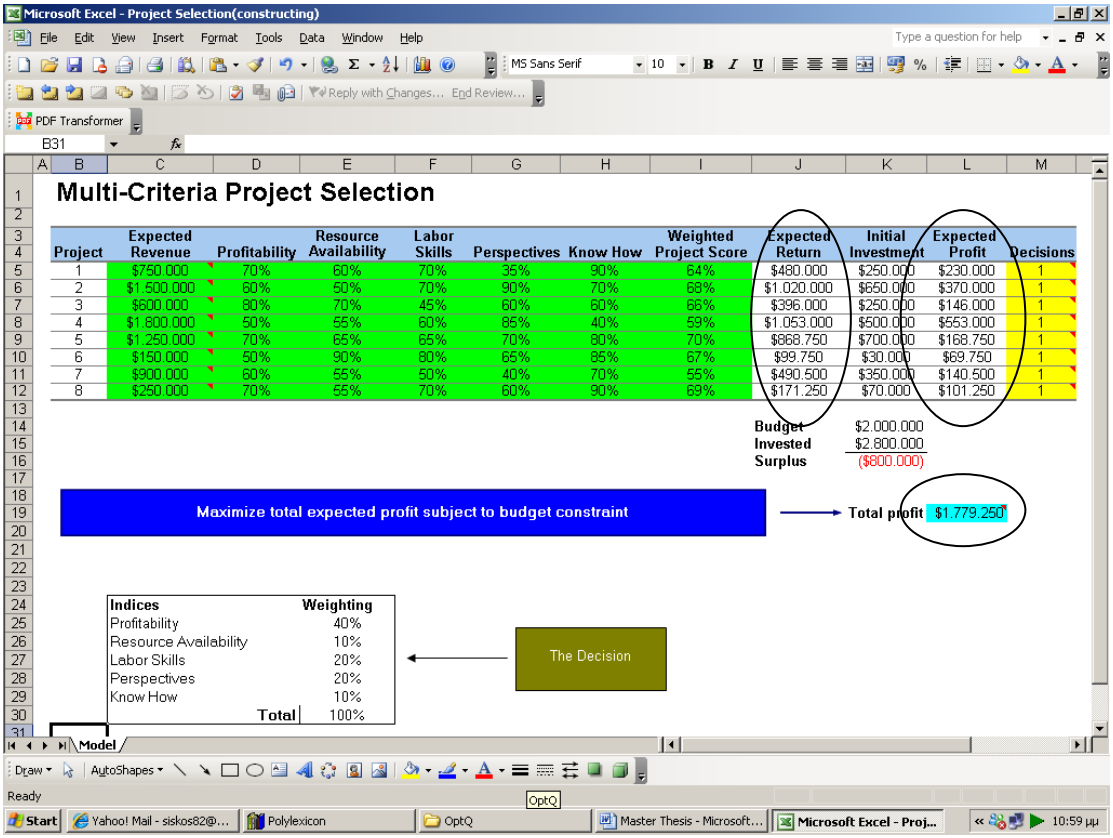

Figure 7

MCA / STEP 6 – Incorporate risk analysis

The most essential step in MCA process is the one where the manager, in collaboration with risk management department, identifies risks and thereinafter allocates their impacts into the percentages which are already given. The “green” cells represent variables values, which contain risk dosage. The manager has to incorporate risk deviation into every “green” cell in order to accomplish realistic results and help his organization plan based on true data.

As mentioned in the previous paragraph, every “green” cell hides a risk distribution. In order to allocate risk distribution for every column between C5 – I5, the manager has to decide previously about the type of risk which he will ascribe to every variable factor. When he decides risk distribution, he selects the button “define assumption”.

Variable 1 – column C

Expected Revenue

Description: Expected revenue depends on many factors. Estimating without counting risk is quite dangerous. Historical results show that giving a standard deviation of 10% is realistic enough.

Risk Distribution: Normal Distribution

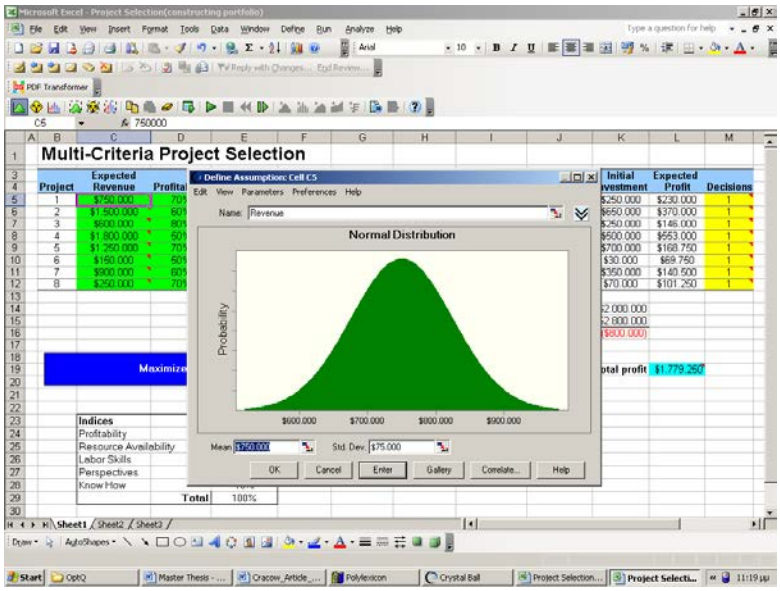

Figure 8: Normal Distribution

Variable 2 – column D

Profitability

Description: It is the factor which almost every firm counts most. Its approach should be very careful. Potential mistakes in its calculation may guide organizations into undertaking wrong projects. Risk allocation is in parallel to expected revenue.

Risk Distribution: Normal Distribution

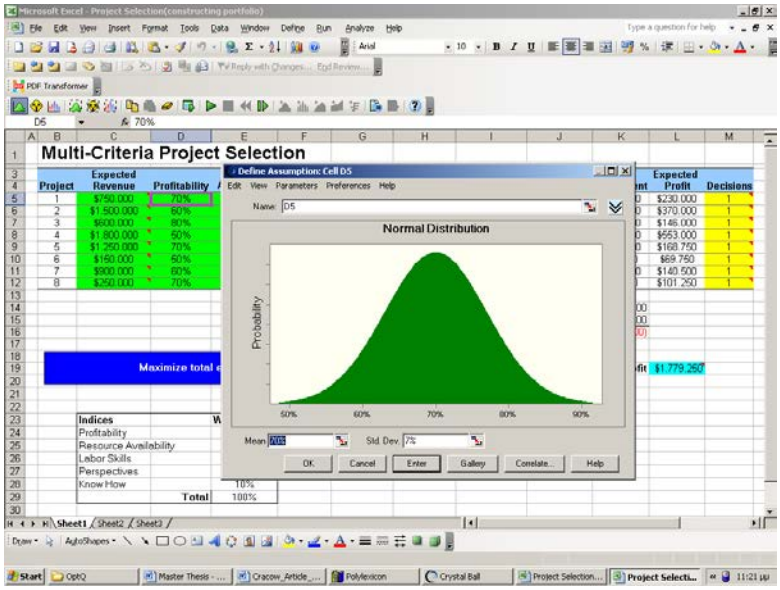

Figure 9: Normal Distribution

Variable 3 – column E

Resource availability

Description: Physical resources are scarce by their nature. Artificial resources are being reduced in proportion to the number of projects implemented simultaneously. The larger the number of projects the fewer the resources.

Risk Distribution: Minimum Extreme Distribution

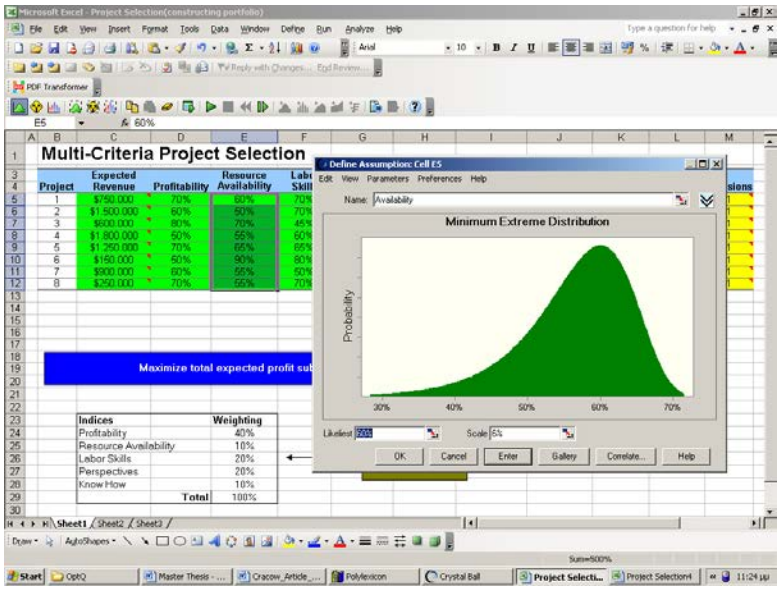

Figure 10: Minimum Extreme Distribution

Variable 4 – column F

Labor skills

Description: Departments are usually being constituted by personnel who hold big variety of skills. During projects life cycles, circumstances may occur skill needs which weren't been predicted. Thus, risk variance should include a wide range of potential values.

Risk Distribution: Uniform Distribution

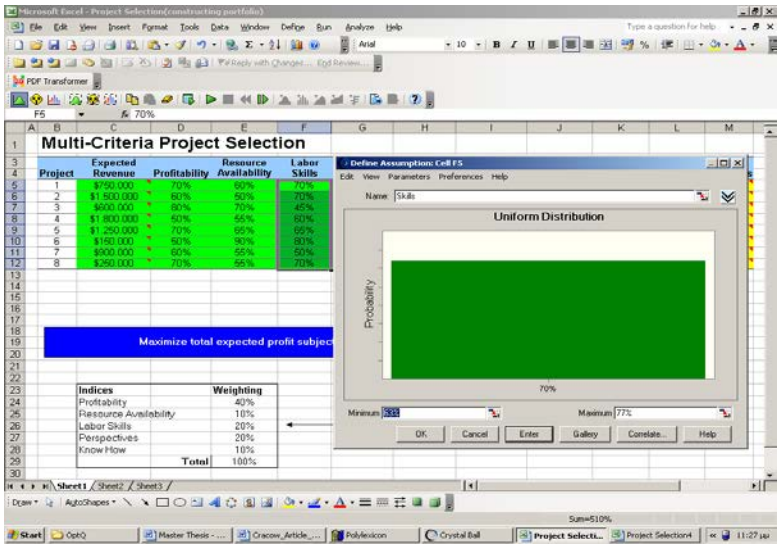

Figure 11: Uniform Distribution

Variable 5 – column G

Perspectives

Description: Projects generate many perspectives. Perspectives are a difficult criterion to quantify as it endangers many risks. Perspective deviation risk can be influenced by anything during project implementation. It usually takes values inferior to the prospective.

Risk Distribution: Pareto Distribution

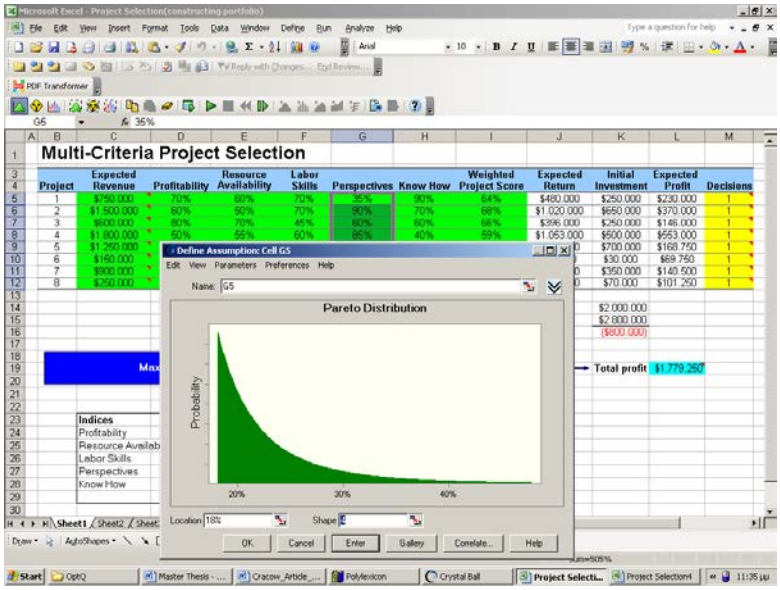

Figure 12: Pareto Distribution

Variable 6 – column H

Know how

Description: This criterion seems to be as the most unfussy one. That because when similar projects are being implemented, then the firm acquires know how and feels more secure to undertake new ones. Risk allocation becomes more accurate. However some possibilities still exist so as to turn over the whole project. That happens when unknown technology occurs.

Risk Distribution: Binomial Distribution

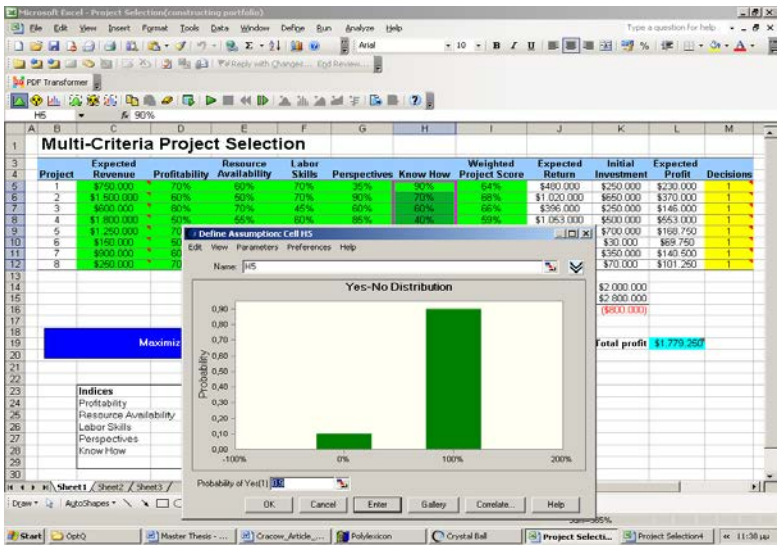

Figure 13: Binomial Distribution

MCA / STEP 7 – Produce multiple combinations

As long as risk distributions have been allocated, it is time to simulate using Monte Carlo simulation, as it has been already mentioned in §4.6. This method selects random values for each cell depending on the deviation the manager had previously given to every criterion. Then, we run Monte Carlo simulation through 1,000 trials of the execution scenario.

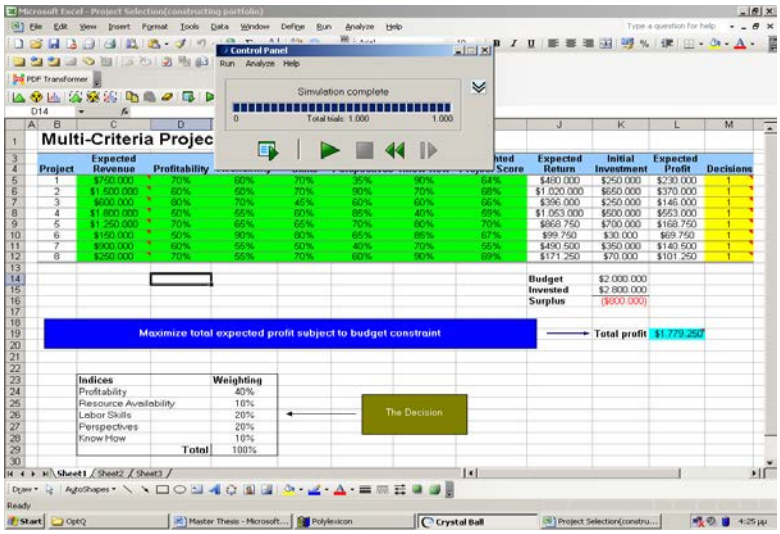

Figure 14: Simulating with CB

MCA / STEP 8 – Select the appropriate solution

By the time we have concluded one simulation we can run Optimum Quest. OptQuest requires decision variables (*figure 15*), which are model variables over which the user has control. The eight decision variables defined in this model are in cells M5:M12 of the Model worksheet. These will be either a 0 or a 1 showing rejection in the first and selection in the other one. Each decision variable is yellow colored.

OptQuest starts from the Run menu. The OptQuest Wizard is used to define the settings for the optimization. The problem has one constraint (total cost will not

exceed budget limit of $2.0 million) and one objective: to maximize Total Profit (*figures 16, 17*).

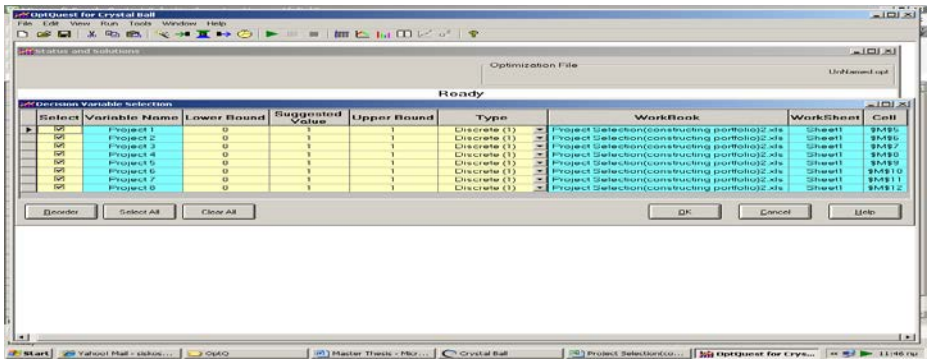

Figure 15: **Decision variables.**

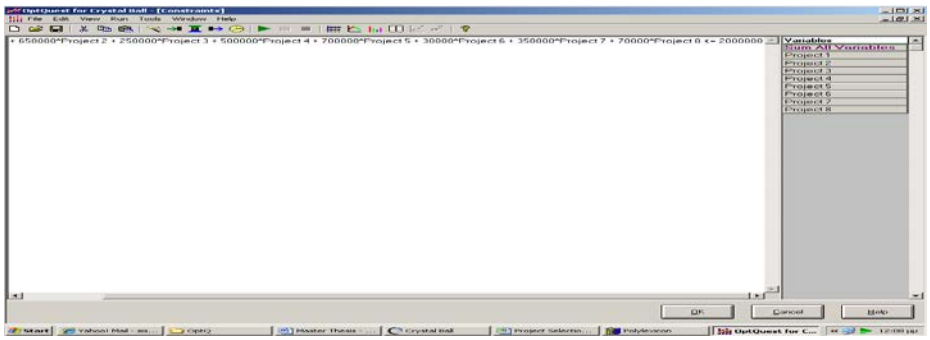

Figure 16: Constraint (total cost will not exceed budget limit of $2.0 million).

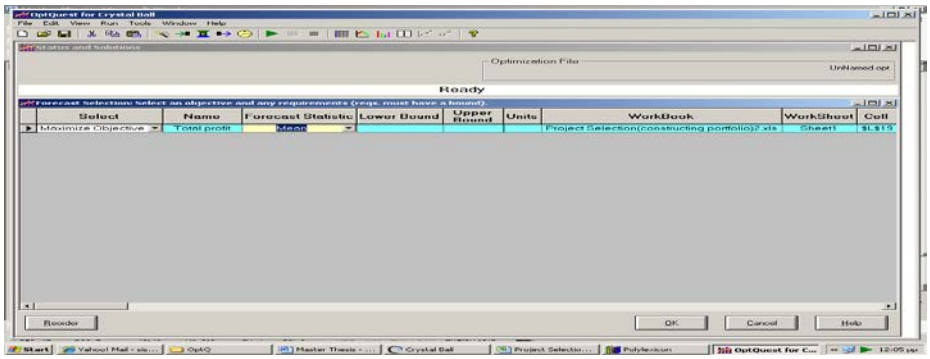

Figure 17: **Objective (maximize Total profit).**

When the settings are defined (*figure 17*), Optquest is ready to start the optimization. For each optimization, OptQuest selects a new value within the defined range of each decision variable (e.g., a 0 or a 1) and runs a Crystal Ball simulation. OptQuest then saves the mean Total Profit value. OptQuest then runs another simulation on a new set of decision variables. OptQuest repeats this process,

constantly searching for the maximum Total Profit until it either works through every possible solution or reaches the end of the set running time.

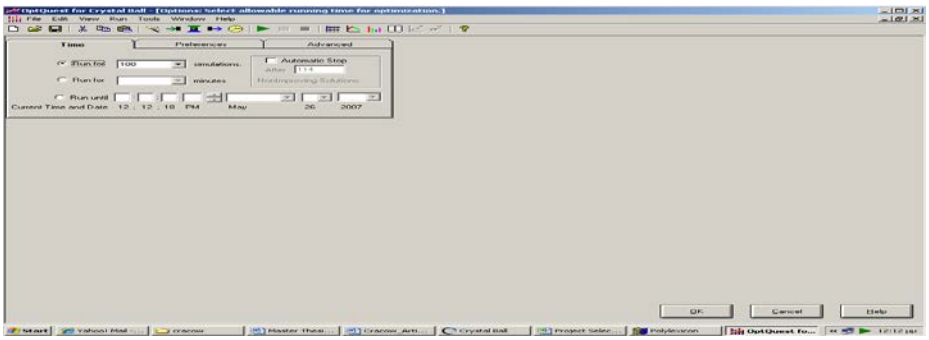

Figure 18: **Options Setting.**

As OptQuest runs, it uses multiple metaheuristic methods and techniques to analyze past results and improve the quality and speed of its process. One can watch OptQuest's progress through the performance graph (*figure 19*), which shows a flattened line as it converges to an optimal result.

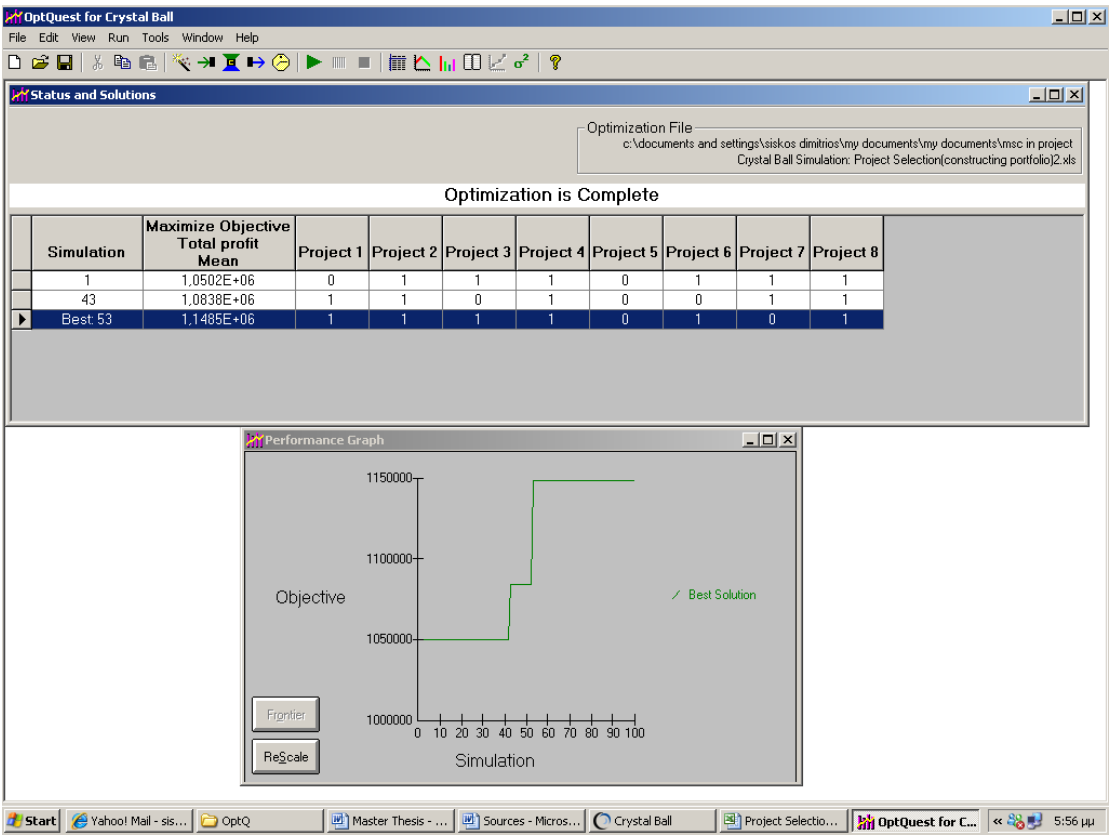

Figure 19: **The performance graph.**

CHAPTER 5 RESULTS

5.1 BRIEF RESUME

By the execution of the above processes, the methodology concerning the establishment of a capable and dynamic model has been set up. This model includes decision parameters, expected revenue, five criteria, expected return, initial investment, and expected profit per project, total profit and risk elements. The next step for the manager is to get informed about the outcomes which are being generated by running the simulation briefly described in the previous chapter. The elements interrelate so as to result in many useful reports which will help decision managers to select the appropriate projects.

5.2 APPLYING THE 9TH MCA STEP

MCA / STEP 9 – View the results

This step comes out as the result of **7th step** application. After simulating model for 1000 trials, the manager finds himself in the position which has to view and translate all of the reporting results.

Report No 1

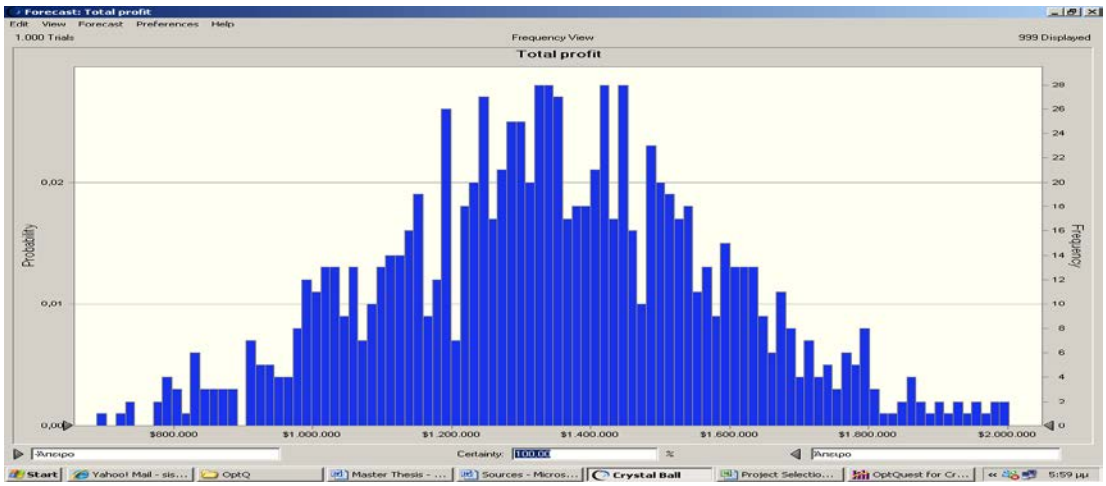

Figure 20: Frequency Chart

The resulting distribution illustrates the average Total profit if the manager selects all projects to be executed. This report shows to the manager the values which Total Profit forecast is most probable to take according to risk distributions. Thus if the manager decides to select all projects, the total profit will be approximately between **$690.000 and $2.050.000**.

Report No 2

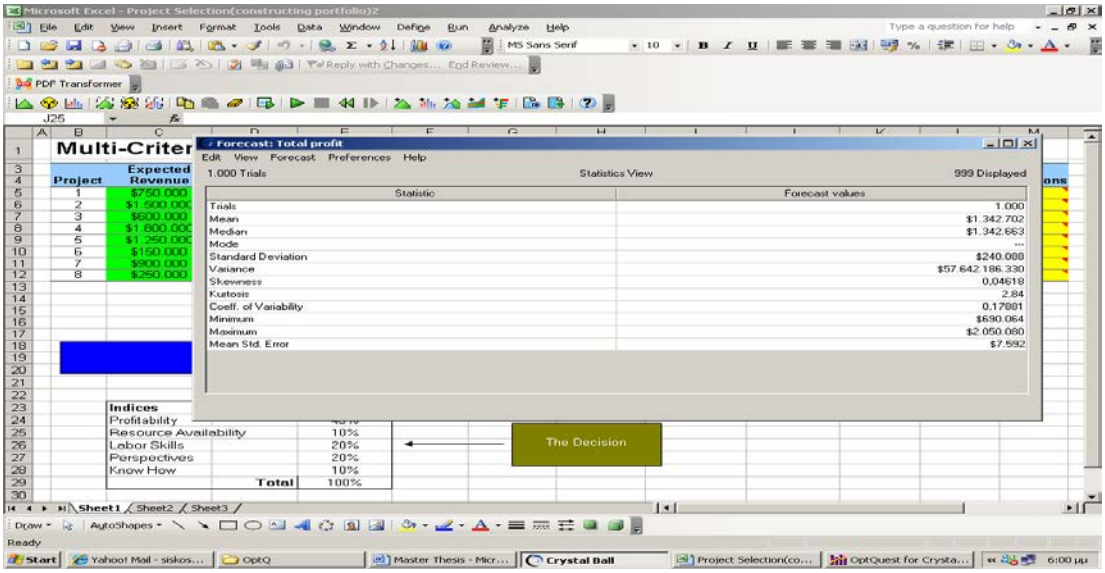

Figure 21: Statistics

Substantially, this report repeats the results of the previous one, but this time the report is depicted numerical. Consequently, the outcomes are more precise, informing about valuable facts such as the minimum TF (total profit), the maximum TF, the mean TF, the standard deviation of the TF in relation with the number showing in cell L19 which does not includes risk and further more data that are useful.

Report No 3

This report has to do with the profitability elements of the model. It is called “the sensitivity chart”. As it is easily can be derived, this report depicts the impact that each of the projects has in Total Profit according to the individual profitability

percentage.

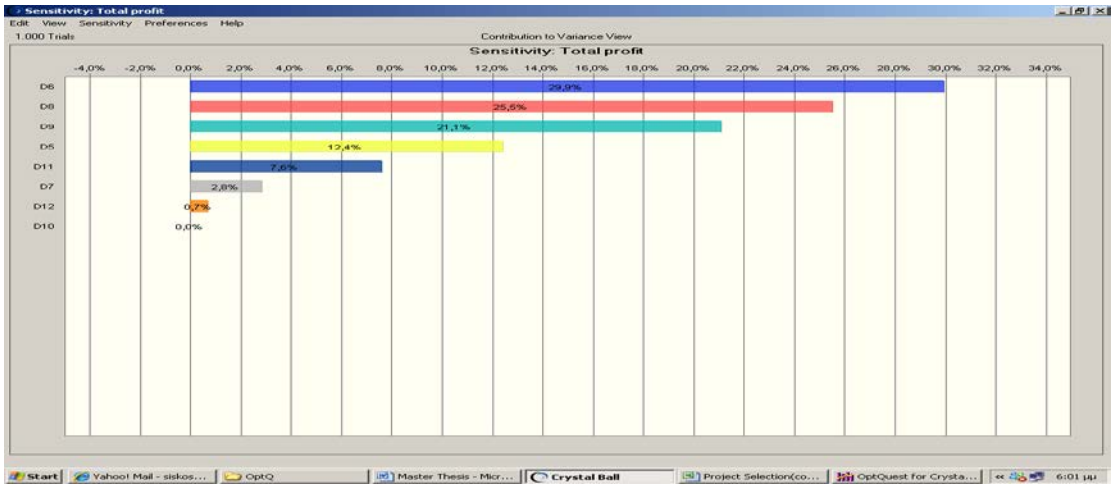

Figure 22: Sensitivity Chart

The project's percentage, depending on profitability criterion, depicts on the vertical axis of the report starting from the cell that impacts Total Profit the most and concluding to the one that impacts it the least.

Report No 4

Once OptQuest is finished, one can copy the optimal results back to the spreadsheet through the Copy to Excel option in the Edit menu. The spreadsheet now displays the optimal solution (*figure 23*), and Crystal Ball displays the forecast chart for the simulation from the best optimization (*figure 24*). The OptQuest's Solution Analysis tool can be used to review the other optimization results.

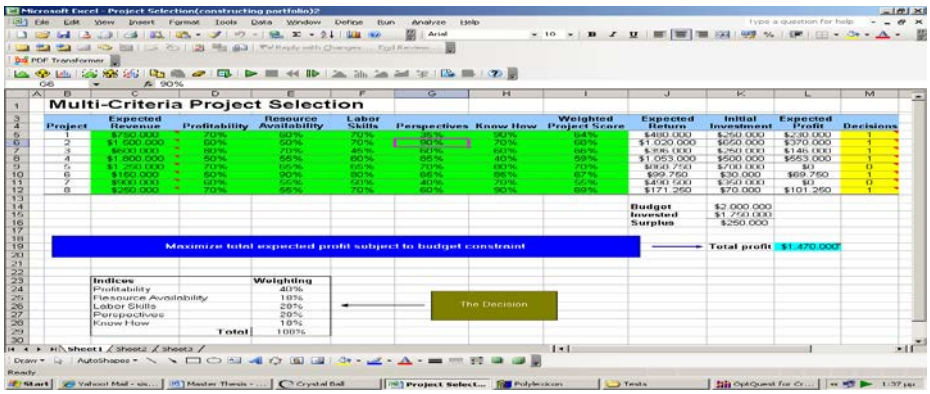

Figure 23: Copy of optimal solution to spreadsheet

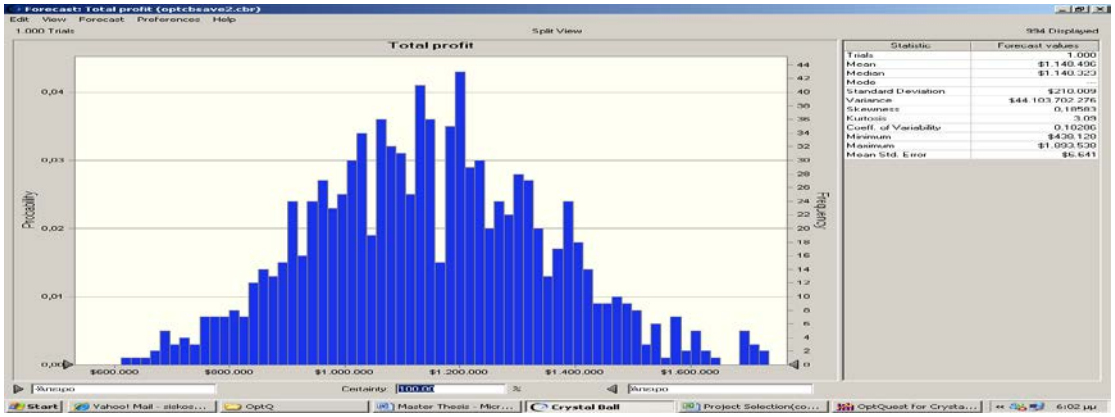

Figure 24: Frequency of the optimal solution

5.3 CATEGORIZE THE RESULTS

The process is MCA oriented which means that there are many complex interrelations which result in a big number of results. As far the results are too many, it is necessary to briefly categorize them according to the type of information they are offering to the decision manager. The results contain similar reports which are divided into two categories:

1. Results coming out **without** incorporating risk into the process.
2. Results coming out **after** incorporating risk into the process.

TYPE OF RESULT **CATEGORIES**	Selected Projects	Rejected Projects	Mean Total Profit (supposing the selected projects are 1,2,3,4,6,8)
1	Not Known -Empirical -Randomly	Not Known -Empirical -Randomly	$1.470.000
2	1,2,3,4,6,8	5,7	$1.148.000

Table 8: Briefly sum of the results.

Deeper analysis and discussion about the reports is given to the next chapter.

CHAPTER 6 DISCUSSION, CONCLUSIONS, RECOMMENDATIONS

6.1 APPLYING THE 10TH MCA STEP

MCA / STEP 10 – Evaluation and Recommendations

It is clearly enough from the results of Chapter 5 that the methodology proposed by MCA is very important and effective. One of the most crucial steps of MCA technique is the 6th one called "*Incorporate risk analysis*". This step becomes more decisive when discussing about the results.

As shown in *Table 8* in the previous chapter, the results are much definite and different after the application of 6th step of MCA methodology. Below it is an analysis of the results, briefly shown in chapter 5, per type and category.

1. During the first steps of the spreadsheet, the image that the manager obtains from the "problem" is quite muddy. In fact, the user does not have specific solutions about what projects to select so as to maximize Total Profit and not exceed Budget. Given the initial investment data, the expected profit, the decision variables and the Total profit, he could estimate randomly which project to select in order not to exceed budget.

TYPE OF RESULT / CATEGORIES	Selected Projects
1	Not Known
2	1,2,3,4,6,8

Table 9: Part of table 8

For example, he could make many combinations of the selected projects (placing 0 into rejected projects) but he should relate that to the maximum Total Profit which is being resulted by different selected portfolios.

Initial Investment	Expected Profit	Decisions
$250.000	$230.000	1
$650.000	$370.000	1
$250.000	$146.000	1
$500.000	$553.000	1
$700.000	$168.750	1
$30.000	$69.750	1
$350.000	$140.500	1
$70.000	$101.250	1
Total profit		$1.779.250

Table 10: Numerical Data

That kind of activity is very difficult and complex. The manager will definitely need a lot of time as the number of alternative combinations is very huge. Moreover, the result will be a number of calculations which contains unitary values without including risk deviations.

When incorporating risk distributions into the assumptions and after running OptQuest, the manager has a proposed solution like the one shown in *figure 25*. This one informs him about the projects which the organization should select in order to maximize Total Profit without exceeding budget.

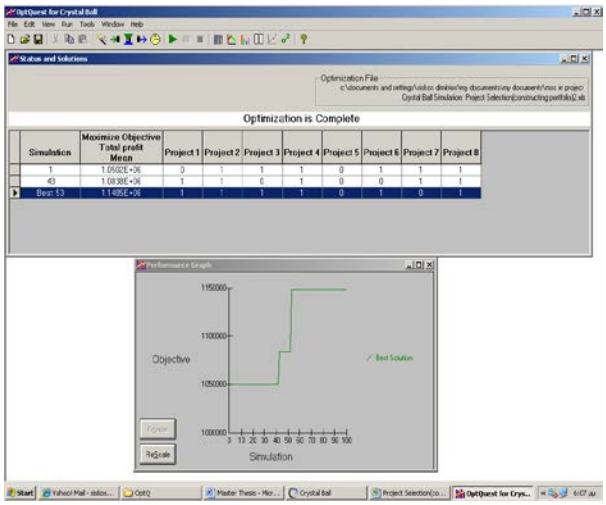

Figure 25: Optimization using OptQuest

Thus, the selected projects are 1, 2, and 3,4,6,8.

2. Following the above process, the results concerning the rejected projects this time are quite similar. Before applying the 6th step of MCA process, the projects which the manager should reject were unknown for him, or he should reject projects randomly, or calculating unitary values.

TYPE OF RESULT / CATEGORIES	Rejected Projects
1	Not Known
2	5,7

Table 11: Part of table 8

In order not to exceed budget, the manager had to reject more than one projects as long as the budget break was $800.000 and none of the projects cost $800.000 by his own. So he had to make multiple different combinations in order to result in potential rejected projects.

Applying MCA steps and especially step 6th, data become much more simplified than it was in the situation previously described. According to *table 11*, the reported results arising by MCA application offer a transparent solution. Projects 5, 7 should

be rejected as long as rejecting them, the portfolio stays within budget and theirs impact in Total profit is the minimum could be.

3. Approaching the problem only by his profitable view, the facts are quite similar. As mentioned before and according to *table 12*, the successful combination of the selected projects result in Mean Total Profit of $1.148.000.

TYPE OF RESULT CATEGORIES	Mean Total Profit (supposing the selected projects are 1,2,3,4,6,8)
1	$1.470.000
2	$1.148.000

Table 12: Part of table 8

In order to ascertain that even if the manager had estimated successfully which projects to select (without applying MCA technique), he would have take the wrong decision again, it is acceptable to convert values in the decision variable cells M9, M11 from 1 to 0. Selecting 0, the spreadsheet doesn't count projects 5 and 7 in its calculation. Automatically, the Total Profit cell is being reduced taking new a value. The new value of TF is $1.470.000 as shown in *table 13*.

As it is easily discerned, Total Profit is different when it is being calculated in the spreadsheet than when the manager has incorporate risk deviations and the calculation is being executed through OptQuest.

$250.000	$230.000	1
$650.000	$370.000	1
$250.000	$146.000	1
$500.000	$553.000	1
$700.000	$0	0
$30.000	$69.750	1
$350.000	$0	0
$70.000	$101.250	1
Total profit	$1.470.000	

Table 13: Rejecting projects 5, 7

The above difference in TF occurs because in the first case, the assumption cells (the green ones) contain unitary values and all calculations are happening using fixed values. In the second case, the assumption cells contain risk deviations. Thus, the calculations, made by the simulations running through OptQuest, include risk impact and they are more realistic.

The accounting balance between the two different values of **TF** is **$322.000**. That amount shows the necessity of using MCA technique. The manager would have taken the wrong decision and it would possible be very damaging for his organization.

6.2 CONCLUSIONS

Considering the outputs of the proposed methodology, people related to that kind of selection processes should appropriate interpret them according to the business action field. Every business area has different needs and particularities. Consequently, there is not only one solution for all business areas. That proposed model should be parameterized according to those features.

Concerning the assumption, that the problem occurs in the construction area, the author obtained information and elements from the questionnaire outputs. Thus he converted those facts into the model. Criteria, percentages, ratings and all other model parameters modulated appropriate in order to fit better to the surveying area. According to the answers of the questionnaire, if the business area would have been different than constructing, then the above mentioned parameters would be much more different.

As far concerning the results shown in 6.1 paragraph, they should be analyzed before the author be ready to provide some useful recommendations.

An organization faces many and complex problems during its “life”. All of these problems require appropriate decisions. Most matters are becoming problems as a result of inappropriate decisions. Similarly, the situation described before, despite being an example, is a very usual phenomenon.

The decision manager would have taken the wrong decision if he hadn’t approach the problem using the steps of multi-criteria process. Speaking more specific, it would

be almost impossible for the manager to predict successfully the best choice. As long as data were not being combined each other, no risk was being incorporated, and no software running multiple combinations was used, and then it was quite obvious that project portfolio selection would be a random and not realistic process.

These omissions result in schedule delays, profit losses, conflicts and in further other similar symptoms. Moreover, many organizations are obliged to withdraw project portfolios because of unexpected turns that projects take. This is exactly the point where this survey takes advantage of, in order to place its results.

Importing the MCA steps, all information are classified per process. Following this methodology approach, all the related data combine theirs knowledge background each other so as to help manager take the appropriate solution. Very important step is the 6th one where the users need to incorporate risk distribution into the assumptions. Consequently, the results are very different before and after incorporating risk. As shown in 6.1 paragraph, the decision would be different if no risk had been assessed.

All the above information is being summarized in the below decision table, which shows the results' diversity divided into two different periods. The one where no MCA process is being applied and the other one where MCA steps taking place.

DECISION MAKING TABLE			
Results	**Before applying MCA**	**Applying MCA**	
		1st- 5th step	**After 6th step**
Data	-Data is not being interrelated with the decision	-All data are being interrelated both to each other and to decision	-All data are being interrelated both to each other and to decision
Criteria	-The only criterion used is usually "profit"	-Many criteria that influence decision participate in process	-Many criteria that influence decision participate in process

Risk	-Risk is being summarized as an amount in budget	-Still, risk distributions have not been assessed	-Risk management is applied to all the assumptions
Project Portfolio	-Numerous of failed projects	-The results contain only unitary numbers. -Still, there is deviation to reality	-The results are very close to reality. -Wrong decisions are reducing. -Organizations seem to be more credible.

Table 14: The Decision Making Table

This table defines the necessity of an innovating system establishment. Organizations depend their existence on decisions. In order to ensure that, they need firstly to improve the decision processes. Afterwards they have to be supplied with the appropriate tools so as to successfully implement the decision executables. Most of them apply the above chain backwards.

6.3 RECOMMENDATIONS

Recommendations derive from all parts of the survey. In order to make recommendations more clearly, the author separated them into three parts:

Recommendations for Action

As a result of this study, it is recommended that organizations view project portfolio decisions as part of their business activities. Like any of them, they have an input, a process and an output. Most of organizations begin to work on strongly during the implementation of the projects. This study intends to create the desire along with pressure to organizations so as to view the selection process as one of the most important part of their works. As a sequence, the proposal of this survey includes the staffing of a PPDT (Project Portfolio Decision Team), which will be constituted by people from different departments. In order to use that model as

realistic as it could be, information should be gathered from expertise people in areas of finance accounting, planning, marketing, risk, and further more.

Recommendations for Dissemination

It is recommended, whoever is responsible in the PPDT to deliver a handbook, which will provide information to every related person or department. The handbook's content will vary depending on the receiver. Below there is a list of the receivers.

- PPDT

The handbook will inform every member of PPDT about the processes which have to be followed for every project portfolio.

- Upper level management

The handbook in this case will be constituted by the results of MCA technique application for every project portfolio. It will contain a list of the projects to implement, to reject or to transfer to others portfolios. The final approval has to be given by them.

- Project members

People who are responsible to execute every project should have a kind of information related to the proposed process. They have to be informed about the cost limits, the impact to project portfolio, the criteria, and many technical elements of the project. All these are important in order to maintain each project's stability, which will final drive portfolio to success.

Recommendations for Additional Research and Study

As a result of this study, it was determined that additional research needs to be developed in order to fit MCA technique more, in order to exact results in relation to the Work Packages of the WBS (Work Breakdown Structure). This action would have

as an output a better control of the portfolio per project. Cost and schedule controlling will be applied in a higher level.

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APPENDICES

I. QUESTIONNAIRE

MASTER'S THESIS TITLE: THE SIGNIFICANCE OF IMPLEMENTING A WELL ORGANIZED PROJECT SELECTION METHODOLOGY USING MULTI-CRITERIA ANALYSIS

Please enter your name:

Please name your current position:

Please enter the name of your company:

QUESTIONS RELATED TO PROJECTS SELECTION CRITERIA

1. **What are the 5 most significant reasons that influence your organization in order to select one project against to another?**

a.

b.

c.

d.

e.

2. **How many projects per year are getting failed to meet cost, schedule or performance (even if they were considered to be successful)? (Please give an approximate percentage for each one)**

Percentage of projects that fail to meet **cost:** %

Percentage of projects that fail to meet **schedule:** %

Percentage of projects that fail to meet **performance:** %

3. **What is mainly the most usual specification, which most projects in your company fail to meet? (Please underline the preferable)**

   a. Cost

   b. Schedule

c. Performance

d. Other

4. **Does your company use any kind of software or other kind of facility so as to optimize projects selection ability? If yes, please name it. (optional)**

5. **Do you think that your organization counts all of the potential criteria that might influence project success?**

.

6. **Please rate from 1 to 5 the below project selection criteria according to your company policy. (1=Lowest of concern, 5=maximum of concern).**

Criteria	Rate
Labor skills	
Relativity to company's profile	
Competition	
Profit	
Reputation	
Maintain customer relationships	
Impact on project portfolio	

7. **Have you ever rejected a profitable project because you considered it to be very risky for your company or irrelevant to your business field?**

Please indicate here if you want to receive survey's results
Underline the preferred sentence:

Yes, I want to receive survey's results

No, I do not want to receive survey's results

Thank you for your cooperation