Financial Risk Assessment in Project Selection

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ABSTRACT

This paper examines financial risk assessment in the project selection process. In the project selection process the feasibility analysis is used to evaluate projects, with the financial feasibility as the dominating factor. In recent years more emphasis has been on risk assessment in project management, and methods of assessing financial risk have been developed. Project managers are realising the opportunities that risk management entails. The findings of this paper are that the project selection process should not only focus on the financial feasibility of a project, but also the financial risk assessment. Risk assessment provides project managers with a better base to a more sound decision making. Monte Carlo simulation helps project managers to focus on risk and the effects of all uncertainties in projects. A simple project comparison is used to illustrate the application of this financial risk assessment in practice.

1. INTRODUCTION

When selecting a project it is necessary to determine whether or not the planned project is feasible. A feasibility analysis can be used to evaluate projects from various perspectives, and the financial feasibility is often the dominant factor in the feasibility analysis. Precision and reliability of financial feasibility analysis relies on the accuracy of information used in the analysis.

Risk management, sometimes called uncertainty management, is a growing field as project managers are realizing the opportunities it entails (Meredith & Mantel, 2010). Project risk management is the processes of planning, identification, analysis, response planning, and monitoring and controlling a project. Project risk analysis can be both qualitative, assessing risks and combining their probability of occurrence and impact, or quantitative, numerically analyzing the effect of identified risks (PMI, 2008).

Project selection process should be based on a financial feasibility analysis where it can predict the success of a project (Astebro, 2004). The need for reliable financial information is critical when evaluating financial feasibility of a project. The uncertainty of financial information has to be evaluated to conduct a financial risk assessment. This financial risk assessment may lead to a different project selection than the original financial feasibility analysis. Because it may lead to selection of an alternative that has lower return if it has less risk than an alternative with higher returns but more risks. Conducting a quantitative risk analysis produces a better understanding of risk exposure and it provides a base to more sound decision making.

Risk analysis on the financial feasibility analysis for project selection is the main focus in this paper. The paper will show the benefits of using the results of quantitative risk analysis on the financial feasibility for project selection.

This paper is structured in the following way: Chapter 2 is an overview of the theory of financial feasibility and risk analysis methods. Chapter 3 presents two projects proposal, a financial feasibility analysis, and a financial risk assessment. In chapter 4 conclusions of the paper are listed.

2. LITERATURE REVIEW

In this section the base for a project selection is covered with focus on the financial and risk justification for a project selection. Both the financial feasibility and risk analysis are described and their theoretical background.

Project selection

Project selection is the process of evaluating projects and then choosing to implement those projects that will benefit the organization. Project selection is only one of many decisions associated with project management (Meredith & Mandel, 2010). When selecting a project it is necessary to determine whether or not the planned project is feasible. A feasibility analysis can be used to evaluate projects from various perspectives, e.g. technical, social, legal, financial, market, and organizational. The financial feasibility is the most critical factor in the feasibility analysis, as most projects will not be realized if they do not promise future profit for the project owner.

Financial feasibility

A feasibility analysis can be used to evaluate projects from various perspectives and the financial feasibility is often a dominant factor in feasibility analysis. Precision and reliability of financial feasibility analysis relies on the accuracy of information used in the analysis. Estimates of costs as well as the expected income generated are necessary in determining the financial feasibility of a project (Bennet, 2003).

There are several methods that can be used to measure the financial feasibility of a project, such as the Net Present Value (NPV), Internal Rate of Return (IRR) and the Modified Internal Rate of Return (MIRR), which is relatively new and still infrequently used (Park, 2007).

The NPV method calculates the net present value of an initial investment based on the required rate of return, which management must determine and usually is the Minimum Attractive Rate of Return (MARR) (Meredith and Mantel, 2010) (Park, 2007).

The IRR method calculates the rate of return for a given cash flow for the project period. When there is only one sign change in cash flows, the rate of the IRR method presents is the rate that will give the zero NPV for the project period (Park, 2007).

There has been some criticism on the lack of robustness in the NPV and IRR methods, as they assume reinvestment is always possible at the discount rate. To avoid these problems, and to provide more accurate measure of financial feasibility, it is recommended to use the Modified Internal Rate of Return (MIRR), also referred to as External Rate of Return (ERR) (Kierulff, 2008).

The MIRR method, also known as the ERR method, is almost identical to the IRR method. The only difference is that the IRR assumes reinvestment at the calculated IRR, but MIRR assumes reinvestment at another rate, i.e. an external rate of return (Remer & Nieto, 1995). The MIRR has not gained many followers because it requires both a return on investment that takes into account the risk of the investments, and a reinvestment rate considering the risk associated with the future investments of the cash flows (Kierulff, 2008).

According to Svavarsson (2011) the use of financial feasibility analysis is scarce in project selection in organizations in Iceland. The results from the financial feasibility analysis can only be as reliable as the data used in the analysis. To get the most accurate assessment possible, specialist within the field of the project need to make estimates and forecasts. Rather than precise answers it is often preferable to develop ranges of potential outcomes (Helfert, 2001). If the decision maker chooses to use only the value that is most likely, then the assumption is that there is only one possible outcome. This is decision making under conditions of certainty which is rarely true in the real world.

The quantitative risk assessment methods

The outcome from the financial feasibility analysis is often assumed with complete certainty in data. Even though the outcome can provide reasonable decision, the decision maker should not disregard the uncertainty in the financial feasibility analysis. Risk analysis is a powerful tool that can be used to analyse the variability in the financial feasibility of a project.

The quantitative risk analysis and model techniques that can be used are the sensitivity analysis, scenario analysis and simulation. Sensitivity analysis can be used to identify key input parameters, which are then used in the scenario analysis to examine several possible scenarios, e.g. best and worst case. Simulation is used to generate all possible outcomes between the best and worst case, which can for example be used to analyze the probability of the project not meeting the project objectives (or in this case the hurdle rate) (Park, 2007).

Risk in project selection

Risk has been, for the most part, interpreted as being the uncertainty in tasks durations and costs, but uncertainty plagues all aspects of the work on projects. So it is important to consider uncertainty as it affects the selection process (Meredith & Mantel, 2010).

Project risk is always in the future where risk is an uncertain event, if it occurs, it has an effect on the project objective; scope, schedule, cost and quality. Organizations and stakeholders are willing to accept varying degrees of risk, called risk tolerance. Risks that are threats to the project may be accepted if the risks are within tolerances and are in balance with the rewards that may be gained by taking the risk (PMI, 2008).

Project risk management in general is the processes of planning, identification, analysis, response planning, and monitoring and control on a project. Risk management is used to decrease the probability and impact of negative events and increase the probability of positive events in the project (PMI, 2008).

Project risk analysis can be both qualitative, assessing risks and combining their probability of occurrence and impact, or quantitative, numerically analyzing the effect of identified risks (PMI, 2008).

The qualitative project risk analysis is the process of prioritizing risks for further analysis or action by assessing and combining their probability of occurrence and impact. This analysis is usually quick and not expensive and lays the foundation for quantitative risk analysis (PMI, 2008).

The quantitative risk analysis is the process of numerically analyzing the effect of indentified risks on overall project objectives. This analysis is performed on risks that have been prioritized by the qualitative risk analysis, and it presents a quantitative approach to making decisions in the presence of uncertainty. To quantify the probability and impact of risks on project objectives, experience and historical data is used. Information should be gathered on the optimistic, pessimistic and most likely scenarios for some commonly used distributions. The most frequently distributions used in quantitative risk analysis are the beta and triangular distributions (PMI, 2008).

Quantitative risk analysis techniques

The principle of the three point method is to not only decide the most likely value but also two other estimates, an optimistic value and a pessimistic value. These three values are then used to calculate the actual expected value for the estimate. Instead of using the normal distribution a probability distribution is selected that is more accurate in determining the expected estimate

It is well known that cost estimates have a tendency to be underestimated and the revenue estimates tend to be overestimated (Chapman, Ward & Harwood, 2006). Because of these biases of those estimating it is recommended to use the three point estimates instead of the regular contingency method where a fixed percent of the total is added to estimate for contingencies (Meredith & Mantel, 2010).

The method of the three point estimation (PMI, 2008) or triple estimates (Kerzner, 2010) has existed for a considerable time or ever since the invention of the Program Evaluation Review Technique (PERT) for the Polaris project in the mid 1950s. The basis of PERT was a detailed diagram of all tasks in a project, organized into a network, which represented the dependence of each task and the tasks needed to precede it. Although a small portion of the Polaris project was managed using the technique, PERT was great success from a public relations point of view. This success led to the development of PERT/cost in 1962 that addressed cost issues as well (Galway, 2004).

The Critical Path Method (CPM) was being developed by DuPont at the same time that PERT was being invented. The CPM also used a network representation and increasing computing power led to the inclusion of probability distribution for estimates in CPM. This probability distribution allowed straightforward Monte Carlo simulation to be substituted for the PERT assumptions. The stochastic CPM is now the preferred methodology for assessing estimation risk in project management (Galway, 2004).

A further extension of PERT/CPM is the Graphical Evaluation and Review Technique (GERT) which was developed in the mid-1960s as an outgrowth of NASA work (Pritsker, 1966). The GERT is a network analysis technique that allows probabilistic estimation and is only used in complex systems as it allows loops between tasks. Many of these generalizations have been subsumed into CPM (Galway, 2004).

The Venture Evaluation and Review Technique (VERT) is similar to PERT/CPM in that it is structured as a network. However, each activity is characterized by costs incurred and performance generated in addition to time consumed. VERT was based upon the thinking that there is a relationship between time, cost, and performance.

With VERT, a manager could obtain a more integrated analysis of a venture or project. VERT is more powerful than techniques such as GERT, which are basically time and cost oriented. VERT has been helpful in cases where there is a requirement to make decisions with incomplete information (Moeller & Digman, 1981).

Critical Chain Method (CCPM) was introduced in 1997 and is based on methods and algorithms derived from theory of constraints. CCPM puts the main emphasis on the resources required to execute project tasks rather than task order and rigid scheduling like CPM and PERT (Galdratt, 1997).

Lichtenberg uses a slightly modified version of the three-point estimation in his successive principle. Lichtenberg uses the group triple estimates with more than one person doing the estimation. By using the Central limit theorem the standard deviation can be found for the project as a whole because the theorem states that a large set of independent variable will be normally distributed as each variable has a mean and variance (Montgomery & Runger, 2007). This means that the square root of the sum of the variance of each element in the estimation will grow closer to the normal distribution as more elements are added to the calculation, even if they are not themselves normally distributed. The likelihood that a project will be finished within budget can be estimated using the normal distribution when the standard deviation for the whole project has been calculated. Estimating 95% probability that the project will be on budget is found by adding two standard deviations for the contingency. This successive principle helps project managers to better describe and reason the extra money instead of just adding a 10% to the total and call it contingency (Lichtenberg, 2000).

3. CASE STUDY

The purpose of this case study is to demonstrate how financial risk assessment may lead to a different project selection than using just basic financial feasibility analysis. Project selection is generally based on financial feasibility analysis using a measure of value such as the net present value (NPV) or internal rate of return (IRR).

3.1 Two project proposals

Project manager, often the decision maker, has to select one out of two projects from this case study. The projects are evaluated on the basis of its IRR. Because the project manager has more projects than he can fund, he has a certain "hurdle rate", say 10%. Which mean that a project will be selected if it has IRR of equal or more than 10%.

The case used to show the function of the financial feasibility analysis is fictive, but in order to make it as realistic as possible, it was based on real projects when building the case. The assumptions for the projects below include:

- Both investments are assumed to be $100.000
- After the projects are developed it is estimated that first year sales for project A is $95.500 and for project B $120.000.
- Operating cost are assumed to be on the first year $80.000 for project A and $100.000 for project B.
- Revenue and costs are expected to grow 4% annually.
- The forecasts of revenue and cost will be made for a 5 year period, and assumed to be constant all the time. The net present value after the fifth year is represented by the residual value which is the value of an annuity that throws off that cash flow at the discount rate of 10%.

These inputs and assumptions are summarized in table 1.

Table 1. Summary of assumptions for project A and B.

	Project A	**Project B**
Investment	$100.000	$100.000
First year revenue	$95.000	$120.000
First year cost	$80.000	$100.000
Annual revenue growth rate	4%	4%
Annual cost growth rate	4%	4%

3.2 Financial feasibility analysis

The easiest way to compare these two projects is to look at the profit margin per year, which is $15.000 for project A and $20.000 for project B. Figure 1 and figure 2 illustrate the projects assumptions and show that the IRR for both of these projects exceeds the project manager's hurdle rate at 10%.

Project A:

Uncertain inputs	
Investment cost	$100.000
Year 1 revenue	$95.000
Year 1 cost	$80.000
Annual revenue growth rate	4,0%
Annual cost growth rate	4,0%
Discount rate	10,0%

Discounted cash flows calculations

Year	**0**	**1**	**2**	**3**	**4**	**5**
Investment cost	($100.000)					
Revenue		$95.000	$98.800	$102.752	$106.862	$111.137
Cost		$80.000	$83.200	$86.528	$89.989	$93.589
Residual Value						$175.479
Cash flow	($100.000)	$15.000	$15.600	$16.224	$16.873	$193.027

Outputs	
IRR	25%

Figure 1. Profitability calculations for project A.

Project B:

Uncertain inputs	
Investment cost	$100.000
Year 1 revenue	$120.000
Year 1 cost	$100.000
Annual revenue growth rate	4,0%
Annual cost growth rate	4,0%
Discount rate	10,0%

Discounted cash flows calculations

Year	**0**	**1**	**2**	**3**	**4**	**5**
Investment cost	($100.000)					
Revenue		$120.000	$124.800	$129.792	$134.984	$140.383
Cost		$100.000	$104.000	$108.160	$112.486	$116.986
Residual Value						$233.972
Cash flow	($100.000)	$20.000	$20.800	$21.632	$22.497	$257.369

Outputs	
IRR	35%

Figure 2. Profitability calculations for project B.

The models shown above for projects A and B include the assumptions that the revenue and cost lines include exponential growth. Now project A has an IRR of 25% and project B 35%, so decision makers would probably select project B due to a higher profitability.

3.3 Financial risk assessment

The results from the financial feasibility analysis presented above assume complete certainty in data, and therefore certainty in the projected cash flows. Even though the results can provide reasonable decision basis, the decision maker should not disregard the possible effects of uncertainty on the financial feasibility of the project. The term "*project risk*" is used to refer to variability in a project's financial feasibility, and greater risk means greater potential of loss (Park, 2007).

The results for the financial feasibility analysis could be different if some assumptions are added about the uncertainties of investment cost, first year revenue and cost, growth rates, and discount rate. These uncertainties are summarized in table 2.

Monte Carlo simulation makes it possible to generate all possible sets of input parameters, and also an entire distribution of outcomes. The decision maker can use the results from the simulation to study average value of the outcome, in this case the IRR, and also the distribution of the outcome.

Table 2. Uncertainty in assumptions for project A and B.

		Project A			**Project B**	
	Low	**Mean**	**High**	**Low**	**Mean**	**High**
Investment	$95.000	$100.000	$105.000	$95.000	$100.000	$110.000
First year revenue	$90.000	$95.000	$97.500	$95.000	$120.000	$130.000
First year cost	$77.500	$80.000	$85.000	$85.000	$100.000	$120.000
Annual revenue growth rate	3%	4%	4.5%	3%	4%	4.5%
Annual cost growth rate	3.5%	4%	5%	3.5%	4%	5%
Discount rate	7%	10%	15%	7%	10%	15%

Revenue and revenue annual growth rate are now likely to grow less favourably, and the cost may grow as much as 5% while revenue may grow as little as 3%, and make the project less profitable.

After simulating the model using Monte Carlo techniques, the following conclusions illustrated in figure 3 and 4, can be drawn: The expected IRR for project A is 18% and project B is 22% when the effect of risk is included, not 25% and 35% as the base forecast stated. There is also 11% chance that project A will not exceed the hurdle rate, and 26% chance for project B.

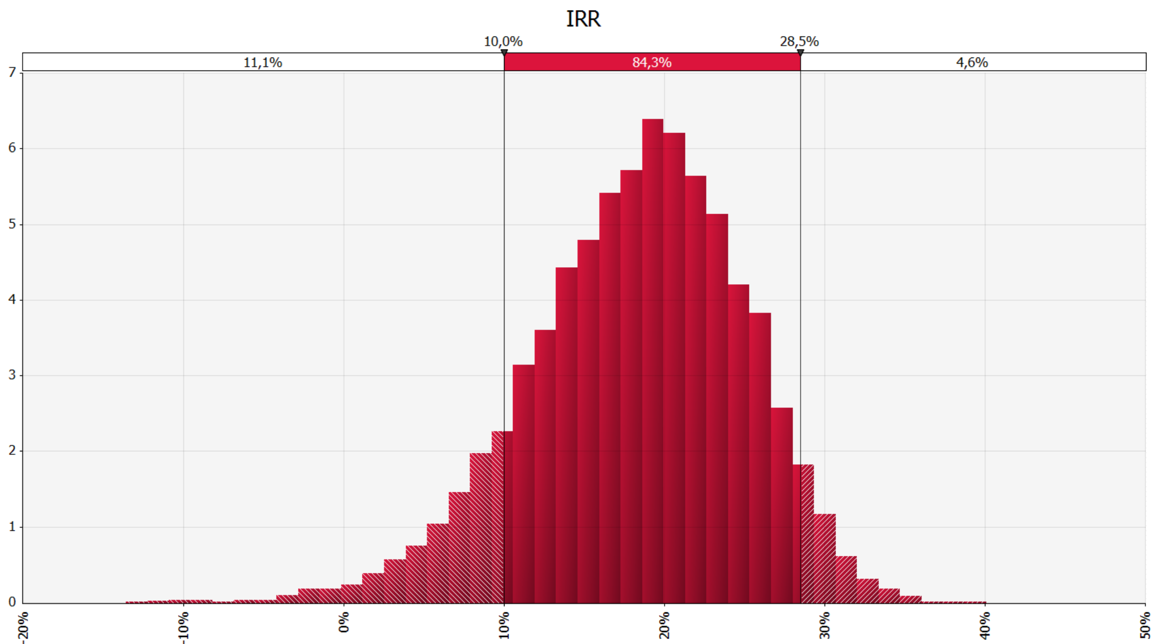

Figure 3. IRR histogram for project A.

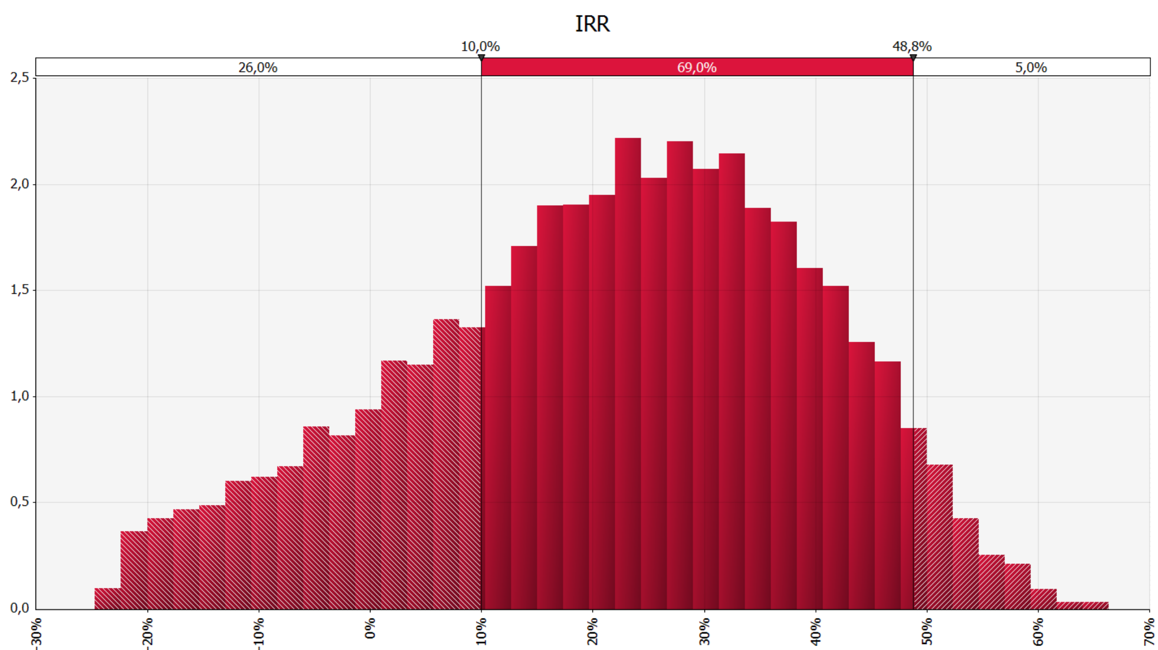

Figure 4. IRR histogram for project B.

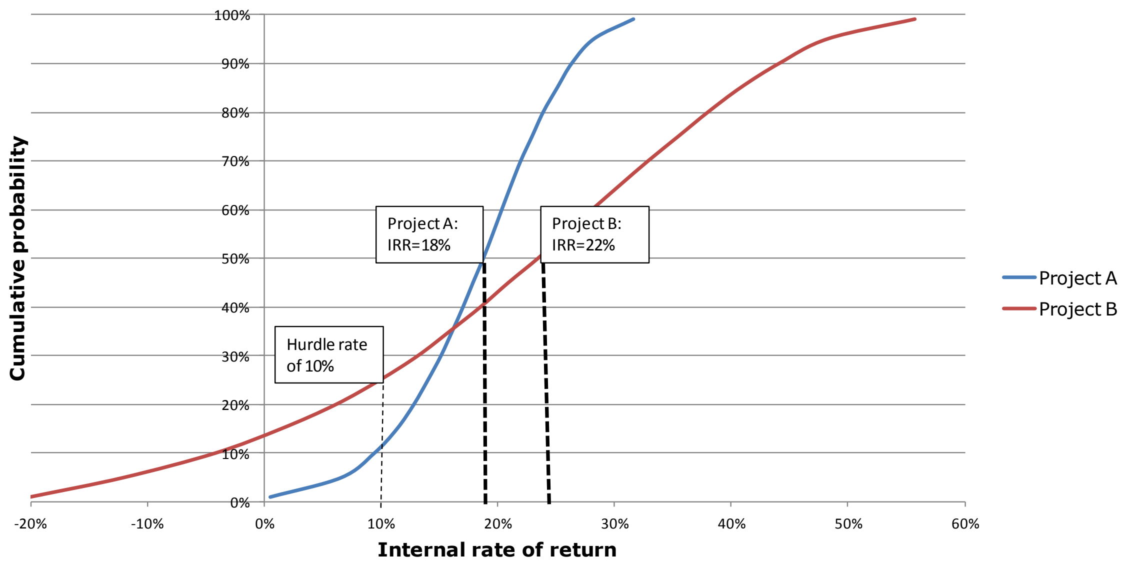

Figure 5. Cumulative probability and profitability for projects A and B.

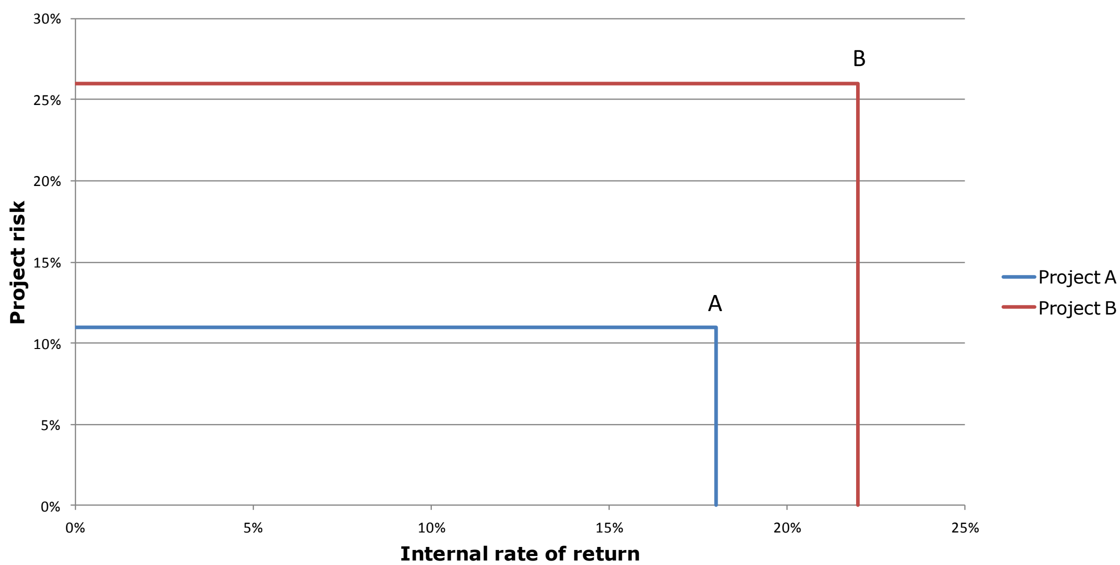

Figure 6. Project risk and profitability for project A and B.

Illustrating the IRR including risk effect and the probability of not exceeding the hurdle rate provides a better understanding of risk exposure and it provides a base to a more sound decision making.

Table 3. Project risk and profitability for project A and B.

	Project A	**Project B**
IRR (base forecast)	25%	35%
IRR (including risk effect)	18%	22%
Risk of not exceeding hurdle rate: 10%	11%	26%

Monte Carlo simulation approach can sort out and order the relationships between the inputs and the outputs. The approach puts the inputs in an ordered list by their association with the objective. This ranking of the inputs by their ranking correlation with the IRR, shown in the "tornado diagram" below, helps to sort through the combination of relative risk and role in the project selection process.

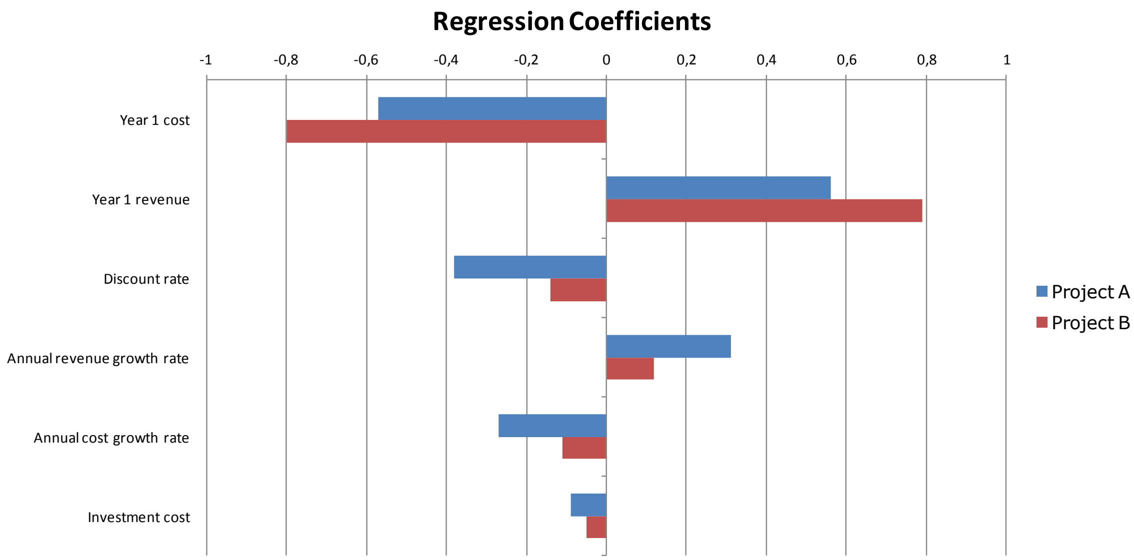

Figure 7. Tornado diagram for projects A and B.

This Tornado graph shows that the uncertainty in the first year cost and revenue are the two most important risks. This may help the project manager to act to improve the likelihood of success for the project.

After this financial feasibility analysis on projects A and B it is clear that project B has a higher expected return than project A. Project B also has substantially higher probability that the hurdle rate will not be exceeded than project A.

It is evident that risk assessment provides project managers with important information and a better base to make a more sound decision. Furthermore, project selections that are only made on the basis of maximum expected are not necessarily the best decisions.

4. CONCLUSIONS

In the project selection process a feasibility analysis should be used to evaluate all aspects of projects. The feasibility should be assed from various perspectives before projects are selected, for example, a technical, social, legal, market, and organisational perspectives. The key factor in the feasibility analysis is the financial feasibility that is aimed at assessing profitability of a project.

The results of a financial feasibility analysis are only as reliable as the data used for the analysis. If the decision maker chooses to use only the value that is most likely, then the assumption is that there is only one possible outcome. This outcome is calculated from estimates but it is important to keep in mind that they are just estimates. The uncertainty involved in each estimate, among other things, is found out by collecting realistic estimates. Using this knowledge of uncertainty, project managers can maximise the value of the information for decision making. This estimate collection is the most difficult and time-consuming part of the risk assessment process.

Conducting a quantitative risk analysis produces a better understanding of risk exposure and it provides a base to a more sound decision making. The benefit of simulation is that it allows all possible values for each variable to be considered. Simulation gives both the mean and the median outcome from the simulation, but also the likelihood that a project will achieve an outcome at, or above, the hurdle rate.

Monte Carlo simulation helps project managers to focus on risk, and it helps organisations, that are often reluctant to talk about risk, to embrace risk objectively. The results of the simulation give the decision makers a deeper understanding of the possible outcome of the project. For example the distribution of IRR can be analyzed and conclusions can be drawn about the financial feasibility of the projects.

The use of a financial feasibility analysis is scarce in project selection in organizations in Iceland (Svavarsson, 2011). From this information it can be inferred that the use of financial risk assessment in project selection is even scarcer.

Even though this paper focuses on the financial risk assessment in project selection, this uncertainty analysis can be applied in other aspects, e.g. a schedule risk and a cost risk. These same techniques can be used to analyse how long a project will eventually take, as how much it will eventually cost. For example Landsnet uses Monte Carlo simulation in their cost estimations (Landsnet, 2010). This is only one of several examples and hopefully more organisations will see the benefits of using this assessment. Because it is in organisations' best interest to base their decisions on more information and that is what risk assessment provides.

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