Risk Analysis and Fuzzy Logic Based Project Evaluation

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Abstract: *This paper reports the tactic to solve risk analysis problems with the purpose of determining the project's attractiveness. Using Fuzzy logic the algorithm created in this paper was developed . Fuzzy logic was used since it is a tool capable of demonstrating complex and uncertain or vague data using simple terminology such as IF-Then statements. This logic is perfect to deal with the uncertainty risk plays in a projects development. This methodology provides a quick and efficient tool for project managers in their use of project evaluation, by allowing the project manager to scrap useless projects without putting the least amount of effort into an analysis.*

Keywords: *—Fuzzy logic, risk analysis, Project Delay Probability Risk, Project Delay Impact, and Project Attractiveness.*

1.Introduction:

Project managers all around the world have to make difficult decisions that could ultimately affect the stability and security of the company. The most difficult decision they must face is determining what projects to undertake and consequently invest money, time, and effort in them. By choosing to invest in a project it is very important that the project be fruitful or else the company ends up losing money, time, and valuable resources that could be used in a more useful endeavor. Consequently project managers have to take into consideration many factors before committing valuable resources to any project. These factors include, but are not limited to, time constraints, tangible costs, and profits. Most of the factors that adversely affect the project attractiveness are called risks, and generally risk is intangible and hard to measure.

Due to the uncertain nature of risk, project managers must somehow determine the impact the risks will have on the project. Good project managers are those that can determine the largest amount of risks and the impact these will have on the project. The impact that risk has on a project is quantified in terms of dollars; how much money would be lost. More often than not, Project Managers try to assess risk using exact values and fail. Since risk cannot be quantified in straight, crisp terms it must be taken and analyzed as a distribution. The software development industry is probably one of the most risky of industries at the present moment. Risk factors are present throughout the whole development process and these can negatively affect the project. These software risk factors are of concern since there has been a large amount of software disasters occurring recently.

Every project that a software company is interested in undertaking includes some sort of risk. These risks can be detrimental to the company, and therefore they must be identified and assessed to determine the impact they may have on the company. Some projects will have more risks involved and probably have greater impacts on the company. It is important to determine the risks and their impact that a given project entails so as to determine the attractiveness of a project. For example, if a project with a high risk of failure whose negative impact will outweigh its benefits is an unattractive project and therefore should not be undertaken

2 Risk Analysis:

Risk analysis is the area of risk management that this work focuses on. As defined earlier risk analysis is the process of examining each identified risk issue to estimate the likelihood of a risk and predict the impact on the project. The purpose in the development of a new risk analysis algorithm is to create a methodology capable of determining qualitatively the attractiveness of a project 'a priori', in other words, before investing any money or effort into the project. This new technique provides a quick and safe decision as to the security in undertaking a given project. If the decision is to undertake the project then other risk management procedures will be implemented.

3.Problem Identification:

Every project that a software company is interested in undertaking includes some sort of risk. These risks can be detrimental to the company, and therefore they must be identified and assessed to determine the impact they may have on the company. Some projects will have more risks involved and probably have greater impacts on the company. It is important to determine the risks and their impact that a given project entails so as to determine the attractiveness of a project. For example, if a project with a high risk of failure whose negative impact will outweigh its benefits is an unattractive project and therefore should not be undertaken.

4. Risk Assessment in Fuzzy Business :

Risk assessment is an "assessment" of something hypothetical defined as "risk", which must then be interpreted as "high", or "low", or "tolerable". Such assessment, whether qualitative or quantified, requires analyst's judgment, expert human knowledge and experience. Quantification of risk in scalar values is subject to uncertainties for many reasons including difficulties in defining the likelihood and consequence severity and the mathematics of combining them. Current approach to risk assessment of industrial installations uses Safety Reports focusing on Safety Management Systems to demonstrate that risks are low or tolerable.

Since risk has no exact value, traditional quantitative risk assessments are usually
qualified with a statement of uncertainty. Mahant (2004) 'presents a novel approach to
overcome the fuzziness in traditional risk assessment, and create a risk assessment model using fuzzy logic'. Fuzzy logic and fuzzy set operations enable characterization of vaguely defined (or fuzzy) sets of likelihood and consequence severity and the mathematics to combine them using expert knowledge, to determine risk. The fuzzy risk model presented is the first of its kind. It is presented with the expectation that it can be developed and refined further with inputs from safety practitioners and experts.

The likelihood of occurrence of incidents is regarded as a function of the robustness of Safety Management System (SMS). Fuzzy logic is used to characterize the robustness of the SMS as the variable which determines the likelihood of incidents. Fuzzy logic is used to characterize consequences and then fuzzy set operations used to combine the severity of consequences and likelihood of occurrence to calculate risk. The model assesses risk of one major hazard at a time He incorporated the principles in the risk model .He also implemented the fuzzy risk model as shown in fig 1 . A simplified model is presented in this paper having two inputs and one output with 12 inference rules. In reality, there are no limits on the number of inputs, or outputs or the number of rules or the number of classes used to define the range of a variable. The model can be refined by adding more inputs and more rules. The modeling process is made convenient by proprietary software

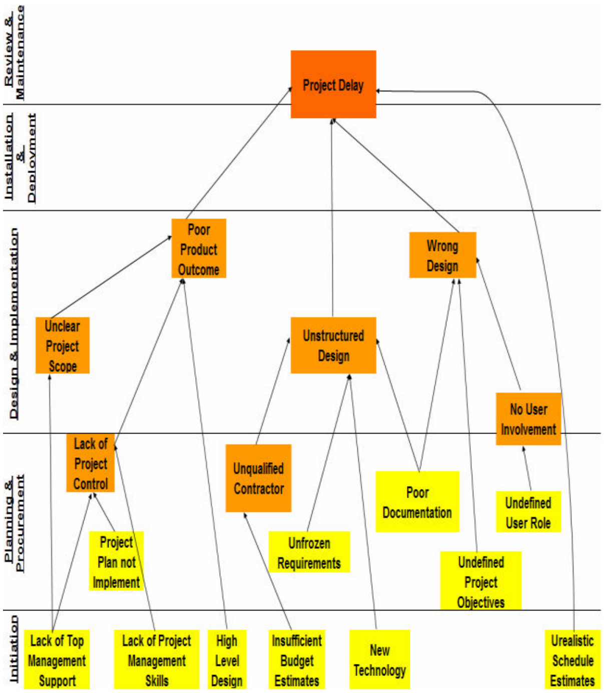

Figure 1 : A Causal and Cognitive Map for the Ensuing Case Study

. This paper provides a good example and guide to processing vaguely defined variables, and variables whose relationships cannot be defined by mathematical relationships. It takes into account the vagueness and uncertainty inherent in risk and provides a good assessment based upon experts judgment. It also provides a guide to the construction of a fuzzy risk model, unfortunately though it does not relate directly with project evaluation, but rather with onsite safety risk assessment.

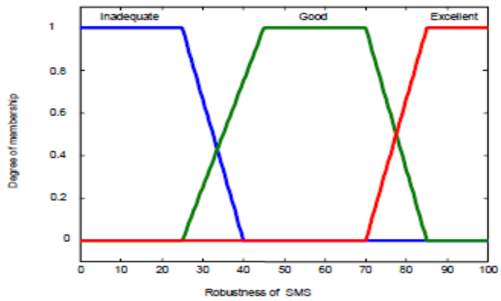

Figure 2: Range and classes of robustness of SMS

5. Model And Algorithm Development

This paper has the purpose of providing a new tool and a new technique to the software development industry. The algorithm presented here is composed of three models: Project Delay Probability Risk, Project Delay Impact, and Project Attractiveness. The way that the algorithm papers is that there are eleven risks that combine and interact with each other contributing to the Project Delay (these risks and the interaction between them are obtained from Al-Shehab, Hughes, Winstanley (2005) and from many other researchers and experts mentioned in the last section). These risks contain two important factors, that of the probability of occurrence and that of the impact these risks have. Therefore two models were created, one to model the interrelationships of the risks contributing to the probability of a Project Delay, and another one to model the interrelationships of the risks contributing to the impact of a Project Delay. These two models return a single value each, the first model returns a probability of Project Delay, and the second one returns the level of impact the Project Delay will cause. A third model was created as well which determines the interrelationship between the probability of a Project Delay and the impact of that delay, returning an output value for the Projects Attractiveness.

The values of risk created for the model of Project Delay Probability is shown in fig.3 The risks represented in this table are acronyms of the risk factors shown in Figure 5.1. These acronyms are:

	Risk Probability	Risk Impact	Project Attractiveness
Very Low	0-22	0-24	0-22
Low	18-41	20-40	18-43
Medium	38-59	37-63	39-62
High	57-81	58-78	57-81
Very High	78-100	77-100	78-100

Figure 3: Values of Risk

6. Model Development

Once identified the objectives of the model, the risk factors that are of important, and the interaction of these risk factors, it was possible to begin to define the rules that compose the models. These rules are the main components of the models; they were developed using the Casual and Cognitive Map mentioned earlier , by gathering a large amount of data across the span of literature that encompasses the software development industry, and by sorting out the logic from the vast ocean of literature

To understand these models it is important to define what the following terms mean:

- Project Delay Probability – this term refers to the probability that the project will be delayed due to the inherent risks in the project contributing to a project failure. This term has a very close relationship to the probability of a project failure.

- Project Delay Impact – this term refers to the negative impact that a project delay will have upon a given project. This term has a very close relationship to the impact of a project failure.

- Project Attractiveness – this term refers to how desirable a project is based upon how high the probability of failure is.

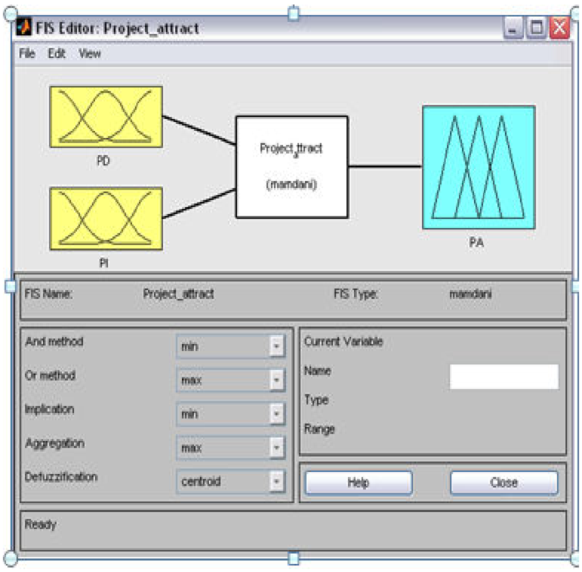

Figure 4: Model Development

7.Results.

The attractiveness of the project is determined by selecting the different values of membership functions. The system can be further be developed to evaluate all risks from the map .The Table 1.1 gives the percentage of Project attractiveness value by model and calculated manually. Initially as per the membership functions the values were entered to get the percentage of project attractiveness. Then the same values are used to make analytical calculations .Thus it was found that the values calculated and obtained by model are nearly same

Table 1.1 Project Attractiveness:

Sr No.	PD values	PDI values	PA values obtained by model
1	12	80	68.3
2	12	68	68.2
3	12	45	89.2
4	12	35	89.2
5	12	15	89.3
6	25	15	89.3
7	35	50	88.8
8	25	70	68.7
9	30	80	68.9
10	30	30	88.7

These results show it is easy to choose between a project that is of medium project attractiveness and another that is of high project attractiveness, but it becomes a bit more difficult to choose between projects that both are extremely attractive. This can never be eliminated but it can be fine tuned by adding on more labels to the analysis. Since this algorithm is a new technique in the analysis of risk, it can not be compared with other methodologies in an empirical way, because the interrelationships and weights of the risks have not yet been defined in a standard way.

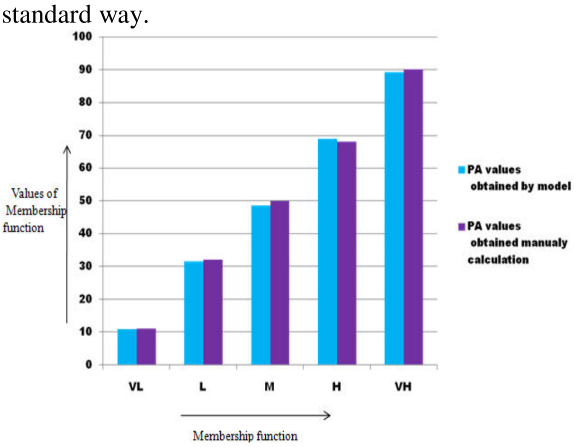

Figure 5. Comparison between manually and calculated values

8. Conclusion

The algorithm created in this paper paper is based upon fuzzy logic, giving this it the ability to solve complex problems plagued with uncertainty and vagueness. Since the software development industry is developing at extremely fast rates, there are lots of risks
involved that can affect the outcome of a project and this industry is still not completely adept at dealing with risk. These risks are relatively intangible in nature, since exact values can not be given. This uncertainty makes stakeholders nervous about investing in a new project, which makes it imperative to analyze these risks, but not in the traditional way where specific values are given to the probability of risks to occur and their impact, but in a new way where the stakeholder has a margin of error that will not affect the analysis.

9.Future Scope:

a) The fuzzified cash flow be implemented into the proposed algorithm in this thesis, as a factor of Present Worth or Return On investment. This incorporation would allow the algorithm to develop from a qualitative approach to a quantitative analysis. The rule set for this new algorithm would look as follows:
IF Probability of Project Delay is ___ and Impact of Project Delay is ___ and
Present Worth is ___ THEN Project Attractiveness is ___.
b) A final recommendation would be to develop the equation of risk exposure, that is seen quite often across the literature, in a fuzzy logic format and taking into consideration the expected value of loss.

10. References

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