ABSTRACT
This paper reports the methodology to solve risk analysis problems with the purpose of determining the project’s attractiveness. The model presented in this paper was developed using fuzzy logic and designed for the software development industry. Fuzzy logic was used since it is a tool capable of modeling 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. The result in this paper is the development of a new line of thought in the area of risk analysis, where the probability and impact of a project delay can determine the attractiveness of the project. This methodology can also be generalized and therefore have the capability of being used in the project evaluation in many different kinds of industries not only the software industry.

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 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 way. Consequently project managers have to take into consideration many factors before committing valuable resources to any project. These factors 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 rupees; 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:
‘Risk’, as defined by one source, “is the chance that an undesirable event will occur and the consequences of all its possible outcomes” A second source defines risk as “a measure of the probability and consequence of not achieving a defined project goal. Most people agree that risk involves the notion of uncertainty. However, when risk is considered, the consequences or damage associated with the event occurring must also be considered. Risk is not always easy to evaluate, since the probability of occurrence and the consequence of occurrence are usually not directly measurable parameters and must be estimated by statistical or other procedures.” This is a perfect justification as to the development of the model proposed in this work, because fuzzy logic was built.
to deal with parameters that could only be estimated since exact values are impossible to determine. “Risk has two primary components for a given event: probability (likelihood) of occurrence of that event and the impact of the event occurring (amount at stake)”. Risk therefore can be conceptually defined as the function of likelihood and impact. Risk = f (likelihood, impact). In the area of software development, the way they define the relation between likelihood and impact is that \( \text{RE} = P(UO) \times L(UO) \), which translates as the Risk Exposure is equal to the Probability of an Unsatisfactory Output times the Loss caused by an Unsatisfactory Output.

3 RISK ANALYSIS:
Risk analysis is the area of risk management that this work focuses on. As defined 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 model 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.

4 FUZZINESS AND FUZZY LOGIC:
In contrast to the true or false world of Boolean logic, fuzzy logic techniques allow the use of degrees of truth to calculate results. The expression “fuzziness” means a sense of vagueness in defining the measures rather than the lack of knowledge about the value of the variables and the causal relationships. However, fuzzy set theory provides a strict mathematical framework within which results are calculated. Fuzzy logic is justified because:
- It is tolerant of imprecisely defined data;
- It can model non-linear functions of arbitrary complexity; and
- It is able to build on top of the experience of experts.

The example is shown in figure 1

5. DEFINITION OF THE PROBLEM:
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.

6. 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 2. 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: Range and classes of robustness of SMS

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: Building a Fuzzy Model

7. MODEL AND MODEL 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.

Figure 3: A Causal and Cognitive Map for the Ensuing case study

A sample of the rules created for the model of Project Delay Probability is shown in Table 1; and project delay impact. The rules are developed by using the
causal and cognitive mappind diagram as shown in fig 3. These acronyms are:

8. CONCLUSION

The model 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 is implemented into the proposed model 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.

b) A final point of concern 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.

REFERENCES