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Artificial Intelligence Approach for Project Portfolio Management

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Abstract: Most of Information Technology (IT) projects do not succeed and reach their objectives. This fact is due to the challenging nature of IT project management. IT project management suffers from high complexity, uncertainty and nonlinearity. This research is concerned about the uncertainty of time management, the complexity of cost management and the nonlinearity that arises in time and cost management when multiple projects are managed at the same time as projects portfolio. To overcome these issues, this research proposes the use of Artificial Intelligence (AI) because of its ability to handle complex non-linear problems. Specifically, two AI techniques will be the focus of our methodology. These techniques are Fuzzy Inference and Artificial Neural Network. The scope of this research will cover time and cost management.

I. Introduction

IT project management is a very complex process that has many dimensions and requires advanced managing skills. The following figure can give simplified insight of IT project management dimensionalities.

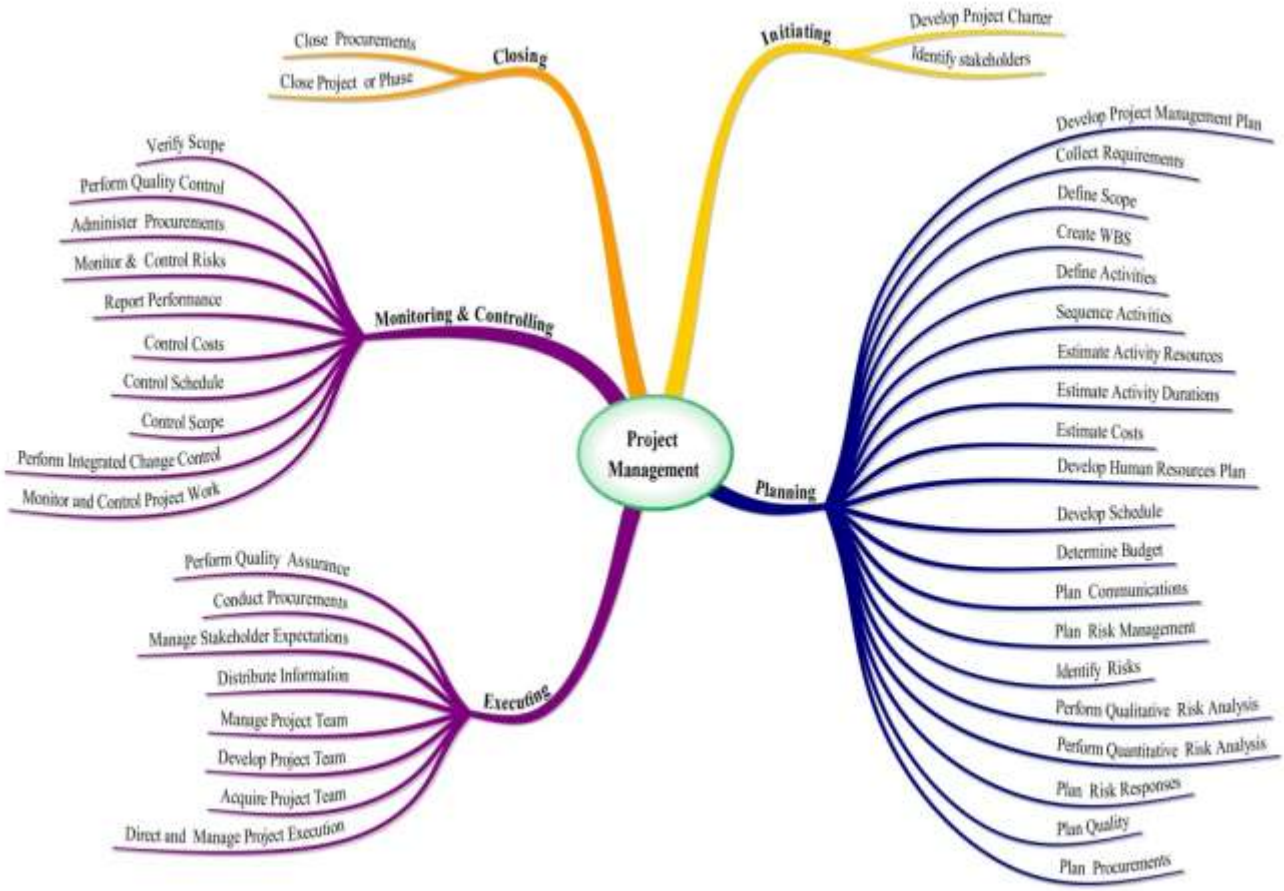

Figure 1: Project Management (PMBOK Guide, 2008).

Management of multiple and concurrent projects at the same time is called Projects Portfolio Management and it is based on Modern Portfolio Theory (MPT) (Markowitz, 1952).This theory has been extremely instrumental as an important tool of identifying and assessing risks that projects can be subjected to and the returns that such project investments are bound to bring to business organizations. Markowitz assumed that investors are normally risk-averse. By creating a basket of portfolios, he attempted to mathematically maximize return for a given risk perception, or minimize risk for a given amount of expected return. Risk is measured in terms of various quantities, such as Alpha, Beta, and R-Squared among others.

While MPT was mainly used for financial analysis, in the latter half of the twentieth century its lessons and insights were also applied to the emerging field of IT Project Management (McFarlan, 1981). This gave rise to Project Portfolio Management (PPM), which is the centralized management of a group of existing projects by a Project Management Office (PMO) or a project manager.

IT Project Portfolio Management Definition

There are several different definitions of IT PPM exist, this thesis will adopt the definition proposed by (Kumaret al, 2008), which is as follows:

"Continuous process to manage IT projects, application and infrastructure assets and their interdependencies, in order to maximize portfolio benefits, minimize risk and cost, and ensure alignment with organizational strategy over the long run"

A PPM framework should subscribe to project areas, or capability definitions, as defined by the Project Management Institute (PMI) as part of its Project Management Body of Knowledge (PMBOK). These nine areas are as follows: Integration Management, Scope Management, Time Management, Cost Management, Quality Management, Human Resource Management, Communications Management, Risk Management and Procurement Management (PMBOK Guide, 1996). IT project portfolio keeps changing over time. However, these changes have to be within organization constrains and limitations. There is no global set of rules to manage projects portfolio.

Every projects portfolio has its own best way of management. This viewpoint of management is called Contingency Theory (Woodward, 1958). This study fundamentally seeks to establish the extent of which artificial intelligence can be used to benefit the management processes of project portfolios in information technology (IT) based Contingency Theory.

Motivation

The central focus of this research is based on the approaches that need to be adopted to improve the evaluation of IT projects or project portfolios. There are various problems that have been associated with these phases of project development. Quite fortunately, there are various solutions that have been provided by artificial intelligence technologies, tools and models, which can be used in the enhancement of portfolio management processes. In the use of these AI technologies, tools and models, it is important to understand what needs to be done in order to make sound and informed conclusions as well as recommendations in this research, which is what this thesis seeks to do.

One of the most critical dimensions of project portfolio management in this research is risk management (Jin & Zhang, 2011). Project portfolios have been associated with a significant number of risks. About 70 percent of IT projects do not achieve the set objectives because they fail to effectively manage the risks. Many projects failure have also been associated with great uncertainties. The need to establish AI technologies, tools and models that can be used in better dealing with these uncertainties has been, therefore, a compelling force in this research. AI is appealing because of the cyclic nature of IT project management process as shown in next figure.

This cyclic behavior will lead to forming pattern inside IT project management process which can be extracted by artificial intelligence tools. This fact is the major motivation behind adopting AI as the main methodology in this research.

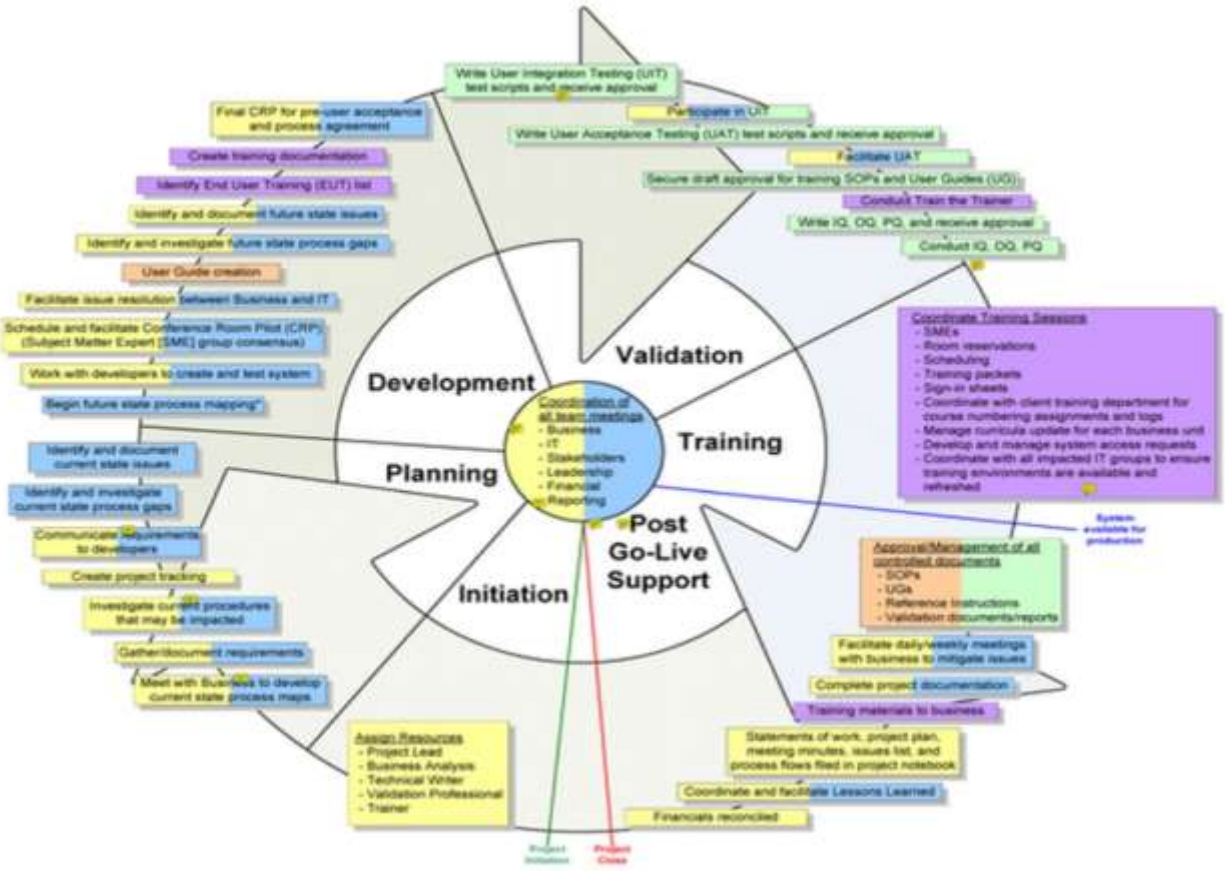

Figure 1: Cyclic behavior of IT project management (Prima, 2012).

Scope

This research study aims at covering a number of dimensions of portfolio management and how its management can be enhanced through the use of artificial intelligence. The study basically focuses on IT project portfolios cost and time management.

Project cost has, in recent years, also come up as a considerable issue in the study of project portfolio management. Different projects have different budgetary constraints which have to be taken to account before the selection, development, implementation or even the evaluation of any IT project begins. Fortunately, there are various technologies, approaches and models that are used in making sure that cost management is facilitated and the project objectives are achieved. These are the general issues that will be discussed as well as the relationships they have with the overall discussion.

The other important part of this discussion that has immense considerations in the literature review, which has to be incorporated in the study, is time management. Information technology projects are associated with numerous complexities that have to be understood prior to the commencement of any phase of a project or a project portfolio consideration. This necessitates the discussion and understanding of all aspects of time and completion deadlines as well as their relationships with cost management (Chen & Wang, 2009, p.241). This is important in all of the project phases, which include the selection, development, implementation and monitoring and evaluation.

Problem Statement

Project development, as a result of its multifaceted formation, particularly in the field of Information Technology, could frequently come across numerous unexpected setbacks, leading to project delays, over-budgeting and poor quality results. Even though such issues cannot be entirely eradicated, they can be managed and limited by implementing adequate and appropriate risk management techniques. Nevertheless, the issue with current and rare methods is that they fail to address the precision or accurately estimate budget and timeline necessary for creation of a perfect product.

It is evident that starting IT projects is sometimes hard; this is allied to the fact that IT projects commonly entail numerous dynamic features; nevertheless, they are commonly constrained by finite circumstances. Some of the said features consist of

measures of implementing control systems, structures, variables as well as methods. Likewise, this may include other aspects such as change control along with risk management. Depending on the nature of the IT project, it has been established that delivery framework is another factor that is allied to the success or failure of any IT project. This is more correlated to the application of system development structures towards the anticipate project.

When starting an IT project, it would be advisable to consider those dynamics, which are within attainable level. Time is of great importance since if well managed it helps in overcoming structural and administrative variables, which can limit the projects perimeters. Other essential dynamics include identifying the projects specific deliverables, how to handle administrative crisis, financial inadequacies as well as operational breakdown.

Estimation of time and cost are considered to be the basic criterion to project success. It is very problematic to predict the time and cost accurately as unexpected events and urgent work are not taken into consideration. Sudden occasions may involve internal and external meetings, sickness and holidays of key staff, equipment breakdown, missed deliveries, quality control rejections, etc. The greatest risk throughout estimation is board's constant assertion for rapid actions during the procedure.

The majority of estimation techniques convey a form as quantification for the dimension of the object to be anticipated. If to found on this idea, a time as an appropriate form (effort) is expanded from the amount of costs, which can be obtained. The project administrator is required to further render the early "sophisticated" project description into a detailed project map that tackles the simplest degrees of execution details.

Time and cost estimation are closely intertwined as time estimation is a key factor of price determining and, hence, the project profitability. Time also makes influence on reliability and competence assessment. Cost estimations greatly depend upon accurate assessments of resources and time. Estimating time accurately is considered to be one of the most complicated tasks as it takes experience and profound understanding of the project. One of the most common issues is that project managers overlook that the execution of this task may take longer than expected.

Each project task will have a cost including the cost of the labor hours of a computer programmer, cost of equipment breakage, total time needed for the project, etc. When the budget of a project is prepared, the cost and time of each task are calculated and totaled. Nonetheless, it is difficult to predict all prices and time due to price change and other unpredicted events. Thus, the effort estimation process within Information Technology has been noted as cost estimation, which is the result of time, schedule and effort evaluation. Due to the complexity and a variety of factors that influence estimation accuracy, there is a need to develop a model which might take all possible factors into consideration.

The problem of accurately estimating time and cost gets worse when multiple projects are being performed at the same time. Each project in the projects portfolio will have indirect effect on the other projects. Sometimes, this effect can be a kind of Butterfly Effect where all parameters start behaving chaotically. Chaotic parameters are exponentially very hard to estimate. Each project in the portfolio has a set of tasks to be completed. Each one of these tasks has a cost and timeframe based on its nature.

Different techniques have been used to solve the problem of time and cost estimation including statistic techniques (correlations), a model based on adjusted curves. The main disadvantage of the above mentioned techniques is that the size is considered as a free variable whereas it remains unknown until the end of the project. Considering all factors and difficulties of cost and time estimation, the issue should be studied under the framework of artificial intelligence approaches.

Research Questions

This study seeks to answer the following research questions:

- What are some of the best approaches that can be used in enhancing cost and time management effectiveness and efficiency in project evaluation?
- How can artificial intelligence be used to prioritize the selection of multiple and concurrent IT projects?

Research Hypothesis

- H1: Artificial intelligence is highly instrumental in the improvement of project portfolio management strategies
- H2: The use of Artificial intelligence in PPM can be improved through the use of approaches that combine fuzzy inference systems and neural networks to better manage risks, costs, personnel and time in PPM

Research Objectives

The focus of this study lies in the use of artificial intelligence to address problems associated with selection, implementation and monitoring, and evaluation of projects in information technology. The use of PPM is taken into deep consideration and how AI can be integrated into it. The following objectives have, therefore, been set for accomplishment.

- To establish methods through which project cost and timeline can be estimated to some degree of confidence to reduce management difficulty.
- To establish ways in which artificial intelligence can best be used to improve the selection, implementation and monitoring, and evaluation of information technology project portfolios
- In the appreciation of the fact that the selection, implementation and monitoring, and evaluation will result in the introduction of new technologies, systems, models and approaches, the study also seeks to establish ways to achieve the highest possible of scalability and absolute adaptability so that not much of the existing infrastructure can be affected by the new developments.

Literature Review

The study of IT projects portfolio management has been important for thousands of researchers and industries and has been conducted over decades. An important of such studies is one that was conducted by Harry Markow and published in 1952, discussing the importance of selecting a project portfolio. He, in his documentation, describes important aspects of portfolio selection. His focus predominantly lies in the "future beliefs on performances of available securities and the choice of portfolio" (Markow, 1952, p. 77). Essentially, his discussion is based on the returns that should be expected from the investments made, on which the decision on the choice of portfolio should be based. This is an important study in this discourse as it reflects upon the future aspects of the project and the predictability of portfolios.

Artificial Intelligence and IT PPM

The use of Artificial Intelligence is the core of this research and an evaluation of how it has been used and studies in the recent past is of absolute importance in the achievement of the above state objectives. There are hundreds of artificial intelligence approaches that have been developed in the world for use in project portfolio management in information technology. The discussion of these technologies has been of great importance in this study.
The study of project portfolio management has shown that project management fundamentally boils down to effective decisions making – it is all about the choices made by the project management team. According to Liang (2009) project management involves decision making processes that have to take to account certain important considerations, including environmental coefficient as well as associated parameters, which has been indicated to be "fuzzy in nature" (Liang, 2009, p.1407). According to this study, it is important, for decision making processes to take to account the lack of precision in present frameworks of project management. Such frameworks have been associated with lack of clarity, which, can in short be said to be with uncertainties. This is where the use of fuzzy systems comes in handy.

Fuzzy Inference and IT PPM

Liang (2010), therefore, focuses on the development of a "two-phase fuzzy mathematical programming (TPFGP)" method of solving project management problems, especially those that have multiple conflicting objectives in an environment that is filled with uncertainties. In this sense, Liang concurs with Ghapanchi (2012) and his group on the need to evaluate the level of fuzziness within the project or portfolio environment and developing strategies to address it. In his approach to solve this problems, Liang developed a "fuzzy multi-objective programming model" that was aimed at enhance decision making and eliminating uncertainties that concern total project costs, project deadlines, imminent projects penalties, not to mention direct and indirect costs associated with the project. In essence, Liang brings about an important picture of just how well fuzzy systems can be used in eliminating uncertainties and risks while propagating effective cost and risk management processes throughout the selection, implementation and monitoring, and evaluation of the project.

Artificial Neural Networks and IT PMM

The importance of artificial intelligence in project management has been felt much more deeply with the use of artificial neural networks (ANN). In a study that was conducted by Yu-Shan Chen, Ke-Chiun Chang and Ching-Hsun Chang, the importance of ANN has been demonstrated in the description of its relationship with research and development projects. The relationship has further strengthened the importance of ANN in the discussion of the various determining factors of the success of R&D projects (Chen, Chang, & Chang, 2012, p.1537). According to the study, some of the key determinants of the success of R&D projects include the skills and capabilities of the project management teams as well as the teamwork capabilities. The uncertainty associated with R&D projects as well as the complexities associated with the selection, implementation and evaluation processes have also come up as important subjects to be studies in this research (Chen,

Chang, & Chang, 2012, p.1541). In addition, the study has also been focused on establishing ways in which project management skills and their capabilities to foster teamwork can be enhanced through the use of ANN.
The use of ANN has come as an important subject of study which interest many projects and in particular, research and development. Interests in this technologies, which simulate the human brains operate and result in highly effective technologies, have been key aspects of R&D in the information technology industry Chen, Chang, & Chang, 2012, p.1541). The importance of the skills possessed by project managers have also been raised as an important determinant of the success of a R&D project and should be evaluated prior to the selection of a project. Finally, the research has made an important contribution that concerns personnel management, which is demonstrated in the mentioning of fostering teamwork. This is quite consistent with a number of other studies outline above.

Related Works

This proposal is inspired by several works in literature (Ghapanchi*et al*, 2012) (Cheng*et al*, 2012) and (Agarwal*et al*, 2011); which can be considered as the anchor papers for this research. One of the most relevant works is (Ghapanchi, Tavana, Khakbaz, & Low, 2012) where the authors modeled the uncertainties of IT project as fuzzy sets. They also used fuzzy set to model the interaction among IT projects under development. To choose the best possible combination of project, authors employed a mathematical programming technique called Data Envelopment Analysis (DEA) (Charnes, Cooper, & Rhodes, 1978). Their approach showed very good performance. However, it suffers from two important limitations. The complexity of the proposed approach grows exponentially as the number of projects increases ($O(2^n)$). In case, there are 10 projects, 1024 portfolio will be processed. If the number of projects increased to 20, 1048576 possible portfolios will be evaluated. Also, the proposed approach considers only pair-wise interaction between projects. It cannot deal with multiple interactions among all projects.

Another interesting work is (Cheng, Tsai, & Sudjono, 2012). In this paper, Evolutionary Fuzzy Hybrid Neural Network (EFHNN) was proposed. The authors were concerned with the uncertainty associated with the cash flow of projects. They used fuzzy set to model this uncertainty. They employed ANN to deal with non-linearity of cash flow problem which led to good results. In addition, they used GA to optimize the proposed approach. Agarwal*et al*(Agarwal, Colak, & Erenguc, 2011) proposed the use of hybrid ANN and GA technique to tackle Resource Constrained Project Scheduling Problem (RCPSP). The results showed the outperformance of hybrid approach over individual ANN and GA.

Methodology

In this research, three Artificial Intelligence techniques will be used. These techniques are Fuzzy Inference System (FIS) (Mamdani & Assilian, 1975), Genetic Algorithm (GA) (Holland, 1992) and Artificial Neural Networks (ANN) (Mammone & Zeevi, 1991). First, time and cost models will be formalized. Then, the adopted AI techniques will be presented.

Critical Path Analysis

This research will adopt the concept of Critical Path Analysis (Kelley, 1961) for time management in IT projects. The main motivation behind choosing this technique for time management is its ability to incorporate uncertainty in the analysis. In addition, there is an increasing interest in literature to combine critical path analysis with fuzzy inference which is one of the methodologies adopted by this thesis. Many authors used time as fuzzy variable in critical path analysis such as (Lorterapong, 1996), (Nasution, 1994) and (Rommelfanger, 1994). Other authors tried to study the issue of path criticality (Chanas, a2002, b2002). It was concluded that calculating path criticality is computationally complex. Hence, fuzzy inference is proposed by this thesis to reduce this complexity.

The critical path concept is build based on a network that represents IT project activities in some sort of order. These activities can be programming, integration, testing or any other project tasks. Let the set containing tasks and activities in IT project be represented by:

$$A = \{a_1, a_2, \dots, a_N\}$$

Each one of a_i activity will have set of activities performed directly before it. This set will be called predecessor B_i which is a subset of A. In other words, $B_i \subseteq A$. The set that contains all predecessors is $B = \{B_1, B_2, \dots, B_N\}$. The relationship between all activities governed by B can be represented as graph. The following figure shows one of the benchmark project problems which is being used in literature (Patterson, 1984).

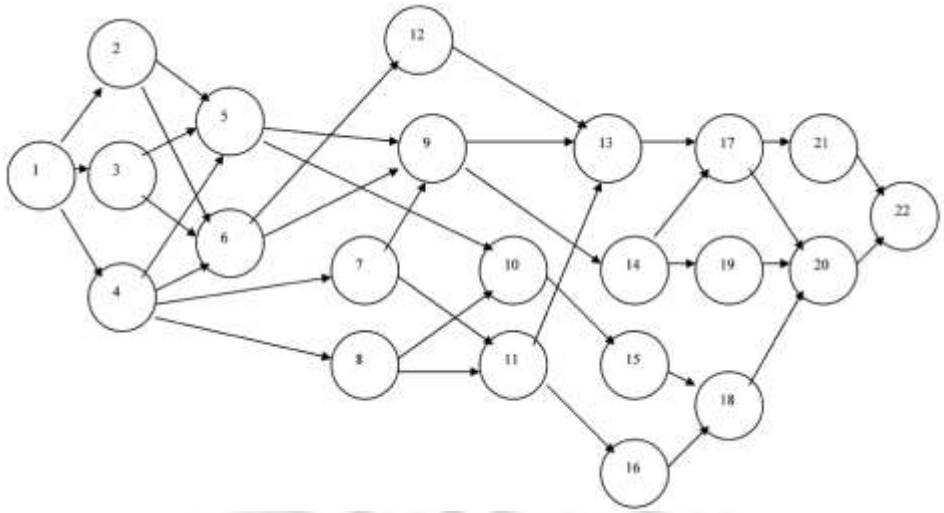

Figure 2: Patterson project 42 where each circle represents an activity.

Each activity takes t_i time unit to be performed where $t_i > 0$ and$t_i \in \mathbb{R}$. The set $T = \{t_1, t_2, \dots, t_N\}$ represents the time needed for each activity to finish. The sequence of activities from a_1 to a_N is called a path p. There are several paths in any project. The path which has the largest accumulated time is called the critical path with length L_{CP}.
Assuming that no activity can start unless all activities in its predecessor has finished, each activity will has earliest possible start time (ES_i), earliest possible finish time (EF_i), latest possible finish time (LS_i) and latest possible finish time (LF_i). By using these variables slack (S_i) can be calculated as follow:

$$ES_i = \max_{j \in B_i} EF_j$$
$$EF_i = ES_i + t_i$$
$$LF_i = \min_{j \ st \ i \in B_j} LS_j$$
$$LS_i = LF_i - t_i$$
$$S_i = LS_i - ES_i$$

After finding S_i, L_{CP} can be calculated. However, hard problem will arise when calculating S_i because of uncertainty in delays in activities operations. As mentioned before, calculating the criticality is computationally complex. Therefore, other approach should be developed.

Time-Cost Tradeoff

The other important dimension of IT projects performance is cost. It can only be treated in a relationship with time. To achieve the highest benefit of IT project to an organization, it should be finished in timely manner and according to due dates. However, reducing IT project developing time will lead to increase in cost. Therefore, a compromise between time and cost should be made in respect to the organization overall goals and budget.
In the previous section, each activity will have duration time of t_i to finish. In reality this time (t_i) is a function of resources used in the activity. For example, developing a component in IT system will take different amount of time if one programmer is working on it or if there are two programmers working on it. As the number of programmers increases, the activity will finish sooner. However, increasing number of programmers will increase cost. Here, two version of the problem can be classified. First, if we have strict Due Date to finish the activity and the budget is open. Our goal will be minimizing activity time (t_i). This version is called Due Date Problem.
The second version is the opposite by having strict budget and wide time frame. Our goal will be minimizing the cost. This version is called Budget Problem. Usually, IT project activities are combination of these two versions. The uncertainty issue mentioned in the previous section will time-cost tradeoff problem as stochastic problem. Many researcher in literature have tried to solve stochastic time-cost tradeoff problem by using heuristic approaches such as (Gutjahr, 2000), (Hagstrom, 1988), (Herroelen, 2004) and (Hillier, 2001).

Another approach is to use the concept of Stochastic Programming with Recourse which treats stochastic time-cost tradeoff problem as decision problem with different stages (Delft, 2004). However, these approaches are not feasible in large projects with many activities, resources and overlapping time frames. To overcome come this difficulty, we propose the use

of Robust Optimization (Ben-Tal, 2002). This methodology has the ability to incorporate uncertainty that inherently exists in IT project management. Also, Robust Optimization proved its capability to handle large and complex problems (Ben-Tal, 1997), (Ben-Tal, 2000) and (Levinger, 2002).

As said before, each activity will have a cost function ($C_i(t_i)$) based on its time. This cost function depends on the activity nature. For example, an activity that requires servers will take in consideration electric bill, maintenance expenses and software cost. The cost function can be linear as in (Kimms, 2001), (Baker, 1997) and (Shtub, 1994); or it can be nonlinear as in (Deckro, 1995) and (Wiest, 1977). In this thesis, we formulate time-cost tradeoff problem as follow:

$$\min\left\{\sum_i C_i(t_i)\right\}$$

Subject to:

$$\sum_i C_i(t_i) < C_{max}$$

$$L_{CP} < D$$

$$t_i > 0, \forall\, a_i$$

Where C_{max} is the maximum allowed budget for the whole IT project and D is the due date for the whole project. In other words, our problem is minimizing project cost while finishing it before the deadline.

Fuzzy Inference System

As starting point of the methodology of this research, all projects parameters with uncertainty should be identified. Fuzzy Set (Zadeh, 1965) will be used to measure the believe of each parameter. This believe will be either input by the manager or it will be generated through the use of FIS which is an expert system that takes fuzzy parameters as input and generates a decision based on a set of rules. This decision can be a value of another parameter or it can be an action. Several FIS system will be developed to optimize projects portfolio. To illustrate how FIS work, we will introduce simple tutorial published by MathWorks (2012). Imagine that we are developing Tipping expert system which helps us to estimate how much should the tip be in a restaurant based on the served food and their service. We construct three rules as follow:

- **If** service is poor *Or* food is rancid **Then** tip is cheap.
- **If** service is good **Then** tip is average.
- **If** service is excellent *Or* food is delicious **Then** tip is generous.

The customer will rate the service and food from 0 to 10. Then, this rating will be used as an input. The first step is to convert the input into fuzzy number using the membership function in process called Fuzzification. The next figure represents an example where the user gave rate 3 for the service and rate 8 for the food.

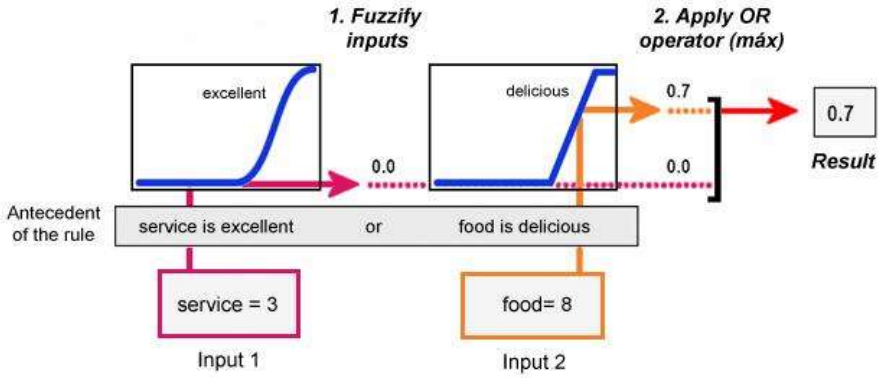

Figure 3: Fuzzification (MathWorks, 2012).

Each rule has IF part (Antecedent) and THEN part (Consequent). The IF part is used to generate a fuzzy number as result (in figure 5 the result is 0.7). This number will be used to cut off the membership function of the THEN part as illustrated in next figure.

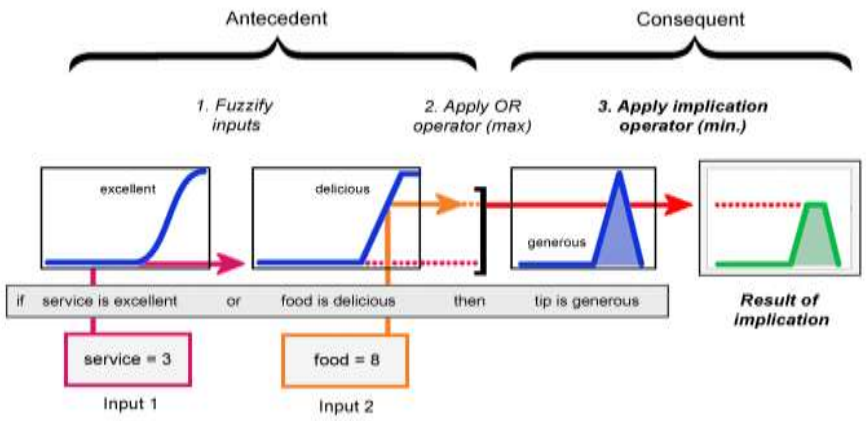

Figure 4: Result of implication (MathWorks, 2012).

The next step will be repeating the same process for every rule in the system and combining the results of all rules.

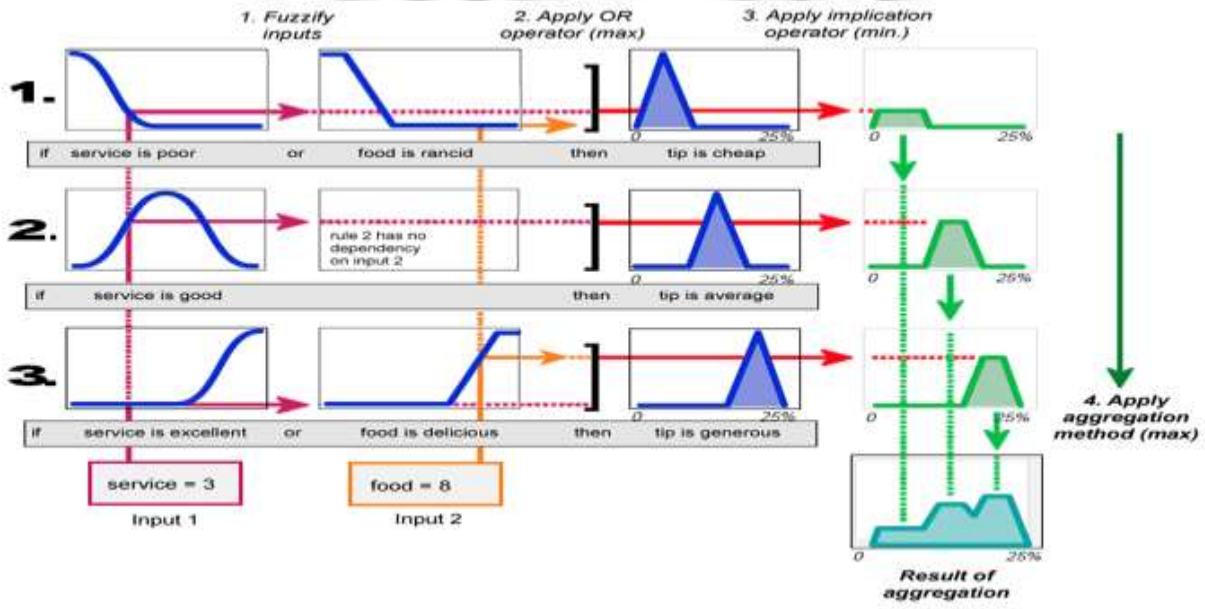

Figure 5: Result aggregation (MathWorks, 2012).

The last step in FIS system is taking the aggregated result shape and applies Defuzzification process. This process has different versions. However, the main idea is to extract a number from the result shape. The most common extraction approach is the area centroid. This approach looks for the center of the shape area. Then, it takes the corresponding value in the x-axis as the output. The next figure demonstrates the idea.

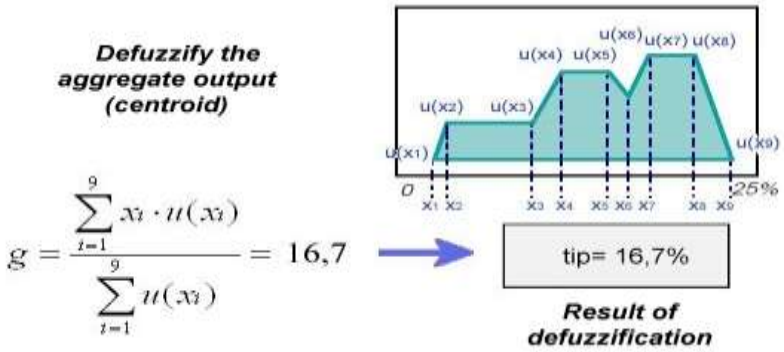

Figure 6: Centroid approach (MathWorks, 2012).

Genetic Algorithm and Artificial Neural Networks

To increase the accuracy and the efficiency of each FIS, GA and ANN will be used to tune all FIS's. GA is meta-heuristic method that searches the solution space for the optimal point. It is inspired by the evolution process in biology. Each possible solution will be encoded as chromosome. These chromosomes can mate and generate offspring. By forcing the mating process to choose only the best chromosomes as parents, the new offspring will perform better because it will have the best genes of each one of the parent. This way every generation of offspring will perform better until the best generation is reached. GA will be responsible about generating the most efficient FIS.

On the other hand, ANN is a universal approximator. It is inspired by the way human brain is constructed. From philosophical point view, any thought or concept that human brain can grasp and understand, there is an ANN that can represent it. It is one of the most powerful tools in AI toolbox. However, it requires a lot of training which not suitable for every application. In this research, ANN will be responsible about adjusting FIS's to achieve the most possible accuracy.

Evaluation and Expected Results

The main evaluation method will be simulation. Several benchmarks can be used such as Patterson benchmark (1984) which consists of 110 problem sets. These sets are mostly resource constrained project problems. Some modification is needed to combine more than one project problem in portfolio. These problem sets will only be tested to perform the comparison of the proposed approach with other solutions in literature. Another set of problems will be developed by this research to focus the evaluation on IT projects.

Developing Environment

Matlab environment (MathWorks, 2012) will be used to develop the simulation scripts. It is very robust development environment that has been used by researchers in all fields for decades. Matlab has many toolboxes built in. Most of them are related to artificial intelligence. This research will utilize three toolboxes which are Fuzzy Inference toolbox, Neural Network toolbox and Optimization toolbox. By utilizing these toolboxes, the evaluation process will be shorter and re-developing and modification will be much easier.

Expected Results

This research will use several performance metrics to evaluate the proposed solutions. The most essential performance metrics are project time, project expending, accumulated delays, risk exposure, resources utilization, average number of concurrent projects in the portfolio, etc. The major expected results are:

- Reduction in average project time of projects portfolio.
- Reduction in average project budget of projects portfolio.
- Increase of available resource utilization.
- Increase of concurrent managed projects.
- Reduction of all sort of risk exposure.

In addition, this research will provide very important insight of how artificial intelligence techniques can be used to enhance the management process of IT projects portfolio.

Expected Limitations

The main feature of artificial intelligence is its ability to extract patterns. For patterns to emerge, some sort of repetition is required. In our case, IT projects, if these projects in the portfolio are not similar in a way or another, the expected improvement after implementing the proposed solution will not be high. The reason behind this is that projects do not have common activities among and each activity may happen only one time. For example, our brain can associate the word "NOKIA" with cellphones and telecommunications because we heard it many times in relation with cellphones and telecommunications context. If we only heard it once in our life, we will not be able to associate it with cellphones and telecommunications. The same is applied to any artificial intelligence technique. However, we can overcome this issue by insuring that projects in any portfolio are related.

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