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F uzzy Cognitive Map b ased Prediction Tool for Schedule Overrun

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Abstract

The main aim of any software development organizations is to finish the project within acceptable or customary schedule and budget. Software schedule overrun is one of a question that needs more concentration. Schedule overrun may affect the whole project success like cost, quality and increases risks. Schedule overrun can be reason of project failure. In today?s competitive world, controlling the schedule slippage of software project development is a challenging task. Effective handling of schedule is an essential need for any software project organization. The main tasks for software development estimation are determining the effort, cost and schedule of developing the project under consideration. Underestimation of project done knowingly just to win contract results into loses and also the poor quality project. So, precise schedule prediction leads to efficient control of time and budget during software development. In this paper, we developed a new technique for the prediction of schedule overrun. This paper also presents the comparison with other algorithms of schedule estimation and Tool developed by us and at last proved that Fuzzy cognitive map based prediction tool gives more accurate results than other training algorithms.

Index terms— FCM, CCM, PERTBN, fuzzy.

1 Introduction

oftware schedule plays a vital role in software development. Making a prediction of schedule overrun is a very challenging task. Schedule always get affected by some certain factors: uncertainty, level of detail of preparing the project plan, managerial factors, lack of past data, pressure to lower estimation and estimator experience [18]. Brooks [2] also stated in his well known book in 1975 that assigning more programmers to a project running behind from desired schedule will make the project more lately. The reason behind this is time we have spent upon these programmers to go through from the project as well as the increased communication overhead. There are some reasons that why estimates are not precise like estimating techniques are poorly developed, when there is schedule slippage, software managers tend to increase manpower and makes the project more worst.

Likewise, there might be so many reasons behind the schedule overrun. This paper represents the review of some techniques to estimate the schedule as well as various considerations related to future work or we can say it represents the sketch of future plan. We cannot straight that one technique is better in providing high level of accuracy than others. All techniques give different level of accuracy depending on data set taken or parameters chosen. Some techniques which were used in the past are not in use during present time, like Fuzzy-ECM Approach [8] the way of work time, many of new advance roads have been suggested for effort estimation like Genetic programming, Fuzzy logic, Neural Network, data mining, etc. Most studies dealing with estimation/prediction focus on a single group of factors affecting the accuracy of prediction. So, there is need to develop a Model that provides high level of accuracy. In this paper, Fuzzy cognitive Map based prediction tool has been developed.

2 II.

3 Review of Literature

Van Genuchten et al., **??**1991) discussed in paper [18] that why software schedule is overrun, the reasons which are behind it. The purpose of this study to do in-depth research that will easily differentiate between planned project and actual project. **??**eichelt et al., (2003) stated that research, design and development projects are not met the required cost and schedule budgets. In this paper [14], author disagree that the tradition tools are the inefficient to predict or estimate the effort regard the project dynamics.

Jun-guang et al., (2011) proposed a systematic method of software project schedule management. This paper [9] comprises with some actual project cases in view of small and middle sized software projects. Papageorgiou et al., (2011) stated all the recent application and trends on fuzzy cognitive maps in previous ten years. Fuzzy cognitive are inference networks that uses cyclic directed graphs for knowledge representations. They stated in paper [19] that in previous year's fuzzy cognitive map has gained the interest of all the researchers and now a day is widely used to analyze casual systems such as system control, decision making, management, risk analysis, text categorization, prediction etc. Elpiniki I., et al., (2013) stated in their survey paper [13] a review of the most up to date applications and trends on the fuzzy cognitive maps. They stated the applications of FCMs (Fuzzy cognitive maps) over the past years.

There are some techniques that are developed by various authors are organized below in systematic manner for the sake of ease is as follows:

4 b) Fuzzy-ECM approach

Jian-Hong, He, et al., (2011) implemented a new approach that is Fuzzy-ECM Approach. Software development always influences by uncertainty that leads to unexpected results. This leads to face unexpected events like changes in technology, framework and market needs. This paper [8] reveals the existed technology that is ECM (Event Chain Methodology). They investigate the ambiguity nature of activities and events in ECM. So they proposed a new technique that is Fuzzy-ECM (FECM) which is used for estimating schedules of the projects by simulation, simulation, interpolation and sampling. c) A Simulation-based approach Lazarova-Molnar et al., (2011) proposed a Simulation-Based Approach. They stated in their paper [11] that project schedules are rigid in nature and often rely on well-planned activities. Each activity has the specific duration. But in real life, projects are often seen stuck in uncertainties. At that time, project definitely leads to re-scheduling and managers need to have some remedial action scenario (RAS) to relief the influence of uncertainty to make the project successful. There is problem which action to take is. To overcome this problem, they propose this approach to enhance project schedules by selection of the optimized RAS when the uncertainty takes place.

process. The purpose of this paper [7] is to identify and manage the factors that influence productivity and hence schedule influences. This model is used to predict the delay in delivery of the project due to these factors in terms of schedule slippage. There are many advantages of this like interdependencies of various risks factors, graphically representation, reduced large volumes of data and prediction of delay. e) IntelliSPM tool Stylianou et al., (2012) proposed a novel prototype tool. In this paper [16], they stated that software project managers face a problem a lot, when they going to implement effective staff and schedule of projects. Planning and estimating the execution of tasks plays a key role in projects. When this is not met then projects are delayed in time and/or over budget. Selecting the non-appropriate developers produces lower-quality and defective software products. To overcome these problems, they presents a intelliSPMa tool that purpose is to support software project managements tasks comprises of may optimization mechanisms which takes from computational Intelligence. The purpose of intelliSPM is to recommend to project managers a set of possible project schedules and staffing strategies. IntelliSPM is found practically beneficial to projects. f) Object oriented based Hou, Yonghui et al., (2012) proposed a model in paper [6] that comprises Petri Net Theory with Objectoriented technology. This efficiently solves the possible state explosion problem and the complex systems are modelled by Petri Nets. They used Process Performance Model (PPM) is used to represent past and present software project scheduling controlling performance. They assemble the PPM of software project schedule controlling with OOPN by which clients can direct and organize the whole project schedule more conveniently and intuitively than others. g) Ant colony optimization based Xiao, Jing et al., (2013) proposed an approach with the use of ant colony optimization. They stated in paper [18] that Software project scheduling problem (SPSP) is one the active and difficult problem in the current software industry. There are few problem of algorithms exist, with the increasing number of employees and tasks called NP-hard hard Problem. To design an efficient algorithm For SPSP, they introduced an ant colony optimization (ACO) approach which is named as ACS-SPSP algorithm. They compare their algorithm with genetic algorithm. By investigating d) K2 algorithm based approach Jeet et al., (2011) stated that main cause of failure of any project is its delay in delivery and the main results, it founds that ACS-SPSP gives better and accurate results compared to genetic algorithm.

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Volume XIV Issue IV Version I (earned value management). They look into three earned value methods, which are PVM (planed value method), EDM (earned value method) and ESM (earned schedule method). The inspection

has shown the results that earned schedule method outperforms on regular as compare to other two methods and a result fails in case of incorrect caution coming from non-critical actions that go through from delays and/or ahead of schedule. The purpose of this paper can be seen as two ways. Firstly, they revise the force of the actions' sensitivity information on the forecasting precision of the earned schedule method. Secondly, they declare the test that in standard environment the indicator of project performance provided by earned schedule method at higher work breakdown structure is trustworthy. More accurately, to improve the schedule performance of a project by removing the harmful effect of wrong warning of the non-critical actions uses activity based sensitivity measures as weighing parameters of the activities.

6 i) Casual and Cognitive Map based

Al-Shehab., et al., (2005) proposed a method through CCMs (Casual and cognitive maps). They states that due to rapid progressive nature of technology and complication of marketplace, software development have turn out to be more difficult. They proposed an estimation framework for recognizing the reasons of shortfalls in implemented project of information systems. This framework is build with the help of a casual map which is a dependency network diagram representing causes and effects. This casual map modeling is done during the longitudinal case study of a setback project and actual implementation of mapping is portrayed in paper [2]. j) Fuzzy Cognitive based approaches Giles et al., (2007) proposed a method in their paper [5] using Fuzzy cognitive map to deal with the well known disease 'diabetes' in medical science. They found that the previous methods to the treatment of diabetes are not good because they often fail to recognize indigenous locally on the informal determinants of the diabetes. To overcome this limitation, they found there is not a technique that is able to define these points of view experimentally.

Zhai., et al., (2009) proposed a method with fuzzy cognitive maps that examine the problem of credit risk evaluation of particular companies. At last, they present the working and simulation of the credit risk evaluation of particular companies using Fuzzy cognitive map. In the first section, they found and describe the of the Fuzzy cognitive map based model for appraising credit risk of particular companies [27].

Giabbanelli., et al., (2012) proposed a fuzzy cognitive map based technique for the diagnosis of obesity based on physiological behavior. In this paper [4], firstly they survey that obesity or also can say overweight found in the two thirds of the American and this continuously going to increases. Doctors face difficulties in solving the tough problem of obesity because the factors are in interdependent to each other.

In their paper, model represents the existence of relationship on which factors relies comes with thorough survey. The strength of these dependencies was estimated by team experts. The expert estimations were transformed to values that used by their model by different methods. They made test cases that are defined as rules that show the little depiction of the patients' cases can be used for the identification. These depictions could be acquired by filling a survey form or questionnaire before the appointment with doctor. This helps in guidance for probable behavioral change. All this helps in fuzzy cognitive technique for the prediction.

Salmeron., et al., (2010) implemented a technique in his paper [14] that is of fuzzy cognitive map based technique. They stated that fuzzy cognitive map is an inventive technique of soft computing. They examined the IT projects execution risks and the dependency between the relationships using the fuzzy cognitive map. They surveyed that companies of software projects spend billion of money in IT projects. That's why, IT risk management is found to be a crucial problem. They said that by this proposal, it is achievable to examine which the most pertinent risks are or can say that which have the strong impact on IT projects.

A Fuzzy Cognitive Map (FCM) was first introduced by Kosko [10] as a modelling approach. Dickerson and Kosko used the Fuzzy cognitive map to model how sharks and fish hunt in a virtual world. Fuzzy cognitive map is graphical representations of the relationships between events of the system [12]. Fuzzy cognitive map is defined as "Fuzzy cognitive maps (FCMs) show how causal concepts affect one another to some degree. Causal concepts in virtual worlds include events, values, moods, trends, or goals, etc". A fuzzy cognitive map is the way by which we see the interdependencies between the relations between the parameters that are responsible for the cried risk of the particular companies based on qualitative criteria. In second section, they describe how to implement the elements (concepts, events, project resources) and is used to compute the "strength of impact" of these factors or say elements.

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Volume XIV Issue IV Version I In Figure 1, each node in FCM represents a concept. Each arc (Ci, Cj) is directed as well as weighted, and represents causal link between concepts, showing how concept Ci causes concept Cj. Moreover, FCM are efficient in solving the problems like Classification, Prediction, Knowledge representation, Decision making, Modeling, Controlling etc.

8 Introduction to Fuzzy Cognitive Map

The main advantages of Fuzzy cognitive map [18] that motivate us to use Fuzzy cognitive approach are like easy to construct and parameterize, flexible in representation of complex structures, easy to use, easily understandable to non-technical persons or can say higher transparency, able to handle complex issues related to management and

knowledge elicitation, handle dynamic effects due to the feedback structure of the modeled system, dependency of the concepts.

9 IV.

10 Problem Statement

Precise estimation of project duration and schedule management becomes an issue of prime importance because many projects are terminated when it becomes obvious that they will notably go beyond their planned time and budget goals. In today's rapidly growing world, achievement in managing projects is a crucial factor for the success of the entire organization. Estimation that either overestimated or underestimated both is very essential. In case of Overestimating time and effort, due to a presumed lack of resources or because the projected completion is too late, can influence management not to approve projects that may otherwise contribute to the organization. On the other hand, underestimation may result in approval of projects that will fail to deliver the expected product within the time and budget available. In spite of the critical role of accuracy, examples of incorrect estimation abound, especially in IT projects, resulting in enormous waste of time and money. As discussed in introductory part most studies dealing with estimation errors focus on a single group of factors affecting the accuracy of estimation. So, there is need to develop a Model that provides high level of accuracy and improved prediction of results. An schedule overrun. This is the reason of estimating development effort in central to the management and control of a software project. One of the mind striking question that needs to be asked of any estimation method is how accurate are the predictions. And the exact prediction leads us to the successful projects. There is plenty of estimation models exist for schedule prediction. However, there is a need for novel model to obtain more accurate estimations. There are various models with their own advantages and also limitations. We cannot state that one approach gives better to another. I will develop a mathematical model with increased accuracy to estimate Software Effort. The model will be developed with the help of MATLAB. I will create the Fuzzy Inferences in MATLAB to calculate the weights of the Fuzzy cognitive Map.

V.

11 Proposed Methodology a) Choosing Parameters

The parameters I choose are responsible for the project's schedule overrun. These factors are used to make the Fuzzy cognitive map of my technique by which we can see the interdependency between the factors in a graphical representation easily. The factors that are responsible to project's schedule overrun are as follows: For the prediction of schedule, tool is generated with the help of MATLAB (Matrix Laboratory R2012A). This has been shown in Figure 2. MATLAB (R2012A) Matrix Laboratory environment is one such facility which lends a high performance language for technical computing. As Fuzzy cognitive map algorithm is used, so this algorithm is integrated with this GUI (Graphical User Interface) for graphical convenience as shown in figure below.

12 Experimental Results

We supposed the various combinations that if during the development process some factors which affect the schedule of the software project then what would be the possibility of the schedule slippage. These various combinations are shown in table 2.

In case 1, we considered that IF High staff turnover rate, Lack of management support and Wrong design and complex coding are on. The tool predicts the schedule based upon the weights assign to each factor. The following diagram shows the different ON factors and the output panels shows the chances of schedule slippage would be 4.243 months.

In case 2, we considered that IF High staff turnover rate, Lack of management support and Wrong design are on. The tool predicts the schedule based upon the weights assign to each factor. The following diagram shows the different ON factors and the output panels shows the chances of schedule slippage would be 3.1566 months.

In case 3, we considered only one factor that is insufficient budget is on. The tool predicts the schedule based upon the weights assign to each factor. The following diagram shows the ON factor and the output panel shows the chances of schedule slippage would be 3.167 months.

In case 4, we considered that IF Less qualified staff and complex coding are on. The tool predicts the schedule based upon the weights assign to each factor. Table **??** :

and the output panels shows the chances of schedule slippage would be 2.3094 months.

In case 5, we considered that IF Less qualified staff, complex coding and undefined project objectives are on. The tool predicts the schedule based upon the weights assign to each factor. The following diagram shows the different ON factors and the output panels shows the chances of schedule slippage would be 3.1566 months.

In case 6, we considered that IF High staff turnover rate, Lack of management support and Wrong design are on. The tool predicts the schedule based upon the weights assign to each factor. The following diagram shows the different ON factors and the output panels shows the chances of schedule slippage would be 3.1566 months.

In case 7, we considered that IF High staff turnover rate, Lack of management support and Wrong design and complex coding are on. The tool predicts the schedule based upon the weights assign to each factor. The

following diagram shows the different ON factors and the output panels shows the chances of schedule slippage would be 4.243 months.

13 Comparison

In paper [7], for inputs Reliance on key personnel as probable, Immature Technology as Frequent, Lack of Client Support as Occasional and Lack of Contact Person Competence as Remote, the Schedule slippage is computed as 6.53061 months.

In the proposed tool, we select input values as Lack of Management Skills, Less qualified Staff, Lack of Project Control, High Staff Turnover Rate and New Technology. These inputs have been selected with a thorough study of input parameters. The reason behind the choice of these input parameters is that the first three input parameters viz. Reliance on key personnel, Immature Technology, Lack of Client Support have values Probable, Frequent and Occasional respectively which when defuzzified acquire more than 50% probability of occurrence whereas the final input parameter namely Lack of Contact Person Competence having value Remote is translated as less than 50% probability of occurrence. We selected our input parameters corresponding to the inputs with high occurrence probability.

14 Conclusion

Software schedule management is one of the most important tasks for the development of failure free projects. To develop the software project failure free, it should be highly preferred for the accurate prediction of cost and schedule overrun. Most studies dealing with estimation/prediction focus on a single group of factors affecting the accuracy of prediction. So, there is need to develop a Model that provides high level of accuracy. Fuzzy cognitive map (FCM) based prediction tool for schedule overrun is developed using MATLAB. Many of new advance roads have been suggested for Schedule estimation and there could be more investigation takes place regarding the improvement of schedule prediction. Year 2014 [1] [2]

Figure 1:

[1] © 2014 Global Journals Inc. (US) Fuzzy Cognitive Map Based Prediction Tool for Schedule Overrun
[2] © 2014 Global Journals Inc. (US) Fuzzy Cognitive Map Based Prediction Tool for Schedule

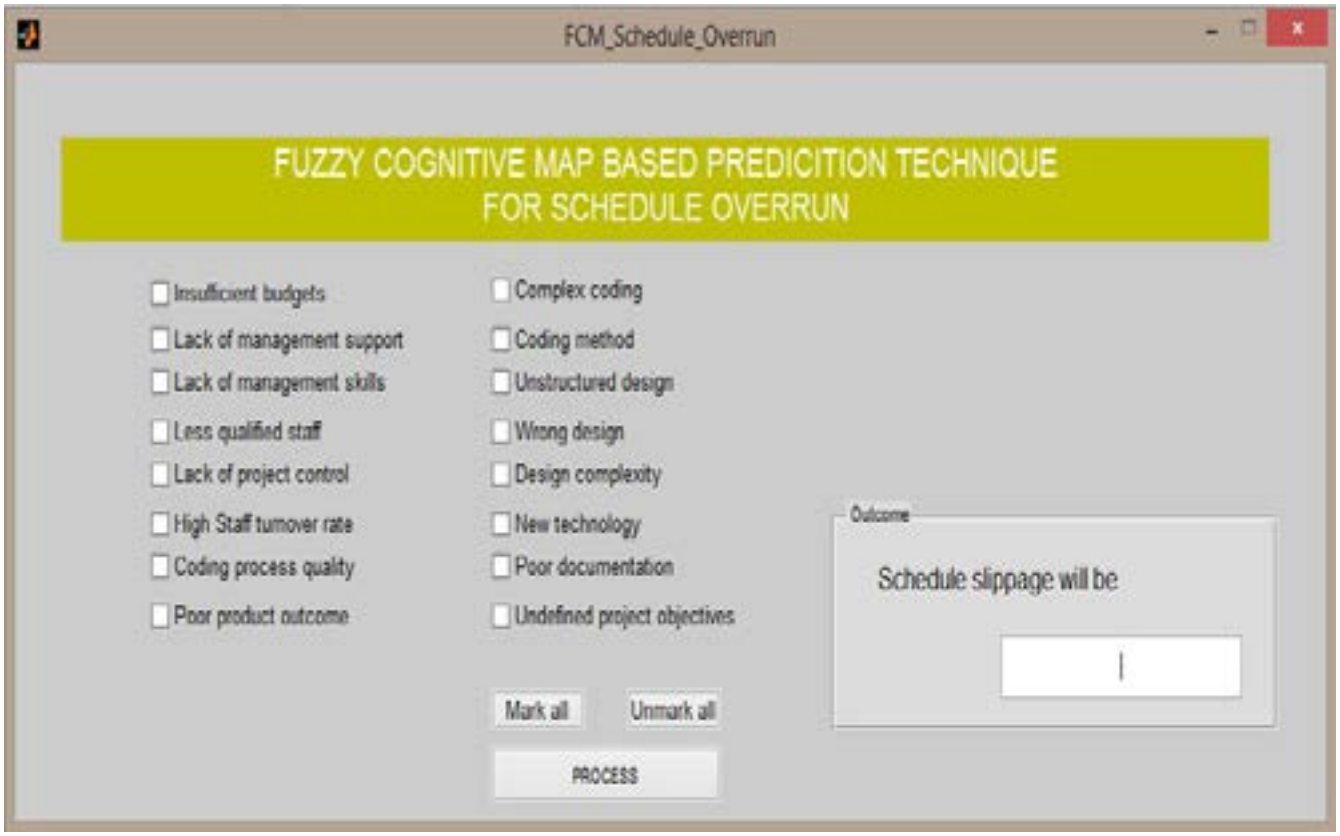
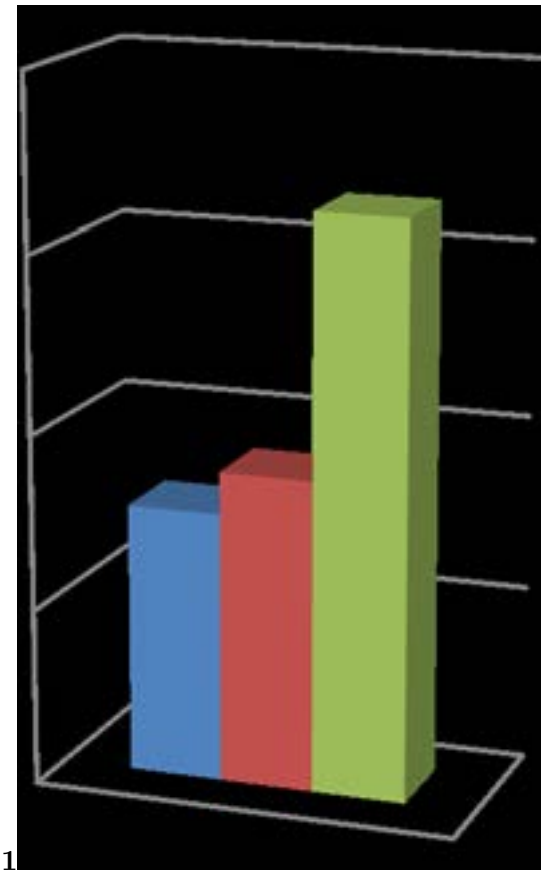


Figure 2:



1

Figure 3: Figure 1 :

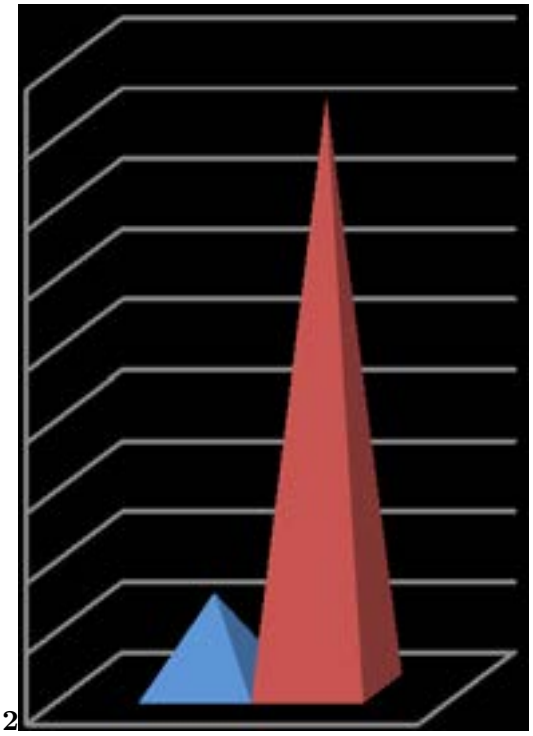


Figure 4: Figure 2 :

Figure 5:

C2
C1 C4
C3
C6 C5

1. Insufficient budgets
2. Lack of management support
3. Lack of management skills
4. Unqualified staff
5. Lack of project control
6. Staff turnover
7. Coding process quality
8. Poor outcome
9. Coding complexity
10. Coding method
11. Unstructured design
12. Wrong design
13. Design complexity
14. New technology
15. Poor documentation
16. Undefined project objectives

b) Data Gathering

I made this survey form by taking various factors which affects the schedule in software development. This survey form has been sent to various multinational companies for response. This data will help me to make inferences in development phase. After taking the responses from experts, I tested the consistency of the responses by applying Mann-Whitney test.

The Fuzzy inference System is calculated with the help of Fuzzy Editor of MATLAB. There are total 36 important aspect of software development is made project delivery in time.

Figure 6:

2

Sr. No:	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Average expected	Average expected in months	Schedule slippage in months
1.	Insufficient Budget	Undefined project objectives				23.67%	2.84	2.67
2.	Insufficient Budget	Undefined project objectives	Complex coding			26.67%	3.20	3.17
3.	Insufficient Budget					15%	1.81	1.80
4.	Less qualified staff	Complex coding				19.67%	2.36	2.31
5.	Less qualified staff	Complex coding	Undefined project objectives			27.34%	3.28	3.16
6.	High staff turnover rate	Lack of management support	Wrong design			30.34%	3.64	3.78
7.	High staff turnover rate	Lack of management support	Wrong design	Complex coding		36%	4.32	4.24
8.	Lack of management skills VII.	Less qualified staff	Lack of project control	High staff turnover rate	New technology	29.67%	3.56	3.08

Figure 7: Table 2 :

3

Schedule slippage In months	Proposed technique	Actual	Existed
	3.08	3.56	6.53

Figure 8: Table 3 :

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