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RESEARCH ARTICLE

Impact of Uncertainty Factors in Cost Estimation – Substantiation through Normal Distribution Curve

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ABSTRACT

Software project development process is requiring accurate software cost and schedule estimation for achieve goal or success. Software estimation is essential in software engineering. Accurate software cost estimation is essential for software project success. Uncertainty refers to the lack of certainty and knowledge while predictability means the ability to forecast something that will happen in the future. For a cost estimator, being predictable does not mean forecasting the exact cost of the project, but rather achieving a final cost that is within the accuracy level that is defined by the class estimate for each stage of the project. Each project will have a different capacity for uncertainty. This is a measure of how much uncertainty the project can tolerate. Software organisations should identify their process strengths and weaknesses, improvement areas, potential risks and opportunities. Project managers can use different techniques and tools that are useful to manage projects efficiently. It is important to have a good cost estimate in order to budget a new project. Unfortunately, software effort estimation methods are often inaccurate. Handling uncertainty is essential for the success of software development projects. This paper discusses about the importance of uncertainty factors involved in project, and the influence of thus in cost estimation it presents the feedback of Team leaders, System Analyst and Senior Software Engineer.

I. INTRODUCTION

There are countless terms and definitions used to describe the types of estimates prepared by cost estimators. Project scheduling is an important step in the software development process. [3]Software project managers often use scheduling to perform preliminary time and resource estimates, general guidance, and analysis of project alternatives. Software project managers recognize the importance of managing uncertainties. Many software companies track and analyze project performance by measuring cost estimation accuracy. A high estimation error is frequently interpreted as poor estimation skills.

Software cost estimation is an essential part of most software development. Unfortunately, software development cost estimation is difficult and inaccurate. There are many [4]project planning and scheduling techniques to manage and help to ensure project success. [1]As such, project managers should be knowledgeable of and considering the various industry techniques and tools in the definition and execution of project cost estimation. In this paper discuss about major causes of uncertainty and a questionnaire was designed to investigate the uncertainty factors that affect to the project success.

II. METHODOLOGY

The objective of this study is to investigate the causes of uncertainty of the projects undertaken by the team leaders, system analyst and senior software engineer. [7]A questionnaire was designed to investigate the factors that affecting the project success. The questionnaire consists of six questions. Each Question has asked in different phases. All the six questions are divided in nine uncertainty factors. Each factors influence in the project is divided in three types namely, Low, Medium and High. The value low is equal to one; medium is equal to two and high is equal to zero. The not applicable factor is equal to zero. There are six questions on major uncertainty factors in software development project, which are rated based on a rating of 1 to 3. In this questionnaire, information is gathered from the Team leaders, System analyst and Senior Software engineers in the project. Sixteen different project and in different locations of the Team leaders, System analyst and senior software engineers are rating the questionnaire.

III. ANALYSIS ON PROJECTS

The sixteen project teams were completed the project and invited to answer the questionnaire. The team leaders or system analyst or senior software engineer were answering the six questions in the questionnaire. The questionnaire covered the nine key factors in [6]uncertainty namely, management, project design, communication, staff experience, funding problems, user's response, resources, price changes and technical factors. Table 1 shows the rating given by the sixteen projects on the six questions each. This is a summary of uncertainty factors of six phases of sixteen projects.

Uncertainty factor / Project No.	Management	Project Design	Communication	Staff Experience	Funding Problems	User's Response	Price Changes	Resources	Technical Factors
1	10	8	14	16	6	12	12	7	13
2	10	5	15	14	6	14	12	5	14
3	11	6	13	17	6	14	11	3	12
4	11	7	17	16	4	16	13	4	11
5	10	5	15	13	6	14	10	5	11
6	10	5	16	16	5	15	12	6	10
7	12	5	14	14	6	15	11	5	12
8	10	6	14	15	7	14	12	7	12
9	11	7	16	15	5	13	12	5	14
10	8	9	15	15	4	14	10	6	13
11	9	9	13	17	8	13	12	5	11
12	12	9	17	13	5	14	14	4	13
13	9	9	16	15	8	13	10	5	12
14	9	8	15	14	7	15	14	3	10
15	8	7	15	15	6	15	12	6	12
16	10	9	15	14	7	14	13	4	12

Table 1: Different types of Uncertainty values in sixteen different projects

Normal Distribution Calculation for Project Design uncertainty,

X	F	FX	FX^2
5	5	25	125
6	2	12	72
7	3	21	147
8	2	16	128
9	5	45	405
	17	119	877

Table 2: Uncertainty factor – Project Design Normal Distribution

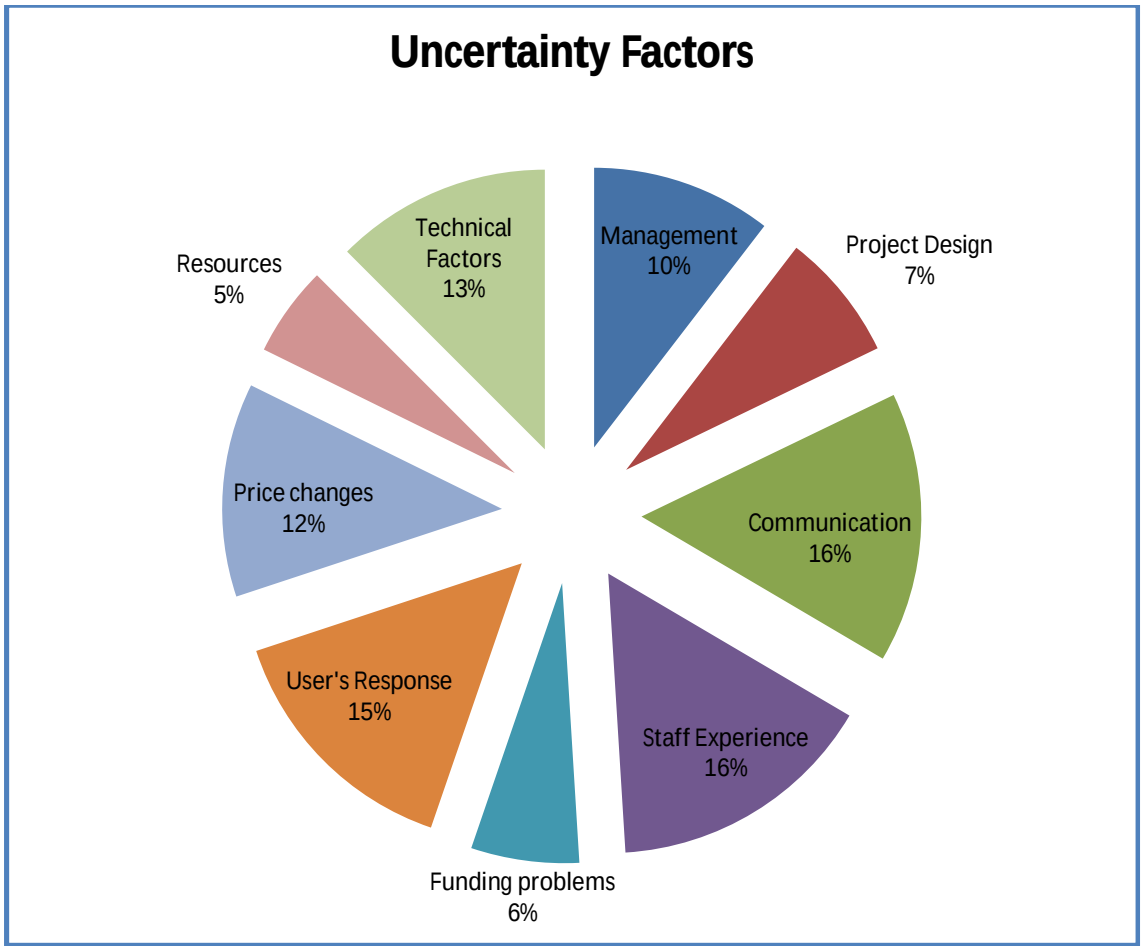


Figure 1: Different types of Uncertainty Factors

Mean – 7
Variance – 2.588235
Standard Deviation – 1.608799

Values	Normal Distribution
5	0.023815
6	1.15595
7	4.216647
8	1.15595
9	0.023815

Table 3: Normal Distribution Calculation – Project Design

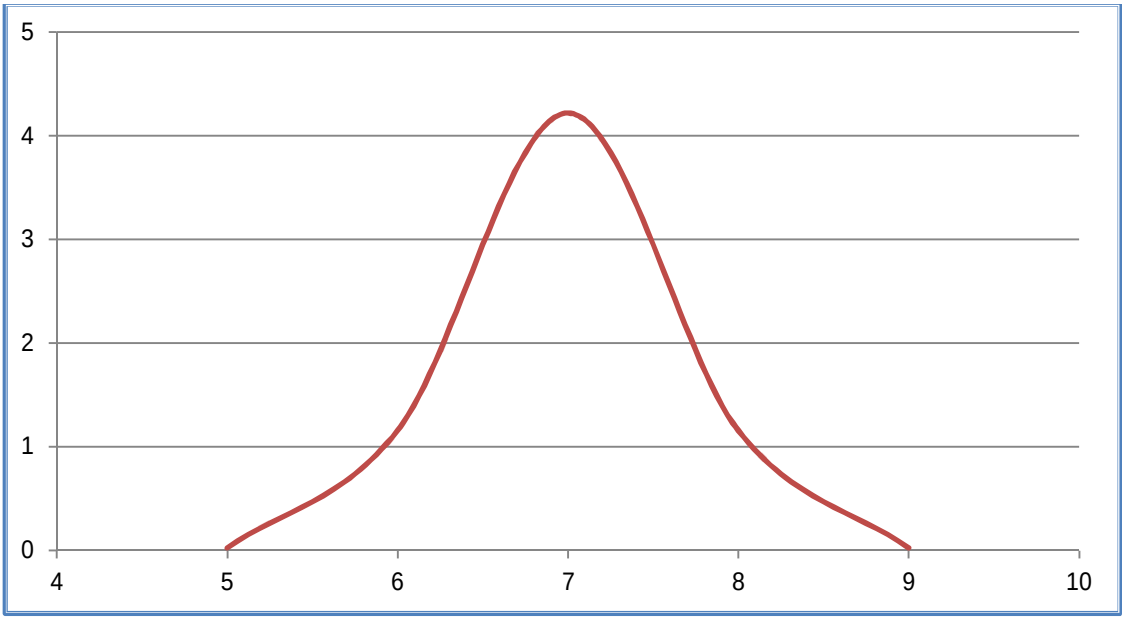


Figure 2: Project Design Uncertainty factor – Normal Distribution Curve

IV. NORMAL DISTRIBUTION

The normal distributions are a very important *class* of statistical distributions. [9]Normal distributions are symmetrical with a single central peak at the mean (average) of the data. The shape of the curve is described as bell shaped with the graph falling off evenly on either side of the mean. To speak specifically of any normal distribution, two quantities have to be specified: the mean μ, where the peak of the density occurs, and the standard deviation σ, which indicates the spread or girth of the bell curve.

The Normal (or Gaussian) distribution is a very commonly occurring continuous probability distribution a function that tells the probability of a number in some context falling between any two real numbers. The normal distribution is immensely useful because of the central limit theorem, which states that, under mild conditions, the mean of many random variables independently drawn from the same distribution is distributed approximately normally, irrespective of the form of the original distribution: physical quantities that are expected to be the sum of many independent processes (such as measurement errors) often have a distribution very close to the normal. Moreover, many results and methods (such as propagation of

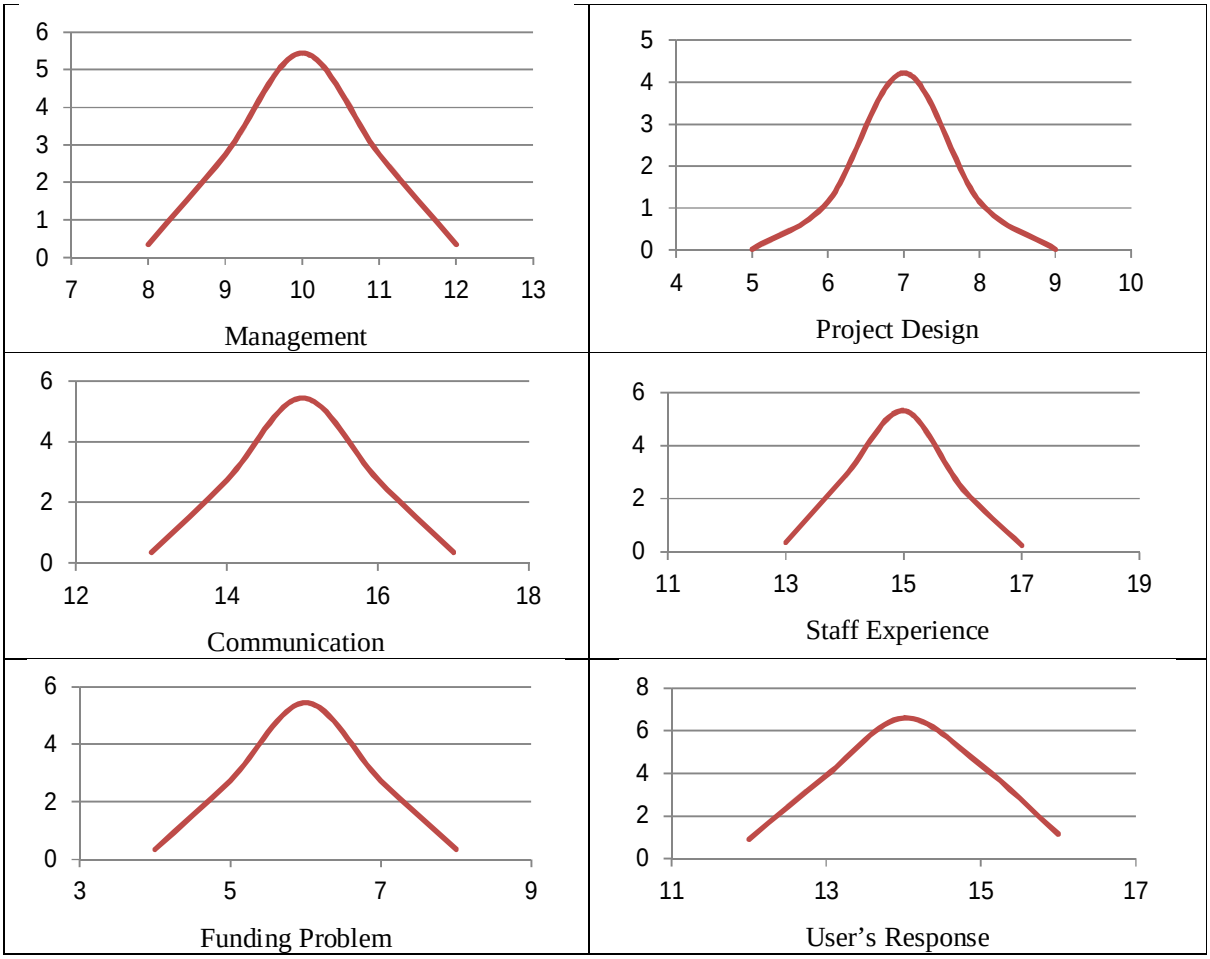
uncertainty and least squares parameter fitting) can be derived analytically in explicit form when the relevant variables are normally distributed.

The [5]Gaussian distribution is sometimes informally called the bell curve. However, many other distributions are bell-shaped (such as Cauchy's, Student's, and logistic). The terms Gaussian function and Gaussian bell curve are also ambiguous because they sometimes refer to multiples of the normal distribution that cannot be directly interpreted in terms of probabilities.

The normal distribution is

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}.$$

The parameter μ in this formula is the *mean* or *expectation* of the distribution (and also its median and mode). The parameter σ is its standard deviation; its variance is therefore σ^2. A random variable with a Gaussian distribution is said to be normally distributed and is called a normal deviate.



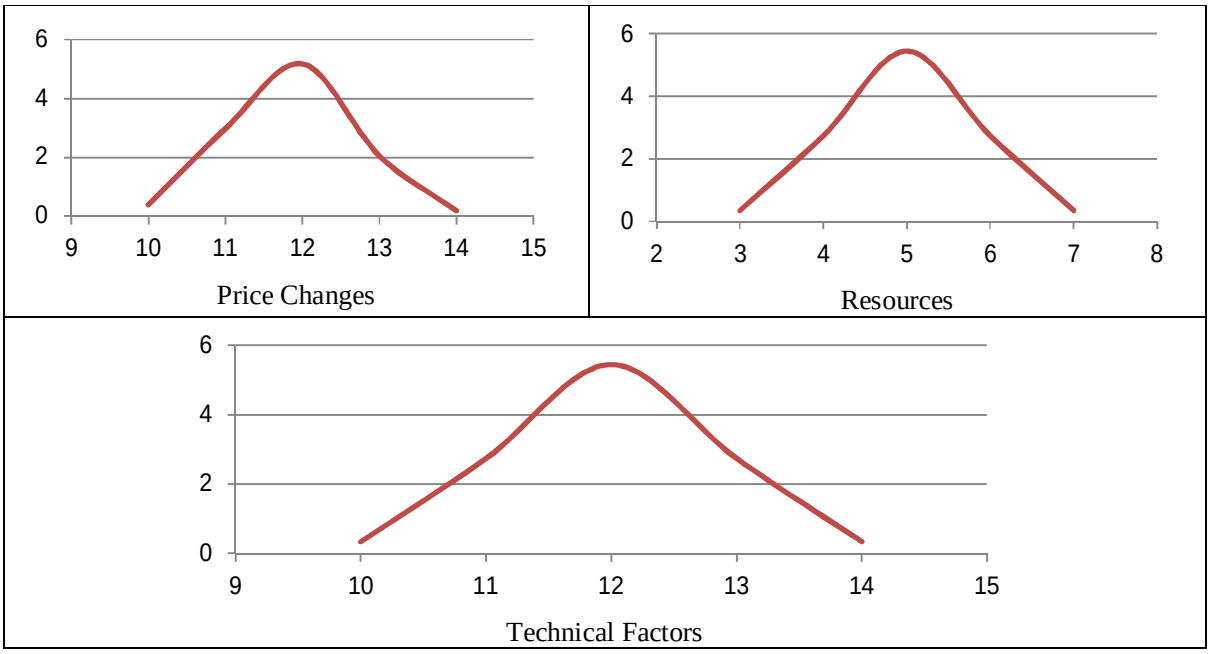


Figure 3: Uncertainty factors in Normal Distribution Curve

The normal distribution calculation was calculated by nine major uncertainty key factors namely management, project design, communication, staff experience, funding problems, user's response, resources, price changes and technical factors. When normal distribution calculation was carried out into graphical representation the Bell shaped curve or normal distribution curve was attained (Figure 3).

V. CONCLUSION

This paper discusses about team leaders, system analyst and senior software engineer rating the questionnaire prepared based on the uncertainty factors, collected in sixteen various projects. This questionnaire contains major uncertainty factors like Management, Project design, Communication, Staff experience, Funding problems, User's response, Resources, Price changes and Technical factors. By managing uncertainty, can recognize the problem caused and analysed. The analysed problem should be minimized and rectified. Applying good management practices would help to avoid these uncertainty factors, and leading to project success. The results explain the occurrence of uncertainty factors in each phase of various projects and also uncertainty factors cause changes in entire project planning. It explains firmly that uncertainty factors play an important role and adding the uncertainty cost as variable in cost estimation calculation.

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