# A Novel Approach of Cost Estimation for IoT based Projects

Simmi Chawla[†], Parul Tomar[††], and Sapna Gambhir[†††]
[†] Research Scholar, Dept of Computer Engineering J.C.Bose University of Science &Technology, YMCA, Faridabad, 121006 INDIA
[††] Associate Professor, Dept of Computer Engineering, J.C.Bose University of Science &Technology, YMCA, Faridabad, 121006 INDIA
[†††] Associate Professor, Dept of Computer Engineering, J.C.Bose University of Science &Technology, YMCA, Faridabad, 121006 INDIA

***Abstract*:- Engineering economic science and IT management created tons of progress towards understanding the thought of the Internet of Things (IoT) still the authors take into account that some aspects of IoT project value management still have to be compelled to be additional developed. At the initial stage of the analysis the authors were inquisitive about the existing cost estimation approaches for IoT projects. This paper is dedicated to estimation of project prices at preliminary stage. The overall findings of the literature review disclosed the matter of estimating total project cost of ascertains paradigms for effective implementation and use of the Internet of things in package engineering it's necessary to contemplate the problems of its cost estimation. The analysis is targeted on constant quantity estimates a lot of correct techniques for estimating total costs and shaping factors that influence the value of IoT based projects. The main objective of this paper is to develop a novel approach based on COCOMO-II model to assist customers as they have to understand the project cost before the completion. The evaluation of the outcomes allowed us to attract the developer's for Program Evaluation and Review Technique gives the gain of correct estimating IoT assignment cost.**

***Keywords: Internet of Things (IoT), cost estimation, COCOMO-II model***

## 1. INTRODUCTION

The Internet of things (abbreviated as IoT) could be a computing conception that started life because the title of a presentation created by Kevin Sir Frederick Ashton at Procter & Gamble (P&G) in 1999. Originally the term was closely connected with identification (RFID) Radio frequency as a network of physical objects that contain embedded technology to act with their internal states or the external environment. The terms coined by Kevin Ashton were employed in the article dedicated to the net of things which appeared five years later. This article explained varied applications of the web of Things (WoT) dynamic easy homes into sensible homes and providing automation of the processes created by home appliances and "things" (for example, medical identification tags). Construct of everyday physical objects and a device being connected to network victimization the web protocol suite that was thought-about within the article has allowed the concept to become progressively popular. However its real revivification occurred in 2010 once the amount of mobile-connected devices exceeded the world population. Today the net of things is known as an inspiration of planning pc networks that encompass "things" interacting with one another and also the external setting [1]. Within the context of technology, things are physical or virtual objects which may be known and integrated into communication networks [2]. Mainly, the IoT applications are used for monitoring and controlling. A new concept of intelligent systems, processes and machines is rising, which also brings new challenges associated to Information Technology (IT). This aspect is of high impact for factories that will be increasingly intelligent with the ability to collect, analyze and distribute data, converted into important information for monitoring and maintenance services.

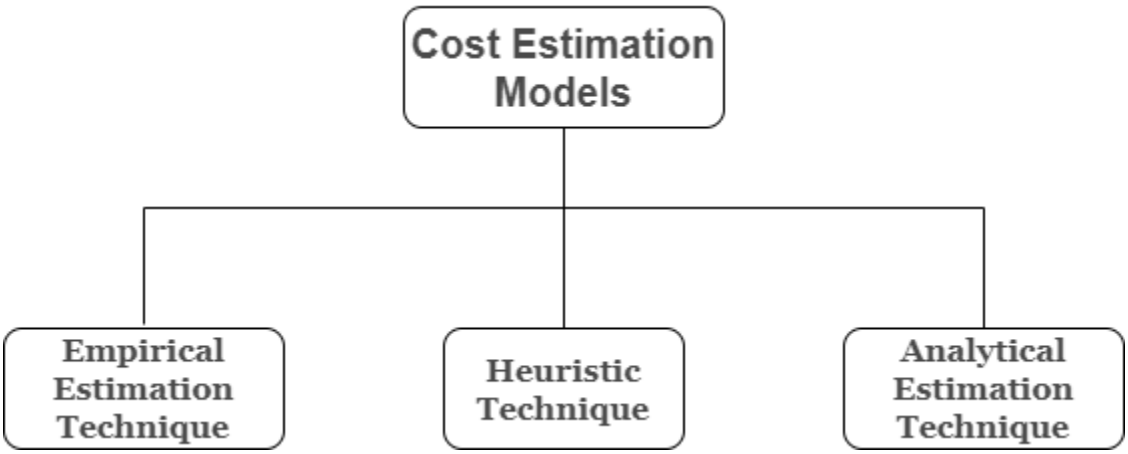
## 2. THE INTERNET OF THINGS IN CONDITIONS OF MODERN DIGITAL ECONOMY

The most basic taxonomy of IoT technologies includes three main components: 1) data processing; 2) identification; 3) measurement. The first component covers possibilities of networks (wired and wireless) ensuring that the Internet of things will react effectively in the case of slow Internet speeds, adapt and achieve fault tolerance. Identification is a basis for the concept of the Internet of things. Various types of optical identifiers and location sensors are embedded in diverse IoT devices. Each identifier has to perform a unique function. The traditional identifier for the object connected to network is MAC address of a network adapter. The idea of the Internet of things consists in obtaining information from the external environment; therefore the technology has to possess measuring instruments, translating data from outside the world into machine meaningful and readable form. When all objects are combined in one network it is possible to use this data for the creation of the system of inter-machine interaction. Experiences present new challenges for the interaction between humans and devices when the later will detect human presence or foresee his/her wishes in order to perform relevant instruction or recommendation. This is the most common concern expressed by practitioners contributing to the development of artificial intelligence and computer-based technologies. The Internet of things promises big change when the machines are able "to learn" and create necessary favorable conditions for human beings [5]. As it was mentioned the Internet of things has penetrated deep into the sphere of industrial facilities. Many companies are starting to reconsider their own ignorant view and look for the ways to use new approach of business management with the Internet of things [6-8]. The reason for this tendency is the desire to get closer to the customers

who use their personal devices actively. Besides simple conveniences, such as automatic sliding doors that automatically open and close as a customer approaches them, the technology enables using biometric data for identification purposes and granting access permissions to these or those services. Devices provide customers with expected solutions on their terms and their schedule. Thus, the Internet of things is an innovation capable to capture the sphere of marketing and entertainments, as its instruments are able to satisfy customer needs implementing mood recognition technology. It is possible to draw a conclusion that in the near future the Internet of things will become a mega trend that will influence everything from our daily personal life to businesses. There are a number of IoT market estimation methodologies to choose from. That is why these estimations would seem inexact. At the same time the situation gets totally absurd – there is much information about the exploration of the market in terms of size and profitability without specifying the method used for the assessment. As a result we have inaccurate information that complicates the assessment of complex IoT systems regarding economic characteristics of its development. According to the latest forecast, the size of the market of IoT is projected to total $ 4,3 trillion by 2020, that is 456% more than a segment share in 2014. Thus, estimates of the future market size of the IoT cover a broad range, but most pundits agree it will dwarf any other market. Taking into account the basic technology components supporting its functioning, such instruments as cloud servers, Internet and new standards for inter-machine interactions are key to its further development.

## 3. SOFTWARE COST ESTIMATING MODELS

Cost estimation simply means a technique that is used to find out the cost estimates. The cost estimate is the financial spend that is done on the efforts to develop and test software in Software Engineering. Cost estimation models are some mathematical algorithms or parametric equations that are used to estimate the cost of a product or a project.
Various techniques or models are available for cost estimation, also known as Cost Estimation Models as shown below:




Empirical estimation is a technique or model in which empirically derived formulas are used for predicting the data that are a required and essential part of the software project planning step. These techniques are usually based on the data that is collected previously from a project and also based on some guesses, prior experience with the development of similar types of projects, and assumptions. It uses the size of the software to estimate the effort. In this technique, an educated guess of project parameters is made. Hence, these models are based on common sense. However, as there are many activities involved in empirical estimation techniques, this technique is formalized. For example: Delphi technique and Expert Judgment technique.
Heuristic word is derived from a Greek word that means “to discover”. The heuristic technique is a technique or model that is used for solving problems, learning, or discovery in the practical methods which are used for achieving immediate goals. These techniques are flexible and simple for taking quick decisions through shortcuts and good enough calculations, most probably when working with complex data. But the decisions that are made using this technique are necessary to be optimal.
In this technique, the relationship among different project parameters is expressed using mathematical equations. The popular heuristic technique is given by Constructive Cost Model (COCOMO). This technique is also used to increase or speed up the analysis and investment decisions.
Analytical estimation is a type of technique that is used to measure work. In this technique, firstly the task is divided or broken down into its basic component operations or elements for analyzing. Second, if the standard time is available from some other source, then these sources are applied to each element or component of work.
Third, if there is no such time available, then the work is estimated based on the experience of the work. In this technique, results are derived by making certain basic assumptions about the project. Hence, the analytical estimation technique has some scientific basis. Halstead’s software science is based on an analytical estimation model.
The model parameters are derived from fitting a regression formula using data from historical projects. The Use Case Points (UCP) method is a useful model of estimating cost on software development projects. It is based on the use of general-purpose modeling language (Unified Modeling Language – UML). The formula for calculations looks as follows:

$$UCP = (UUCW + UAW) \times TCF + ECF$$

where: UUCW – unadjusted use case weight ; UAW – unadjusted actor weight; TCF – technical complexity factor; ECF – environment complexity factor. The three-point estimation technique is a modification of PERT method (Program Evaluation and Review Technique) removing the existing uncertainties in assessment. The formula looks as follows:

$$E = (O + 4M + P) / 6, \quad (1)$$

where: O – the optimistic scenario for the best case;
P – the pessimistic scenario for the worst case; M – the most probable scenario.
For all of the foregoing reasons, the best method for the analysis of IoT cost estimate is the method of parametric estimate as when having inaccurate information we will be able to make mathematical model and thus reveal a tendency for total cost to change. In this research we focus on identifying the parameters being in a proportional relationship with IoT cost changes.

## 4. CONCLUSION

The costs of the Internet of things are measured mostly by the amount of information stored in databases. Low price of installation and LPWAN technology allows reducing costs of the Internet component. Within the range of IoT problems special emphasis is made on engineering economics. The program for studying the aspects of cost management aimed at identifying an adequate parametric model and included calculations using Program Evaluation and Review Technique that enabled to draw a conclusion about the IoT project cost. Developing the concepts of the algorithmic software cost estimation model COCOMO-II and the parametric cost estimation method Use Case Points, it is possible to ascertain that the costs of information security will grow depending on the amount of information, thus making the importance of this aspect obvious. Moreover the authors could reveal some peculiarities of the mechanism for reducing cost of the Internet component.

## REFERENCES

[1] Wang Z, Li W and Dong H 2017 Review on open source operating systems for internet of things J. Phys.: Conf. Ser. 887 art. no. 012044
[2] Ibarra-Esquer J E, González-Navarro F F, Flores-Rios B L, Burtseva L and Astorga-Vargas M A, 2017 Tracking the evolution of the internet of things concept across different application domains Sensors (Switzerland) 17 art. no. 1379
[3] Sethi P and Sarangi S R 2017 Internet of Things: Architectures, Protocols, and Applications Journal of Electrical and Computer Engineering art. no. 9324035
[4] Zhang J, Guo Z-L, Chen S-S, Shao B-Q and Wang Y-T 2017 IoT-based detection for tropical flower Proc. Int. Conf. Information System and Artificial Intelligence ISAI 2016 (Hong Kong; China) (IEEE) pp 219–222
[5] Amri Y and Setiawan M A 2018 Improving Smart Home Concept with the Internet of Things Concept Using RaspberryPi and NodeMCU Material Science and Engineering: Conf. Ser. 325 art. no. 012021.
[6] Joni K, Haryanto and Rohim D F 2018 Smart Garbage Based on Internet of Things (IoT) J. Phys.: Conf. Ser. 953 art. no. 012139
[7] Zhang A-L 2017 Research on the architecture of internet of things applied in coal mine Proc. Int. Conf. Information System and Artificial Intelligence ISAI 2016 (Hong Kong; China) (IEEE) pp 21–23
[8] Tedeschi S, Rodrigues D, Emmanouilidis C, Erkoyuncu J, Roy R and Starr A 2018 A cost estimation approach for IoT modular architectures implementation in legacy systems Procedia Manuf. 19 pp 103–110
[9] Jog V V and Murugan T S 2018 A Critical Analysis on the Security Architectures of Internet of Things: The Road Ahead Journal of Intelligent Systems 27 pp 149–162
[10] Sha K, Wei W, Andrew Yang T, Wang Z and Shi W 2018 On security challenges and open issues in Internet of Things Future Gener. Comput. Syst. 83 pp 326–337