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Descriptive Literature Review of Requirements Engineering Models

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Abstract--- Requirements Engineering (RE) is major part in development of software system. Revolution and emerging business environments demands for precisely defined requirements for successful software development. Even though, several requirements engineering methods, tools, frameworks and techniques are available for practitioners but some techniques are successful with certain systems but not for others. Selection of suitable RE methods and techniques can be difficult task which leads to project failure. This research paper illustrates various requirements engineering processes, methods, tools, frameworks and techniques and their related problems. It also presents some recent advance methods in this field.

Keyword(s)---Requirements Engineering (RE), Maturity Assessment, Agile Software Development, Test Driven development, Requirements Engineering Models etc.

I. INTRODUCTION

A Requirements Engineering (RE) is a conceptual illustration of various steps that are involved in creating, analyzing, documenting, validating and maintaining software requirements of stakeholders for system [1]. It is considered as the most significant phase in software design and development as it deals with significant problem of designing the right software for the customer [2]. RE is a not considered to be an easy task. ***Jiang et al***. declared that bad RE practice results in projects failure [3]. ***Macaulay*** displayed benefits of RE by presenting many practical proofs [4]. ***Nuseibeh et al.*** demonstrated the importance of appropriate RE techniques in improved software quality [5].

Earlier, requirements phase was not taken seriously, which resulted in numerous software problems. ***Standish Chaos Report 2014*** illustrates that 61% of projects today are unproductive in terms of cost, delivery time and functionality due to lack of user contribution, partial requirements, altering requirements specifications, unproductive requirements and project management[6]. ***Boehm*** suggested that errors in system requirements could be 100 times more expensive to fix than errors introduced during system implementation [7]. ***Hall*** carried out case study in which 12 companies were considered and revealed that among 268 development problems cited 50% (128) were due to poor requirements engineering [8]. Efficiency of software system increases by implementing security aspect since the inception of software (requirement phase). This paper deals with literature survey of existing requirements engineering process models. Rest of the paper is organized as follows: In Section II, research in requirements engineering process is briefly reported, in Section III, we present the future research directions. Conclusion is described in Section IV.

II. LITERATURE REVIEW

Literature review contains existing information which consists of findings, facts, hypothetical, theoretical and practical contributions. In this review paper we are considering various existing methodologies which numerous authors have already worked upon. We are trying to seek benefits they gained from their research and are keen to recognize shortcomings which exist in their outcome so that, the model we shall propose will accommodate further improvement. ***Pete Sawyer, Stephen Viller and Ian Sommerville*** illustrated various ways to integrate benefits of requirement engineering process in current software development and focused upon incorporating requirement process maturity model for improved requirement engineering process and requirement management [9]. ***Sacha Martin, Aybuke Aurum, Ross Jeffery and Barbara Paech*** presented literature review on various requirements engineering process models that exist in literature. With the help of qualitative questionnaire a structured interview was conducted. The data obtained from the interview was discussed with respect to requirements engineering process at two Australian companies and an illustrative requirement engineering process model was constructed and compared with three existing requirements engineering process models [10].

Marjo Kauppinen, Reijo Sulonen, ***Jyrki Kontio, Matti Vartiainen and Sari Kujala*** identified some critical factors that affect organizations requirements engineering processes and indicated that organizations can gain benefit by basic RE practices as well as human factors such as motivation, commitment and enthusiasm [11]. ***Ian Sommerville and Jane Ransom*** described an empirical study on requirements engineering process maturity assessment and improvement. The authors evaluated and assessed a requirements engineering process maturity model in nine companies and performed modifications to this model for accommodation of further process improvement [12]. ***Li Jiang*** proposed a Framework for Requirements Engineering Process Development. Developed model is used to build an appropriate RE process model and

RE techniques for software project[13]. ***Shahzad Anwer and Naveed Ikram*** presented a critical study of goal oriented requirement engineering techniques(GORE) that provide an incremental approach for elicitation, analysis, elaboration, refinement, specification and modeling of requirements. They evaluated the underlying concepts, process and advantages of GORE with respect to requirement engineering activities [14]. ***Betty H.C. Cheng and Joanne M. Atlee*** outlined the aspects of RE research with respect to requirements technologies. It also identified numerous research challenges along with research areas that call for further investigation [15].

Andrigo Gomes, Andreas Pettersson and Tony Gorschek proposed market-driven approach to requirements engineering (MDRE). The proposed approach is applicable to every software organizations. It identifies the requirement engineering process, challenges, competitive environment, business goals, strategic planning, configuration management and market opportunities etc. perspectives in a market-driven situation [16]. ***Donald Firesmith*** explored the twelve most common RE problems of real working projects along with their negative consequences. Authors suggested industry best practices that can give support to escape from these problems [17]. ***Vinu V Das*** analyzed effects of different users in RE process. They also describe details to assist the concern of various users in influencing the software requirement practitioners and the system as a whole[18]. ***Yanwu Yang, Fen Xia, Wensheng Zhang, Xian Xiao, Yiqun Li, Xuhui Li*** proposed an integrated framework for semantic requirements engineering. The proposed framework inculcates domain ontology, enterprise ontology and user ontology to facilitate semantic demonstration and interpretation of software requirements [19]. ***Tabinda Aftab*** explored requirements modelling in agile framework. The paper highlighted on just-in-time requirements in agile development. The framework had three main phases. First phase involve Initial Envisioning(Functionality Analysis, User Story Analysis, Architectural Analysis) while second phase is Proof of Concept Modeling Through TDD(Test Driven development) and last is Reviews. It proof that by using TDD in requirements analysis significantly reduces project risk and development time [20].

Chetankumar Patel and Muthu Ramachandran described a suitable process improvement model for story cards based requirement engineering process. They also explained requirements engineering practices at agile software development environments. They illustrated various features of Story Card Maturity Model process along with improvement from assessment based on story cards practices for agile software development [21]. ***Aaqib Iqbal, Farhan M, Khan, Shahbaz. A. Khan*** illustrated a critical analysis of techniques for requirement prioritization and open research issues [22]. ***Mr. Shams-Ul-Arif, Mr. Qadeem Khan, S. A. K. Gahyyur*** discussed about software requirements engineering with the help of various standardized tools, technologies, process models and methodologies. Authors recommended to make use of novel tool for automatic requirements engineering process [23]. ***Jac Ky Ang, Sook Bing Leong, Chin Fei Lee, Umi Kalsom Yusof*** described importance of requirements engineering in developing an expert system along with the possible techniques that can be applied to expert system developments. They proposed the most appropriate techniques for the expert system developments based on the analysis [24].

Azlena Haron, Mazlan Harun, Shamsul Sahibuddin and Nor Hawaniah Zakaria suggested a framework that will guided to identify the RE practices in Malaysian Public Sector. The RE practices identified in the paper will guide the IT Personnel in preparation of the requirement for software project development in a correct manner [25]. ***Mina Attarha and Nasser*** discussed about various aspect of requirement engineering and their impact on successful software development [26]. ***Ruben Mijwaart*** presented a Requirement Engineering Process Model for Software Development and Requirements Management. They also explained about various phases and notations used to show the flow of control in requirement engineering phase [27]. ***Dhirendra Pandey, Ugrasen Suman. and A.K. Ramani*** proposed requirement modelling framework with the analysis of modern requirements modelling techniques. Feasibility of proposed framework was illustrated with case study of inventory management system [28]. ***Waleed Helmy, Amr Kamel and Osman Hegazy*** described in detail about architecture related issues in agile requirements engineering process and proposed methodology to guide and assist practitioners adopting agile requirements engineering in the complete development process [29]. ***Lachana Ramingwong*** provided a review of requirements engineering processes, essential characteristics, models and their related problems [30].

Badariah Solemon, Shamsul Sahibuddin, Abdul Azim and Abdul Ghani proposed new maturity model for requirements engineering process. Aim of the paper is to provide an overview of building the RE maturity model and present a basis for potential improvement in the area of RE process advancement[31]. ***Bechoo Lal and Dr. Chandrahauns R. Chavan*** reviewed the existing requirements engineering processes. Objective of this research was to refine pre-processing process which can be implemented in the software development environment [32]. ***Neha Aggarwal and Rachna Soni*** described systematic review of requirements engineering methods by identifying its major phases presented in existing literature [33]. ***Heba Elshandidy and Sherif Mazen*** discussed about requirement engineering process in traditional and agile software environment (ASD). The paper acknowledged various challenges associated with adoption of Agile software Development and related current research areas[34]. ***M.Usman Malik, Nadeem Majeed Chaudhry and Khurram Shahzad Malik*** described importance of requirements engineering in both traditional software development life cycle and agile development approach. They discussed evaluation of efficient requirement engineering approaches [35].

Asma Batool, Yasir Hafeez Motla, Bushra Hamid, Sohail Asghar, Muhammad Riaz Mehwish Mukhtar and Mehmood Ahmed presented comparative evaluation of two different approaches -traditional RE and Agile RE. The authors proved that Agile RE has better performance than traditional RE in large organizations [36]. ***Tousif ur Rehman, Muhammad Naeem Ahmed Khan and Naveed Riaz*** reviewed the well-known processes, tools and technologies used in the requirement gathering phase. This study helps to understand strengths and limitations of the existing requirement engineering techniques [37]. ***Huma Hayat Khan, Mohd. Nazri bin Mahrin, and Suriayati bt Chuprat*** performed

systematic literature review for identification of situational factors affecting requirement engineering process in global software development. For data merging, they used thorough data coding techniques adopted from Grounded Theory. The outcome of the study symbolizes significant contribution to the Requirement Engineering body of knowledge [38]. ***Syazwani Yahya, Safiah Sidek and Massila Kamalrudin*** evaluated various security requirement engineering tools and analyzed existing gaps in security requirement engineering tools [39].

Swarnalatha k, GN Srinivasan, Meghana Dravid, Raunak kasera and Kopal Sharma presented a survey on software requirement engineering for real time projects based on customer requirement. They proposed a framework for requirements engineering process model to produce improved requirements for any software development [40]. ***Zhi Wang, Bing Li and Yutao M*** presented analysis of automated method for assessment and trends analysis in software engineering. They considered high-quality 7638 papers published in various 36 publications for assessment and identified various research topics in software engineering [41].

Swarnalatha K S, G.N Srinivasan and Pooja S Bhandary proposed BEE-HIVE model for requirement engineering process. The proposed model ensures correctness of the timely generated code, which is important factor in enabling software development and designing the prototype [42]. ***Rajinder Singh*** presented a study to find out practices and requirement engineering processes that reduce chances of rework which results in low cost. For the study, 38 divergent projects were observed from 9 companies in India and investigate the impact of those practices on rework and software development cost [43].

III. FUTURE WORK

After analysis of various research papers in the area of requirements engineering it has been found that there is a need of further improvement in requirements engineering process. Below diagram shows some related features that result in high productivity and efficiency of the software system when inculcated in RE process model. Emphasis is given on the support of traditional as well as agile software development, requirements preprocessing, application specific elicitation techniques and calculation of effort rendered during the requirements phase.

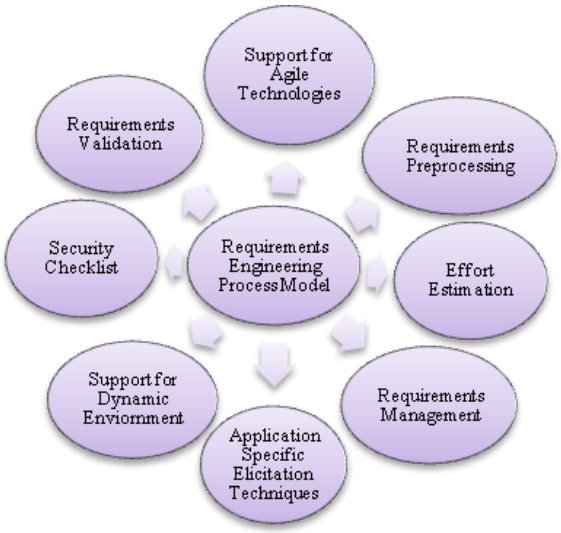

Fig 1: Desired features in RE Process Model

IV. CONCLUSION

This paper presents the work published by various researchers in the field of requirements engineering. After analysis, it is seen that requirements should be definite, comprehensible, acceptable, inclusive, adaptable, supportable and consistent because these characteristics critically affect quality and success of subsequent software development. In the scenario of current software development, RE processes should support traditional software development as well as agile software development for high quality software.

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