

**THE REQUIREMENTS MANAGEMENT PRACTICES: A STUDY AT
UUM IT**

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Abstract

Requirements engineering is a main process in software engineering that focusing on development and managing the user requirements. One of the requirements engineering activities is requirements management. It plays an important role when it comes to the support of product development teams. Despite this, there is a lack of practice in requirements management activity in the software project development. Malaysian software markets are still facing several problems in requirements management practices such as requirements quality, requirements inadequately, and identification of requirements; with limited studies that address it. In this study, UUM IT as computer services provider in a local universities in Malaysia is design as case study, to represent as one organization in Malaysia software markets. This study aims to investigate the current situation for the requirement management in UUM IT, and assess the relationship CMMI level 2 with the requirements management practices in UUM IT. This study adopted mixed method through used questionnaire with the UUM IT team, as well as, interviews with managers of UUM IT for more reliability. The outcome of study showed that the UUM IT are used requirements management activities but there is a need for more attention and improve. Moreover, the study proposes CMMI appraisal method to enhance the performance of software development team.

Keywords: requirements engineering, CMMI level 2, UUM IT

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CHAPTER ONE

INTRODUCTION

1.1 Introduction

The software industry is one of the fastest growing industries in the world due to the huge and increasing demand for software applications. The ways of software development can be by standards, needs and company's circumstances. Software engineering is the application of a systematic, disciplined, quantifiable approach to the development, operation, and maintenance of software (Hoda, Noble, & Marshall, 2012; De Lemos, et al., 2013; Fitzgerald & Stol, 2014; Šmite, Wohlin, Galviņa, & Prikladnicki, 2014). However, the development of the software has become a challenge in order to support the complexity in this domain. Although there are various ways of software development; the weaknesses from the management perspective in software development are always being criticized (Shahid, Ibrahim, & Mahrin, 2011; Osman, 2013).

Requirements Engineering (RE) is a main process in software engineering that is focusing on development and managing the user requirements (Laplante, 2013; Katina, Keating, & Ra'ed, 2014); it is essential during software development in order to ensure the successfulness of software development projects. Theoretically, Requirements Management (RM) is one of the RE activist that focuses on managing requirements over the entire software development (Shahid, Ibrahim, & Mahrin, 2011). According to (Zainol & Mansoor, 2008), there is a lack of practices of RM activist during software project development. With the intention to guarantee the quality of a software product,

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REFERENCES

- Abran, A., & Moore, J. W. (2001). *Guide to the Software Engineering Body of Knowledge, Trial Version*. Los Alamitos, CA: IEEE Computer Society Press.
- Ahonen, J. J., & Savolainen, P. (2010). Software engineering projects may fail before they are started: Post-mortem analysis of five cancelled projects. *The Journal of Systems and Software*, 2175–2187.
- Anderson, S., & Felici, M. (2001). Requirements engineering questionnaire. *vol, 1*, 15.
- Asghar, S., & Umar, M. (2010). Requirement Engineering Challenges in Development of Software Applications and Selection of Customer-off-the-Shelf (COTS) Components Sohail.Asghar@jinnah.edu.pk Mahrukhumar@yahoo.com important tasks . Entire software is supported by four pillars of requ. *International Journal of Software Engineering (IJSE)*, 1(2), 32–50.
- Basili, V. R., Heidrich, J., Lindvall, M., Münch, J., Regardie, M., Rombach, D., et al. (2013). Linking software development and business strategy through measurement. *IEEE Computer*, 43(4), 57-65.
- Blanchard, B. S., & Fabrycky, W. J. (2010). *Systems engineering and analysis*, Prentice Hall.
- Calinescu, R., Ghezzi, C., Kwiatkowska, M., & Mirandola, R. (2012). Self-adaptive software needs quantitative verification at runtime. *Communications of the ACM*, 55(9), 69-77.
- Carstens, D. S., Richardson, G. L., & Smith, R. B. (2013). *Project Management Tools and Techniques: A Practical Guide*. CRC Press.
- Casallas Gutiérrez, R., & Arboleda Jiménez, H. F. (2011). QualDev process: procesos adaptables de desarrollo de software para proyectos ágiles. *Revista Ingeniería y Competitividad*, 6(2), 93-104.
- Cerpa, N., & Verner, J. M. (2009). Why Did Your Project Fail ? *Communications of the ACM*, 52(12), 130–134.
- Charette, B. R. N. (2005). We waste billions of dollars each year on entirely preventable mistakes. *IEEE Spectrum*, (September 2005), 42–49.

- Chrissis, M. B., & Weber, C. V. (1993). Capability Maturity Model for Software, Version 1.1. *Software Engineering Institute-Carnegie Mellon University. Pittsburgh, Pennsylvania.*
- Chua, Y. P. (2013). *Mastering research statistics*. McGraw-Hill Education.
- Crespo, D., & Ruiz, M. (2012). *Decision making support in CMMI process areas using multiparadigm simulation modeling*. Paper presented at the Proceedings of the 2012 Winter Simulation Conference (WSC), Berlin, (pp. 1-12). IEEE.
- Cuevas, G., & Serrano, A. (2004). Assessment of the Requirement Management Process using a Two-Stage Questionnaire. In *Proceedings Of the Fourth International Conference on Quality Software* (pp. 110–116). Los Alamitos, CA: IEEE Computer Society
- Dalcher, D. (2009). Software Project Success: Moving Beyond Failure. *Experiences and Advances in Software Quality, 5*.
- Damian, D., Zowghi, D., Vaidyanathasamy, L., Pal, Y., Drive, H. B., & Samy, L. (2007). An Industrial Experience in Process Improvement: An early assessment at the Australian Center for Unisys Software Faculty of Information Technology University of Technology, Broadway Unisys Australia Limited 3.
- Davis, A. M., & Leffingwell, D. A. (1996). Using Requirements Management to Speed Delivery of Higher Quality Applications. Rational White Paper.
- Dutoit, A., & Paech, B. (2000). Rationale Management in Software Engineering. In : *Handbook of Software Engineering and Knowledge*.
- Emam, K. E., & Birk, A. (2000). Validating the ISO/IEC 15504 Measure of Software Requirements Analysis Process Capability. *IEEE Transactions on Software Engineering, 26*(6).
- Firesmith, D. G. (2007). Common Requirements Problems, Their Negative Consequences, and the Industry Best Practices to Help Solve Them. *Journal of Object Technology, 6*(1), 17–33.
- Gallagher, V. C., Gallagher, K. P., & Kaiser, K. M. (2013). Mid-Level Information Technology Professionals: Skills and Traits Relevant to Fit, Individual and Organizational Success Factors. *International Journal of Social and Organizational Dynamics in IT (IJSODIT), 3*(2), 22-40.

- Ge, N., & Pantel, M. (2012). Time properties verification framework for UML-MARTE safety critical real-time systems. In *Modelling Foundations and Applications* (pp. 352-367). Springer Berlin Heidelberg.
- Gotel, O. C., Marchese, F. T., & Morris, S. J. (2008). The potential for synergy between information visualization and software engineering visualization. *12th International Conference in Information Visualisation, 2008. IV'08.* (pp. 547-552). IEEE.
- Grenn, M. W. (2013). *A Theory of Information Quality and a Framework for its Implementation in the Requirements Engineering Process* (Doctoral dissertation, The George Washington University).
- Hansen, S., Berente, N., & Lyytinen, K. (2009). Requirements in the 21st Century : Current Practice and Emerging Trends *. In *Design Requirements Engineering: A Ten-Year Perspective* (pp. 44–87). Springer Berlin Heidelberg.
- Heidenheimer, A. J., Hecl, H., & Adams, C. T. (1983). *Comparative Public Policy*. New York: St. Martin's, 248-51.
- Hull, E., Jackson, K., & Dick, J. (2011). *Requirements engineering*. Springer Science & Business Media.
- Jarke, M. (1998). Requirements Tracing. *Communications of the ACM*, 41(12), 32–36.
- Jones, C. (1996). Strategies for Managing Requirements Creep. *IEEE Computer*, 29(6), 92–94.
- Joseph, D., Ang, S., Chang, R. H., & Slaughter, S. A. (2010). Practical intelligence in IT: assessing soft skills of IT professionals. *Communications of the ACM*, 53(2), 149-154.
- KarimJallow, A., Demian, P., N. Baldwin, A., & Anumba, C. (2014). An empirical study of the complexity of requirements management in construction projects. *Engineering, Construction and Architectural Management*, 21(5), 505-531.
- Khan, M. N. A., Khalid, M., & ulHaq, S. (2013). Review of requirements management issues in software development. *International Journal of Modern Education and Computer Science (IJMECS)*, 5(1), 21.
- Khankaew, S., & Riddle, S. (2014). A review of practice and problems in requirements engineering in small and medium software enterprises in Thailand. In *Empirical*

- Requirements Engineering (EmpiRE), 2014 IEEE Fourth International Workshop on* (pp. 1-8). IEEE.
- Kolb, D. A. (2014). *Experiential learning: Experience as the source of learning and development*. FT Press.
- Kragelund, J. (2012). Advanced tool support for requirements engineering. *Master's thesis, Technical University of Denmark*.
- Kulak, D., & Guiney, E. (2012). *Use cases : requirements in context*. Addison-Wesley.
- Kulpa, M. K., & Johnson, K. A. (2004). *Interpreting the CMMI (R): A Process Improvement Approach*. CRC Press.
- Lee, K. H., Min, P. G., Cho, J. H., & Lim, D. J. (2012). Model-driven requirements validation for automotive embedded software using UML. In *Computing Technology and Information Management (ICCM), 2012 8th International Conference on* (Vol. 1, pp. 46-50). IEEE.
- Leffingwell, D., & Widrig, D. (2000). *Managing Software Requirements: A Unified Approach*. Boston MA: Addison-Wesley.
- Li, W., Brown, D., Hayes, J. H., & Truszczynski, M. (2014). Answer-Set Programming in Requirements Engineering. In *Requirements Engineering: Foundation for Software Quality* (pp. 168-183). Springer International Publishing.
- McLeod, L., & McDonell, S. (2011). Factors that affect software systems development project: a survey of research. *ACM Computing Surveys, 43*(4).
- Mizouni, R., & Lazarova-Molnar, S. (2012). Simulation-based feature selection for software requirements baseline. *Journal of Software, 7*(7), 1440-1450.
- Nasir, M. H. N., & Sahibuddin, S. (2011). Critical success factors for software projects: A comparative study. *Scientific research and essays, 6*(10), 2174-2186.
- Nikula, U., Sajaneimi, J., & Kalviainen, H. (2000). *Survey on RE in Small-and-Medium Enterprises*.
- Offermann, P., Levina, O., Schönherr, M., & Bub, U. (2009). Outline of a design science research process. In *Proceedings of the 4th International Conference on Design Science Research in Information Systems and Technology* (p. 7).ACM.
- O'Regan, G. (2010). *Introduction to software process improvement*. Springer Science & Business Media.

- Othman, M., Zain, A. M., & Hamdan, A. R. (2010). A Review on Project Management and Issues Surrounding Dynamic Development Environment of ICT project: Formation of Research Area. *JDCTA*, 4(1), 96-105.
- Park, S., & Nang, J. (1998). Requirements management in large software system development. *IEEE International Conference on Systems, Man, and Cybernetics*, (Vol. 3, pp. 2680-2685). IEEE.
- Park, S., & Nang, J. (2004). Requirements Management in Large Software System Development. In *Proceedings of IEEE International on System, Man and Cybernetics*. IEEE Computer Society.
- Pohl, K. (2010). *Requirements engineering: fundamentals, principles, and techniques*. Springer Publishing Company, Incorporated.
- Pohl, K. (2013). The three dimensions of requirements engineering. In *Seminal Contributions to Information Systems Engineering* (pp. 63-80). Springer Berlin Heidelberg.
- Pohl, K. (2013). The three dimensions of requirements engineering. In *Seminal Contributions to Information Systems Engineering* (pp. 63-80). Springer Berlin Heidelberg.
- Product Development Team. (2002a). *Capability Maturity Model Integration (CMMI), Version 1.1, Staged Representation* (p. CMU/SEI-2002-TR-012). Pittsburgh.
- Product Development Team. (2002b). *Capability Maturity Model Integration (CMMI), Version 1.1, Continuous Representation* (p. CMU/SEI-2002-TR-011). Pittsburgh.
- Purbasari, A., Iping, S. S., Santoso, O. S., & Mandala, R. (2013, July). Designing Artificial Immune System Based on Clonal Selection: Using Agent-Based Modeling Approach. In *Modelling Symposium (AMS), 2013 7th Asia* (pp. 11-15). IEEE.
- Reddivari, S. (2013). Visual analytics for software requirements engineering. In *Requirements Engineering Conference (RE), 2013 21st IEEE International* (pp. 389-392). IEEE.
- Regnell, B., Svensson, R. B., & Wnuk, K. (2008). Can we beat the complexity of very large-scale requirements engineering?. In *Requirements Engineering: Foundation for Software Quality* (pp. 123-128). Springer Berlin Heidelberg.

- Robertson, S., & James, R. (2012). *Mastering the requirements process: getting requirements right*. Addison-Wesley.
- Rose, R. (2004). *Learning from comparative public policy: A practical guide*. Routledge.
- Rosenkranz, C. (2012). The Emergence of Shared Understanding: Applying Functional Pragmatics to Study the Requirements Development Process. *Information Systems Journal*.
- Saleem, H., Khan, M. Z. A., & Afzal, S. (2012). Towards Identification and Recognition of Trace Associations in Software Requirements Traceability. *perspectives*, 2, 6.
- Schulze, S., & Pretorius, L. (2013). An Exploratory Case Study on the Requirements Business Processes of a Typical South African High Technology Systems Engineering Company. *SAIEE Africa Research Journal*, South African Institute of Electrical Engineers. *104*(1), 11-21.
- Singer, L., Sim, S., & Lethbridge, T. (2008). Software Engineering Data Collection for Field Studies. In *Guide to Advanced Empirical Software Engineering* (pp. 9–34). London: Springer Publishing Company, Incorporated.
- Sommerville, I. (2010). *Software Engineering* (9th Editio.). Addison-Wesley
- Tahir, A., & Ahmad, R. (2010). Requirement Engineering Practices - An Empirical Study. *2010 International Conference on Computational Intelligence and Software Engineering*, 1–5. doi:10.1109/CISE.2010.5676827
- Team, C, P. (2006). *CMMI for Development, version 1.2*.
- Teijlingen, E. R. van, & Hundley, V. (2001). The importance of pilot studies. *Social Research Update*, (35).
- Thayer, R. H., & Dorfman, M. (1990). *System and Software Requirements Engineering*. Los Alamitos, CA: IEEE Computer Society Press.
- Wahono, R. S. (2003). I j w - 2 0 0 3. In *Proceedings of the IECI Japan Workshop 2003* (Vol. 5, pp. 55–58).
- Weber, C. V., Curtis, B., & Chrissis, M. (1995). *The capability maturity model: Guidelines for improving the software process* (Vol. 441). Reading, MA: Addison-wesley.
- Wieggers, K. E. (2003). *Software Requirements* (Second Edi.). Redmond Washington: Microsoft Press.

- Wieringa, R. J. (2014). Requirements Specification. In *Design Science Methodology for Information Systems and Software Engineering* (pp. 51-57). Springer Berlin Heidelberg.
- Yadav, M., & Kumar, K. (2014). CMM or CMMI, which is more appropriate for a software industry?. *International Journal in IT & Engineering*, 2(1), 24-33.
- Young, R. . (2004). *The Requirements Engineering*. Boston: Artech House.
- Yu, A. T. W., & Geoffrey, S. Q. . (2013). Problems and solutions of requirements management for construction projects under the traditional procurement systems. *Facilities*, 31(5/6), 223–237.
- Zainol, A., & Mansoor, S. (2008). Investigation into Requirements Management Practices in the Malaysian Software Industry. In *Proc of International Conference on Computer Science and Software Engineering* (pp. 292–295). Wuhan, China: IEEE Computer Society.
- Zhang, Z., Li, X., & Liu, Z. (2014). A closed-loop based framework for design requirement management. In *Moving Integrated Product Development to Service Clouds in the Global Economy: Proceedings of the 21st ISPE Inc. International Conference on Concurrent Engineering*, September 8–11, 2014 (Vol. 1, p. 444). IOS Press.