Integrating ISO/IEC 29110 into Agile Workflows: A Practical Intervention Strategy for Very Small Entities

Luis T. Portela-Peñúñuri

Department of Computing and Design - Sonora Institute of Technology
Ciudad Obregón, Sonora, México.

tadeo.portela@potros.itson.edu.mx

Abstract. *Very Small Entities (VSEs), crucial to the software industry, often struggle to balance agile practices with the need for standardized processes to ensure quality. This research addresses the challenge of adopting ISO/IEC 29110 in agile VSEs, where resource constraints and a preference for informality hinder standardization. We propose a multi-faceted intervention strategy focusing on gradual, low-intrusion adoption of ISO/IEC 29110, leveraging existing tools and aligning with agile principles. The methodology mapping, case studies, and professional surveys to develop and validate this strategy. The expected outcome is an implementation strategy, supported by tools and instruments, to enhance both process and product quality in VSEs.*

Keywords: ISO/IEC 29110, Agile Methods, Very Small Entities.

1. Introduction

Around the world, micro, small, and medium-sized enterprises (MSMEs) play a crucial role in the global economy, contributing approximately 40% of the Gross Domestic Product in both developing and developed countries [Madgavkar et al., 2024][Sabando-Vera et al., 2022, p. 10]. In the software industry, a subgroup of MSMEs known as Very Small Entities (VSEs) plays a similar role by contributing to the growing demand for software [Muñoz et al., 2021]. These entities with no more than 25 employees represent a substantial share of the global software market. Estimates suggest that between 93.5% and 99% of all software companies worldwide fall into this category, depending on the country [ISO/IEC, 2024][Stojanov, 2022].

VSEs are characterized by flat organizational structures, fewer hierarchical levels, and limited human and financial resources. Due to their small team sizes, their management processes tend to be informal and less well-documented, reflecting a preference for working software over comprehensive documentation [Laporte & O'Connor, 2016]. In software development, VSEs often encounter challenges in managing small-scale projects, adapting to evolving requirements, and responding to changes rather than strictly following a plan [Beck et al., 2001]. Consequently, there is a need for lightweight management processes that encourage client interaction and provide the flexibility to accommodate changes, emphasizing customer collaboration over contract negotiation [Muñoz et al., 2018]. Furthermore, all available human and financial resources of VSEs are typically dedicated to essential tasks necessary for the enterprise's survival [Muñoz et al., 2021]. As a result, VSEs tend to adopt agile methodologies to implement and take advantage of less regulated approaches.

However, the adoption of agile methodologies also entail certain risks and drawbacks, such as insufficient documentation, scope creep, technical debt and

knowledge vaporization, [Santos et al., 2023][Nolan et al., 2021]. These risks and challenges can lead to maintenance difficulties, limited reusability, insufficient reliability, and performance degradation, thereby putting long-term software quality at risk [Pinna et al., 2023]. It is important to mention that developing high-quality products or services is fundamental to their survival and growth [Muñoz et al., 2021][Laporte et al., 2023]. Another issue to consider is that the 17th State of Agile Report (2023) shows that most participants in their study do not implement projects in a purely agile or purely traditional manner. Only a small proportion of the respondents, 15%, claim to implement all aspects of their projects consistently, either agile, traditional, or balanced. 42% reported using a hybrid of agile or other. This means that some companies may completely lack a structured engineering method or practice, which can lead to inconsistency, lack of direction, and difficulty in measuring business value [CertiProf, 2022].

To meet the demand for high-quality products, the International Organization for Standardization (ISO) highlights the importance of establishing systematic processes to ensure quality products and services (ISO, 2024). There are several options for VSEs to encourage adopting software engineering practices through process standardization and software process improvement (SPI) models. Some examples of these models are the following: MoProSoft, Competisoft and MPS.BR, along with international standards such as ISO/IEC 29110 offers guidelines designed explicitly for VSEs for implementing standardized best practices in software engineering [Suárez & León, 2019].

The ISO/IEC 29110 standard was released in 2011 and is mainly based on MoProSoft and ISO/IEC/IEEE 12207. It is not intended for any particular life cycle, whether waterfall, iterative, incremental, evolutionary, or agile [Muñoz et al., 2019]. According to [Minero et al. 2020], adopting the standard could significantly reduce long-term costs by minimizing errors, rework, and maintenance issues; it could also provide a set of good practices that can aid agile methodologies in enhancing the quality of their products and processes, and offers support in areas such as project planning, cost and effort estimation, progress tracking, quality control, and managing changes and work products; the standard also contributes to clarity in roles, agile risk management, and rework reduction within agile projects [Negrete et al., 2021]. It helps formalize essential artifacts within the software development process, improving the overall process without disrupting the agile methods [Muñoz et al., 2021]. By enhancing the quality of the final product, the standard also boosts the operational efficiency of VSEs, shortens the time-to-market for new products, and increases customer satisfaction [Sommerville, 2020][INCOSE, 2023].

Despite the benefits highlighted in this section, the lack of formal agile practices and barriers to adopting standardized processes in VSEs are still being reported in the literature [Laporte et al., 2023]. This persistence suggests that the strategies for adopting standardized processes are still insufficient or outdated, particularly in the face of technological advancements and changes in the VSE context, which introduce not only new features to the existing challenges but also new opportunities to address them.

2. Research questions and objectives

Addressing the challenges of adopting standardized processes requires considering the needs and context of agile VSEs. To understand how this could be achieved, first, it is necessary to answer the following questions:

1. What intervention strategy would facilitate a gradual and seamless adoption of standardized processes within the context of agile VSEs while overcoming the current challenges identified in the state of the art and the state of practice? The following sub-questions also need to be addressed:

1.1 What are the most significant challenges and specific needs faced by software development VSEs, particularly those employing agile methods, when attempting to adopt standardized processes based on ISO/IEC 29110?

1.2 What is the gap between the characteristics of VSEs using agile methods and the basic profile defined by the ISO/IEC 29110 standard?

1.3 What support tools and instruments could facilitate the gradual and seamless adoption of the management and implementation processes established by the standard?

The primary objective of this project is to develop an intervention strategy that facilitates the gradual and seamless adoption of standardized processes in the context of agile VSEs while overcoming the challenges currently identified in both the state-of-the-art and the state of practice. The goal is to enhance both process and product quality. In addition to this objective, this research also focuses on the following specific goals:

1. Identify the factors that influence the effective adoption of the ISO/IEC 29110 standard disciplines in VSEs that utilize agile methods through an analysis of the state of the art and the state of practice.

2. Determine the factors that have the most significant impact on software process and product quality during the adoption of ISO/IEC 29110 disciplines in VSEs that utilize agile methods.

3. Analyze available tools and instruments, assessing and comparing their capabilities to address the specific gaps between agile VSE practices and ISO/IEC 29110 requirements, prioritizing solutions that offer seamless integration with existing agile workflows.

4. Integrate tools and instruments to support the implementation of ISO/IEC 29110 disciplines in agile VSEs, considering the identified factors, challenges, needs, and industry best practices.

5. Evaluate the impact of applying these tools and instruments in an agile VSE within a controlled environment, analyzing their effectiveness in improving software process and product quality.

3. Current knowledge of the problem domain.

The complexities surrounding the adoption of Software Process Improvement (SPI) strategies within VSEs have garnered considerable attention. Software engineering literature research explores these challenges [Ragkhitwetsagul et al., 2024]. It is widely acknowledged that the implementation of SPI strategies can substantially enhance software quality, augment productivity, and fortify the competitive standing of such enterprises [Küpper et al., 2019]. Nonetheless, Small and Medium-sized Enterprises (SMEs) frequently encounter significant impediments when embarking on SPI initiatives. These obstacles predominantly arise from constrained financial and human capital, an incomplete foundational knowledge of SPI methodologies, and the inherent complexity often associated with conventional SPI models [Oktaba et al., 2005]. To mitigate these

issues, a range of tailored solutions has been conceived to facilitate the assimilation of SPI within SMEs. Prominent among these are specialized software process models, including MoProSoft, COMPETISOFT, and ISO/IEC 29110. Each model is designed to streamline and adapt best practices, aligning them with the specific exigencies of smaller software development firms [Oktaba et al. 2005]. Key features of these instruments are delineated below:

MoProSoft [Oktaba et al. 2005] offers a suite of functionalities specifically designed to assist VSEs in the adoption and implementation of SPI strategies. This model furnishes adjustment guidelines that empower organizations to customize the SPI framework to their unique operational and strategic imperatives. Processes are described with varying degrees of granularity, enabling VSEs to adopt procedures that are optimally suited to their business context and maturity level.

COMPETISOFT [Suárez and León 2019] has been deployed across numerous Ibero-American nations, including Spain, Argentina, and Colombia. It emphasizes the commitment of senior management, the organizational ethos, corporate culture, and the receptiveness of personnel involved in implementation as crucial factors for favorable outcomes. This model provides tools for process assessment and continuous improvement, such as PMCompetiSoft and EvalSoft. PMCompetiSoft, an agile process improvement model, facilitates incremental enhancements and cultivates a culture of ongoing refinement.

ISO/IEC 29110 [Suárez & León, 2019] is centered on simplifying the selection and deployment of SPI practices for VSEs. It offers profiles and implementation guides specifically tailored to diverse VSEs. The central aim of ISO/IEC 29110 is to enhance accessibility to, and the application of software engineering standards within VSEs. This, in turn, promotes adherence to internationally recognized best practices in software development, ultimately enhancing software quality and organizational competitiveness.

4. Research Methodology

This research will employ design cience research methodology [Peffers et al., 2007], focusing on the creation and evaluation of an intervention strategy to facilitate the adoption of standardized practices proposed by the ISO/IEC 29110 standard in agile VSEs. The methodology will incorporate elements of qualitative and quantitative research to provide a comprehensive understanding of the problem and the effectiveness of the proposed solution. The research will be structured in the following phases:

Phase 1 - Problem Identification and Motivation: To define the specific challenges VSEs face in adopting ISO/IEC 29110 standardized practices within agile workflows, and to justify the need for an intervention strategy. Methods: Systematic Mapping Review (SMR) to analyze the barriers and enablers to ISO/IEC 29110 adoption in VSEs, particularly within agile contexts. This includes: examining resource constraints, agile principles that may conflict with standardization, and the need for process improvement; analysis of the gap between current VSE agile practices and the standardized practices outlined in ISO/IEC 29110; identify the specific factors that influence VSEs to effectively adopt standarized practices; identify the factors that have the most significant impact on software process and product quality during the adoption of ISO/IEC 29110 practices in VSEs that utilize agile methods.

Phase 2 - Objectives of a Solution: To define clear and measurable objectives for the intervention strategy, focusing on improved adoption of ISO/IEC 29110 practices and enhanced process and product quality. Methods: Define objectives that specify how the intervention strategy will lead to VSEs adopting ISO/IEC 29110 practices. Objectives should include measurable outcomes related to process improvement and product quality. Determine what support tools and instruments could facilitate the gradual and seamless adoption of the management and implementation processes established by the standard.

Phase 3 - Design and Development: To design and develop the intervention strategy and its supporting tools and instruments, tailored to the specific needs and context of VSEs using agile. Methods: Design a multi-faceted intervention strategy that addresses the identified challenges and facilitates the adoption of ISO/IEC 29110 practices. Develop or adapt supporting tools and instruments that VSEs can use to implement ISO/IEC 29110 disciplines in agile VSEs. The design should consider gradual adoption, low intrusiveness, compatibility with agile, and usability for VSEs.

Phase 4 - Demonstration: To demonstrate the application of the intervention strategy in VSEs. Methods: Demonstrate how the intervention strategy can be implemented in VSEs using agile methodologies. This may involve pilot implementations or case studies to show the strategy in practice.

Phase 5 - Evaluation: To rigorously evaluate the impact and effectiveness of the intervention strategy on VSEs' adoption of ISO/IEC 29110 practices and the resulting improvements in process and product quality, and to use the evaluation results to iteratively refine the intervention strategy. Methods: Evaluate the impact of applying the intervention strategy and its supporting tools in VSEs. This may involve a controlled environment, pilot studies, or real-world implementations. Quantitative: Measure process metrics and product quality metrics before, during, and after the intervention. Qualitative: Gather feedback from VSEs on the usability, feasibility, and effectiveness of the intervention strategy, the perceived benefits and challenges of adopting ISO/IEC 29110, and suggestions for improvement. This can be done through interviews, surveys, and focus groups.

Iteration: Analyze the evaluation data to identify areas where the intervention strategy is effective and areas that need improvement. Based on the evaluation findings, iterate back to Phase 3 (Design and Development) to refine the intervention strategy, supporting tools, and implementation guidance. This iterative process (between Phase 3 and Phase 5) may be repeated multiple times until the intervention strategy demonstrates a satisfactory level of effectiveness and usability. Once the intervention strategy has been refined through iterations, a final evaluation should be conducted to assess its overall impact and effectiveness.

Phase - 6 Communication: To communicate the research findings and the validated intervention strategy to relevant stakeholders, including VSEs, agile practitioners, and the research community. Develop practical guidelines and resources to support VSEs in adopting ISO/IEC 29110 based on the research findings.

5. Introduction of the proposed solution

This research proposes a multi-faceted intervention strategy designed to facilitate the gradual and seamless adoption of ISO/IEC 29110-based software development practices in agile VSEs. The intervention strategy directly addresses the challenges identified in

the literature and practice, emphasizing low intrusiveness, leveraging existing VSE tools and practices, and providing measurable improvements in both process and product quality. The intervention strategy is based on the idea that VSEs are more likely to adopt standardized processes if they are easy to follow and they don't have to change their way of working, only complement it. Currently, the research project is in the SMR stage. So far, we have identified 339 articles using a search string across five databases. Initially, 42 articles were selected for analysis, revealing four key factors, for the time being:

- A lack of resources and a reliance on informal project management, which often do not align with the structured requirements of the standard [Muñoz et al., 2021].

- The need to produce numerous high-quality artifacts, which conflicts with agile methodologies that prioritize working software over comprehensive documentation [Muñoz et al., 2018].

- The limited availability of tools to support the procedures mandated by ISO/IEC 29110 and a need for more supporting materials and guidance [Muñoz & Peralta, 2020].

- Additionally, cultural barriers within organizations have been identified, related to the perceived utility of the standard and resistance to changing current work methods [Muñoz et al., 2021].

This intervention strategy differs from existing approaches as it promotes a gradual adoption that allows VSEs to adopt standardized processes gradually, starting with the most critical elements and generating maturity over time. Low Intrusiveness will be a priority in the intervention strategy with the purpose of minimizing disruption in the workflow of VSEs and making use of existing tools and processes whenever possible. The intervention strategy is explicitly designed to be compatible with agile principles and practices and seeks to integrate ISO/IEC 29110 practices in a way that complements, rather than conflicts with, agility.

Usability: The implementation strategy focuses on providing practical, easy-to-understand guidance and tools that are directly relevant to the needs of VSE developers and managers and leverage the tools the VSE is already familiar with to integrate them into an environment that promotes the adoption of standardization.

The implementation strategy includes mechanisms to measure the impact of adopting the standardized processes of ISO/IEC 29110 both on the products and on the processes themselves, allowing VSEs to track their progress and demonstrate the value of standardization.

Following the completion of the SMR, the research will proceed to confirm and contrast the factors identified in the state-of-the-art with those observed in the state-of-practice. Therefore, the subsequent steps include the completion of Phase 1.

This phase is crucial because it will enable the identification of gaps between VSE practices and the standard's processes. This, in turn, will contribute to the identification of the intervention strategy's most specific characteristics and potential tools and instruments that could assist in implementing standardized processes.

6. References

Beck, K., Beedle, M., Bennekum, A. van, Cockburn, A., Cunningham, W., Fowler, M., & Thomas, D. (2001). Manifesto for Agile Software Development. Recuperado de

https://agilemanifesto.org/

CertiProf. (2022). *Agile Adoption Report 2022*. p. 18. Retrieved from https://cdn.shopify.com/s/files/1/0299/9215/7283/files/CertiProf_Agile_Adoption_Report_2022_SP.pdf?v=1733935623

Digital.ai. (2023). *The 17th State of Agile Report*. consulted at https://digital.ai/resource-center/analyst-reports/state-of-agile-report/

INCOSE (Ed.). (2023). INCOSE systems engineering handbook (5a ed.). John Wiley & Sons.

ISO/IEC (2024). Systems and software engineering - Lifecycle profiles for Very Small Entities (VSEs) (ISO/IEC 29110-1-1:2024(en) https://www.iso.org/obp/ui/en/#iso:std:iso-iec:tr:29110:-1:ed-2:v1:en

Küpper, S., Pfahl, D., Jürisoo, K., Diebold, P., Münch, J., & Kuhrmann, M. (2019). How has SPI changed in times of agile development? Results from a multi-method study. Journal of Software: Evolution and Process, e2182. https://doi.org/10.1002/smr.2182

Laporte, C. Y., & O'Connor, R. V. (2016). Implementing Process Improvement in Very Small Enterprises with ISO/IEC 29110: A Multiple Case Study Analysis. 2016 10th International Conference on the Quality of Information and Communications Technology (QUATIC), 125–130. https://doi.org/10.1109/QUATIC.2016.033

Laporte, C. Y., Verret, G., & Muñoz, M. (2023). A Software Project That Partially Failed: A Small Organization That Ignored the Management and Technical Practices of Software Standards. Computer, 56(5), 138–144. https://doi.org/10.1109/MC.2023.3253979

Madgavkar, A., Piccitto, M., White, O., Ramirez, M. J., Mischke, J., & Chockalingam, K. (2024). A microscope on small businesses: Spotting opportunities to boost productivity. McKinsey Global Institute. https://www.mckinsey.com/mgi/our-research/a-microscope-on-small-businesses-spotting-opportunities-to-boost-productivity#/

Minero, García.,, J. J. & Lara, E. (2023). Automatización de los procesos del estándar ISO/IEC 29110 a través de la Adopción de DevOps. RISTI - Revista Ibérica de Sistemas e Tecnologias de Informação, 49, 37-51. https://doi.org/10.17013/risti.49.37-51

Muñoz, M., Mejia, J., & Lagunas, A. (2018). Implementation of the ISO/IEC 29110 standard in agile environments: A systematic literature review. 2018 13th Iberian Conference on Information Systems and Technologies (CISTI), 1–6. https://doi.org/10.23919/CISTI.2018.8399332

Muñoz, M., Mejia, J., Peña, A., Lara, G., & Laporte, C. Y. (2019). Transitioning international software engineering standards to academia: Analyzing the results of the adoption of ISO/IEC 29110 in four Mexican universities. Computer Standards & Interfaces, 66, 103340. https://doi.org/10.1016/j.csi.2019.03.008

Muñoz, M., Mejia, J., Peña, A., Laporte, C., Gasca-Hurtado, G. P., & Gómez-Álvarez, M. C. (2021). An Exploratory Analysis of the Perception of the Utility of Proven Practices of the Software Basic Profile of ISO/IEC 29110 by a Set of VSEs in Mexico. Communications in Computer and Information Science, 439–456.

https://doi.org/10.1007/978-3-030-85521-5_29

Muñoz, M., Mejia, J., Peña, A., Laporte, C., & Gasca-Hurtado, G. P. (2020). What Motivates VSEs to Adopt an International Standard Such as ISO/IEC 29110? An Exploratory Analysis. En Systems, Software and Services Process Improvement (pp. 730–741). Springer International Publishing. https://doi.org/10.1007/978-3-030-56441-4_55

Negrete, M., Infante, U., & Muñoz, M. (2021). A case study of improving a Very Small Entity with an Agile Software Development Based on the Basic Profile of the ISO/IEC 29110. In *Advances in Intelligent Systems and Computing*.

Nolan, Aaron, Ben, Strickland., Adam, Quinn., Kyle, Gallagher., Murat, Yilmaz., Paul, M., Clarke. (2021). Exploring Aspects of Agile Software Development Risk - Results from a MLR. 486-502. doi: 10.1007/978-3-031-15559-8_35

Oktaba, H., Alquicira, C., Ramos, A. S., Martínez, A. M., Osorio, G. Q., López, M. R., Lira, F. L., López, M. E. R., Orozco, M. J., Ordóñez, Y. F., & Lemus, M. Á. F. (2005). Modelo de procesos para la industria de software MoProSoft (Versión 1.3). Secretaría de Economía.

Peffers, K., Tuunanen, T., Rothenberger, M. A., & Chatterjee, S. (2007). A design science research methodology for information systems research. Journal of Management Information Systems, 24(3), 45-77. https://doi.org/10.2753/mis0742-1222240302

Pinna, A., Lunesu, M. I., Orrù, S., & Tonelli, R. (2023). Investigation on Self-Admitted Technical Debt in Open-Source Blockchain Projects. Future Internet, 15(7), 232. https://doi.org/10.3390/fi15070232

Ragkhitwetsagul, C., Krinke, J., Choetkiertikul, M., Sunetnanta, T., & Sarro, F. (2024). Adoption of automated software engineering tools and techniques in Thailand. Empirical Software Engineering, 29(3), 90. https://doi.org/10.1007/s10664-024-10472-6

Sabando-Vera, D., Yonfa-Medranda, M., Montalván-Burbano, N., Albors-Garrigos, J., & Parrales-Guerrero, K. (2022). Worldwide research on open innovation in SMEs. Journal of Open Innovation: Technology, Market, and Complexity, 8(1), 20. https://doi.org/10.3390/joitmc8010020

Santos, R. B. M. D., Figueiredo, P. S., & Marques, F. T. (2023). Challenges to agile software project management practices in the context of the COVID-19 pandemic. Gestão & Produção, 30, e9722. https://doi.org/10.1590/1806-9649-2022v29e9722

Sommerville, I. (2020). Software engineering (10th ed.). Pearson Education.

Stojanov, Z. (2022, June). Software Maintenance Management in Micro Software Companies. Southeast European Review of Business and Economics, 3(1), 75–92. https://doi.org/10.20544/SERBE.05.01.22.P05

Suárez, D. R., & León, G. (2019). Las PyME de desarrollo de software. Modelos de mejora de sus procesos en Latinoamérica. Revista Espacios, 40(28), 9.