An Exploratory Study for Scoping Software Product Lines in a Collaborative Way*

Marta Cecilia Camacho Ojeda
Institución Universitaria Colegio Mayor del Cauca
Colombia
cecamacho@unimayor.edu.co

Julio Ariel Hurtado Alegría
Universidad del Cauca
Colombia
ahurtado@unicauca.edu.co

Francisco Javier Álvarez Rodriguez
Universidad Autónoma de Aguascalientes
México
fjalvar@correo.uaa.mx

ABSTRACT

Software companies are looking for strategies that allow them to be competitive and stay in the market, these companies must not be limited to create new products, they also need to improve their production and marketing processes. The Software Product Lines (SPL) is a production strategy based on planned reuse that seeks to improve productivity, decreasing the time to market and increasing quality of the products. One of the essential activities in the adoption of this approach and development of a SPL is scoping. The SPL scoping is an interdisciplinary activity that includes different visions such as business, marketing, technical aspects and context issues; therefore, the participation of different people with dissimilar and partial knowledge is a key factor in the SPL Scoping. The diversity of participants is relevant but it is not easy that people with different knowledge and interests interact with each other and agree on the scope of the product line. This paper presents an empirical analysis about the addition of collaborative practices in SPL scoping process. We contrasted the results obtained in SPL scoping when collaborative elements are used in the process, observing the execution and results obtained by two groups that followed two different methods for SPL scoping; a group used the original method and the other group followed the same process but including collaborative elements.

CCS CONCEPTS

• **Software and its engineering** → **Software creation and management;** *Collaboration in software development*

• **Software and its engineering** → **Software creation and management**; *Software development techniques;* Reusability; Software product lines

---

KEYWORDS

Scope, Scoping, Software Product Lines, Collaborative Work

1 INTRODUCTION

The SPL (Software Product Lines) is a software production strategy that, based on the planned reuse of assets, builds a set of products that share common features and satisfy the needs of a market segment [1]. The SPL life cycle includes the Core Asset Development and Product Development activities. The Core Asset Development activities include establishing the production capability, scoping the SPL and development the core assets. The Product Development are these activities for building each product of the line from the core assets [1] [2].

SPL scoping is one of the most relevant activities in this approach. The scoping is an activity that bounds the product line by defining those products that belong to the line and which ones do not, by proposing the product portfolio; it specifies the domain and plans of infrastructure reuse [3]. Therefore, the scoping allows organizations to define the reuse context and help engineers capture SPL common aspects, and variable aspects and constraints [1] [4]. A too broad scope could severely threaten the usefulness and cost-

effectiveness of the software assets reuse of SPL. However, a too narrow scope will give software organizations a low ROI (Return of Invest). Additionally, an incorrect scope could address toward the wrong products to the market opportunity [1]. Thus, according to as scoping activity is performed, SPL production will have more chance to be successful or on the contrary, it will fail [1] [3] [5]. SPL Scoping does not only refer to right size, but it must also aim the right products according to market needs and opportunities, the required efforts and organization's business goals [4].

SPL production is an interdisciplinary process [6]. The scoping requires a participation of technical experts, subject-domain specialists, marketing professionals, salespeople, and managers [3] [2]. If SPL Scoping only considers technical participation, it should result in products not suitable to market. On the other hand, if the stakeholders are limited to subject-domain and marketing experts, it is possible to include products that are very difficult to construct (expensive product development or large time to market). If SPL scoping is without the participation of the administrators, it is possible to define a set of products not aligned with the business objectives. In the same way, without the participation of subject-domain the products considered may not be useful for end users. Therefore, the scope depends on the knowledge distributed among different participants [1] [6] [7].

The diversity in scoping is important, because a diverse group will have a multi-view capability for understanding restrictions, and opportunities and later take decisions [3] [8] [9]; however, the massive participation has risks such as endless discussions, lack of agreements, and low efficiency [8]. Whereby, it is necessary that the participation be effective and the consensuses based on knowledge and business goals [3] [5] [10].

The goal of our study is to assess the inclusion of collaborative patterns for SPL scoping. In this paper, we propose to add collaborative patterns to the tasks proposed by the practical guide to PuLSE-Eco [8]. We evaluated the effect caused by this modification through a SPL development in an academic context.

The paper is organized as follows. Section II includes related work. Section III describes the design, execution, and findings of the study. Finally, conclusions and further work in Section IV.

2 RELATED WORK

The software projects are intrinsically collaborative [11]. The scoping in a software project is where must be negotiated the product objectives and features. As SPL project deals with a set of products, thus, the SPL scoping becomes more critical.

The different approaches for SPL scoping agree that it requires the participation of different participants and diverse knowledge [12] [13], most of these approaches only include brief descriptions of the participating roles; Few indicates specific tasks where roles participate your responsibilities or its interdependencies.

Helferich et al. [14] analyzed the communication factor in scoping; they indicate that perspectives of SPL according to marketing and engineering. Although scoping approaches considered both perspectives, the integration between them is far from perfect. Improving this integration of these visions can allow a company to achieve greater support for decision making.

Rommes' work [9] states that SPL scoping is a communication problem more than an economic one. He considers that the challenge is to achieve that people with different needs, concerns and priorities can cooperatively participate in the scoping. Rommes propose "User Scenarios" that can be drafted and selected collectively, by using the natural language that all the stakeholders understand. However, there is no available information about the way for refining these scenarios toward the scoping artifacts such as the portfolio of products, the dominion models or reference architecture determination.

The "Product Line Planning Game" propose the "stories of reuse" as a means of information exchange, it is a communication and feedback mechanism between application engineers and domain engineers, when the customers request changes during the development of any of the products of the line [15].

Agile methods emphasize in stakeholder involvement and customer collaboration [5]. Balvino defines an agile method to SPL scoping, where it introduces some agile practices oriented to achieve an easy interaction among participants [16]. This author affirms that a systematic and detailed process, with an effective definition of the roles, is fundamental for a scoping [16].

Da Silva et al [17] show an case study using the agile method proposed by Balvino. This study identifies some weaknesses of scoping process such as the inefficiency of communication and collaboration among participants. As main study conclusions, the authors suggest that using collaborative engineering patterns could be an opportunity to support stakeholder participation.

Noor et al [5] [18] propose a collaborative approach for SPL scoping. This process combines agile principles, guidelines and collaboration patterns with the scoping process of PuLSE. PuLSE is a methodology for developing SPL proposed by the Fraunhofer IESE [8]. This proposal is focused on SPL derivated of products previously developed, which is one of the three SPL adoption scenarios [19]. This proposal seeks to improve the participation and contribution of the stakeholders, exchanging marketing and technical concerns in order for them to be able to converge in the SPL solution. This approach does not consider the three scoping levels [3]: Product Portfolio Definition, Domain Analysis, and Reuse Infrastructure. It focuses on product portfolio because is oriented to companies that have successful products, market expertise and whit aware of the target domain.

3 EXPLORATORY STUDY

Empirical methods such as pseudo-experiments, exploratory studies, case studies and controlled experiments [20] [21] are necessary to evaluate software engineering proposals and study the behavior of participants and teams when they perform the processes. This section describes an exploratory study with the aim of comparing the defined scope following two scoping methods: one collaborative and other is not.

This study was planned and performed in the context of "Summer of Scientific Research from the Mexican Academy of Sciences". The study aims to give us empirical and exploratory knowledge about scoping process, regarding the team members,

their participation, and interactions. It also aims to compare the defined scope when collaborative practices are added to a scoping.

The experience was performed with 12 students between sixth and eighth semester of computer science schools of different universities. The students worked for 7 weeks and 25 hours a week. During that time of the project, the students designed a Serious Video Games line for children with dyslexia and developed the first product of the line.

The goal was to gather empirical and exploratory knowledge about the scope definition activity, regarding the team members, their participation, and interaction. It also aimed to compare the defined scope (correctness and utility of artifacts) to include collaborative practices, comparing with the original method. Usually the roles for the scoping process are [8]:

- The scoping expert as the person that drives the scoping.
- The marketing expert who provides knowledge about the products and customers.
- The domain experts who provide knowledge concerning the application domain.
- The technical experts who give technical aspects of development and of the products.
- The SPL manager is responsible for routing the activities for the development of SPL

The research facilitator explained the required roles; each student selected one of the roles, a dyslexia assessor, a user representative, a marketing assessor, a technical assessor, a developer and a SPL leader. Each student prepared and developed his/her role. The students' group was split into two teams of six members each. The preparation time was 10 hours. Both groups had the same conditions, each team had the participation of two students with some experience in video game development like of technical experts and developers, for the other roles the students did not have any experience. During the preparation, the marketing assessor and user representation examined some video games for dyslexic children. The objective was to obtain some initial ideas about games by identifying deficits and the associated exercises. In a first session, the purpose was: to exchange information and achieve a common starting point for the stakeholders. In this case dyslexia and the explored video games.

For the development of Products Lines, students used Small-SPL [22], an adaptation of the SPL framework of the SEI [23] for small entities. The first group, called NCTeam followed the practical guide to PuLSE-Eco [8]. The second team called CTeam followed the same guide combining some collaborative patterns [24] [23]. In both cases, some design elements of serious educational video game were included [25]. The scoping was focused on the product catalog and the domain delimitation. The tasks performed by the CTeam can be observed in table 1

The goal of the scoping was to establish the video games of the line and its characteristics, for which the ages and the objective deficits were determined. Both teams identified four games as part of the line, identifying the common and variable characteristics of the proposed games, thus defining a catalog of products [26] [27].

During the scoping was observed that the Products by CTeam were more clearly defined than NCTeam because of the former

team defined a set of products instead of a single product and its modifications as the latter team did. Also that the first product launched by both teams was very ambitious, including a wide range of ages, but also all possible. The CTeam bounded the target domain at the task "Assess features" as part of the domain engineering; however, the NCTeam only noticed its unbounded domain, when domain engineering had finished.

Table 1: Scoping Task with Collaborative Patterns

Task CollaborativePattern/Thinklet	Purpose
Identify features Diverge/ OnePage	The participants exchange possible features of products
Identify domains Organize/ ThemeSeeker	The participants select the target subdomains
Identify products line goals Convergence/ FastFocus	The participants agree on the objectives of the line
Select characteristics Convergence/ Broomwagon	The participants select the features of the subdomain
Identify products Organize/ ThemeSeeker	The participants exchange ideas on possible products
Specify product feature Matrix Organize/ PopcornSort	To classify the features of each product
Assess features Evaluate/ Bucketwall	To approve the features of the products.
Identify assets Divergence/ Leafttopper	To propose the components that will be developed.
Relate components Evaluate/ Bucketwall	To link the components with the features of the products

The Effectiveness Measurement indicates if a SPL meets its overall goals, specifically if the developers take advantage of the commonalities. One of the measures proposed for measuring this effectiveness is the Market Feature Coverage (MFC). This measure captures the extent to which the features are currently available in the product line cover to those related with the target market [28].

Table 2: MFC of video game lines for children/dyslexia

MFC	NCTeam	CTeam
MFC scoping	75%	87,5%
MFC first product	76,92%	95,2%

To evaluate the effectiveness of the SPL scoping, a speech therapist, treatment, participated. He made the evaluation in two moments, first it has evaluated at domain engineering time and after they evaluated the first prototype of the video game at product engineering time. The evaluation of the SPL was as follows: each group presented the speech therapist their portfolio of products, age range, objective, difficulties and the storyboard related them to the first product. The evaluation objective was to validate products and characteristics with regard to its relevance to support the treatments according to the difficulties and ages considered (market). As

evaluation result, it was possible to deduce that the CTeam identified a greater number of characteristics belonging to the domain (market) than the NCTeam. See table 2.

4 CONCLUSIONS

Under the conditions of the study, scoping artifacts, defined in a collaborative way presented a clearer scope definition, resulting in a greater utility for development of the first product. Although it is an exploratory study, it shows in a concrete way the benefits that the collaborative work has on the scoping activity.

According to this study, SPL scoping requires the participation of different interdisciplinary roles that contribute from different areas of knowledge and expertise. However, to ensure that this participation is effective, a systematic and collaborative way is required that guides the scoping team to make the artifacts correct and useful in the development of the line.

As a future work, we will build a collaborative method based on the reflections of Rommes, Noor and our empirical experiences. This method will have a systematic way to facilitate being followed by a development group and encourage the participation and interaction of the involved stakeholders for bounding the correct and valuable SPL scope.

ACKNOWLEDGMENTS

REFERENCES

[1] P. Clements and L. Northrop. Software Product Lines, Practices and Patterns. vol. 3 ed. Addison-Wesley Professional. Part of the SEI Series in Software Engineering, 2001.

[2] F. J. van der Linden, K. Schmid and E. Rommes. Software Product Lines in Action, The Best Industrial Practice in Product Line Engineering. Springer. 2007.

[3] K. Schmid. Scoping Software Product Lines, An Analysis of an Emerging Technology, in Software Product Lines: Experience and Research Directions, P. Donohoe, Ed. kluwer academic publishers. 2000. pp. 513-532.

[4] P. C. Clements.On the Importance of Product Line Scope, in International Workshop on Software Product-Family Engineering. PFE 2001. Lecture Notes in Computer Science. Berlin, Heidelberg. 2002.

[5] M. A. Noor and R. Rabiser. A collaborative approach for reengineering-based product line scoping, in Workshop on Agile Product Line. 2006.

[6] F. Ahmed and L. F. Capretz. An organizational maturity model of software product line engineering. Software Quality Journal. vol. 18. 2. p. 195–225. 2010.

[7] L. F. Capretz and F. Ahmed. Software Product Line Engineering: Future. Electrical and Computer Engineering. 10. 2009.

[8] I. John, J. Knodel, T. Lehner and D. Mut. A practical guide to product line scoping, in Software Product Line Conference. 2006 10th International. 2006.

[9] E. Rommes. A People Oriented Approach to Product Line Scoping, in PLEES 2003: International Workshop on Product Line Engineering: The Early Steps: Planning, Modeling and Managing. Kaiserslautern, Germany, 2003.

[10] A. Helferich, K. Schmid and G. Herzwurm. Reconciling Marketed and Engineered Software Product Lines, in Software Product Line Conference. 2006 10th International. 2006.

[11] J. Whitehead. Collaboration in Software Engineering: A Roadmap, in Future of Software Engineering. 2007. FOSE '07. Minneapolis, MN, USA. 2007.

[12] M. Moraes, E. Almeida and S. Meira. A Systematic Review on Software Product Lines Scoping. Proceedings of the 6th Experimental Software Engineering Latin American Workshop. pp. 63-72. 2009.

[13] I. John and M. Eisenbarth. A Decade of Scoping – A Survey. Proceedings of the 13th International Software Product Line Conference. pp. 31-40. 2009.

[14] A. Helferich, K. Schmid and G. Herzwurm. Reconciling Marketed and Engineered Software Product Lines, in 10th International Software Product Line Conference SPLC 2006. Baltimore, USA. 2006.

[15] R. Carbon, J. Knodel and D. Muthig. Providing Feedback from Application to Family Engineering, in 12th International Software Product Line Conference. 2008.

[16] M. Balbino Santos de Moraes, E. S. de Almeida and S. Meira. An Agile Scoping Process for Software Product Lines, in Conference: Proceedings of the 23rd International Conference on Software Engineering & Knowledge Engineering (SEKE'2011). 2011.

[17] I. F. da Silva, P. A. da Mota Silveira Neto, P. O'Leary, E. Santana de Almeida and S. Romero de Lemos Meira. Software product line scoping and requirements engineering in a small and medium-sized enterprise: An industrial case study. Journal of Systems and Software. vol. 88. p. 189–206. 2014.

[18] M. A. Noor, R. Rabiser and P. Grünbacher. A collaborative approach for product line scoping: a case study in collaboration engineering. in SE'07 Proceedings of the 25th conference on IASTED International Multi-Conference: Software Engineering. 2007.

[19] C. W. Krueger. Easing the Transition to Software Mass Customization, in Proceedings of the 4th International Workshop on Software Product-Family Engineering (PFE 2001). Bilbao, Spain. 2001.

[20] C. Wohlin, M. Höst and K. Henningsson. Empirical Research Methods in Software Engineering. Lecture Notes in Computer Science. vol. 2765. pp. 7-23. 2003.

[21] P. Runeson and M. Höst. Guidelines for conducting and reporting case study research in software engineering. D. Sjoberg (Ed.) Empirical Software Engineering. pp. 131-164. 2009.

[22] M. C. Camacho Ojeda. Monografía Maestría SPL en las pymes desarrolladoras de software del Cauca. Universidad del Cauca. Popayán. 2013.

[23] G.-J. De Vreede, G. Kolfschoten and R. Briggs. ThinkLets: a collaboration engineering pattern language. International Journal of Computer Applications in Technology. vol. 25. 2/3. pp. 140-154. 2006.

[24] G. Kolfschoten and G.-J. de Vreede. The Collaboration Engineering Approach for Designing Collaboration Processes. Groupware: Design, Implementation, and Use CRIWG 2007. Lecture Notes in Computer Science. vol. 4715. pp. 95-110. 2007.

[25] A. Ibrahim, F. L. Gutiérrez Vela and P. Paderewski Rodríguez, Development methodology of educational video game based on player. Granada: Universidad de Granada. 2012.

[26] K. D. Roman Martínez, J. A. Carlón Rodríguez, S. M. Meza Ocaranza, L. E. Carmona López, V. Portilla Orozco, S. Cruz López, F. J. Álvarez and M. C. Camacho Ojeda. Dislexpace, Videojuego serio para niños con dislexia, in 1er Encuentro Nacional de Innovación Tecnológica para la Discapacidad ENITED 2017. Morelia, Míchocán, México. 2017.

[27] M. C. Camacho Ojeda, F. J. Álvarez Rodríguez, J. Carlón Rodríguez, S. Meza Ocaranza, M. Armendáriz Esparza, J. Ávila Mendoza, M. Sánchez Doroteo, I. Piña Vázquez, S. Cruz López, K. Román Martínez, V. Portilla Orozco, L. Carmona López, J. Cervantes Luna and G. González Rosado. Diseñando videojuegos serios para niños con dislexia, in Jornadas Iberoamericanas de Interacción Humano-Computador. Popayán. 2018.

[28] D. Zubrow and G. Chastek. Measures for Software Product Lines, Software Engineering Measurement and Analysis Initiative. Software Engineering Institute. Carnegie Mellon University. 2003.