Using software product line to improve ERP engineering : literature review and analysis

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***Abstract* - On the one hand, getting advantages of Enterprise Resource Planning (ERP) systems largely depends on their capacity to be configured and adapted to fit the customer and domain requirements. On the other hand, product line engineering (PLE) is a promising approach for configuring and adapting products by means of configuration and derivation processes. While the literature and industrial experiences show the benefits of PLE methods, techniques and tools, there is still a lack of interest in addressing ERP engineering issues with the product line strategy. *Objective*: The aim of this paper is to identify and analyze the different ways presented in the literature to improve ERP engineering issues with the methods, techniques and tools provided by PLE. *Method*: To achieve that objective, we reviewed the literature and analyzed available publications. *Results*: This literature review analyzes six research papers at the intersection between ERP and PLE. It shows that the product line strategy can indeed be applied for ERP configuration and customization. It further shows the evolving interest on this topic and discusses existing contributions.**

***Index Terms*— Enterprise Resource Planning, ERP, Software Product Line, ERP configuration, ERP customization, Systematic Literature Review**

I. Introduction

MANY companies adopt Enterprise Resource Planning (ERP) systems to improve their performance in terms of operational and management control and optimization. The primary goal is to integrate activities across functional departments including planning, manufacturing, purchasing, controlling and maintaining inventory, tracking orders, etc. On the one hand, return on investment (ROI) for companies involved in ERP development largely depends on their ability to properly design, develop and evolve ERPs to respond to all requirements from current business needs up to strategic goals. On the other hand, for companies involved in ERP usage and adoption, and beyond end-user acceptance, ROI depends on their ability to select, configure and maintain the ERP system they implement [1, 2].

According to a recent review [3], ERP implementation seems to play a dominant role in IS research on ERP. ERP implementation is the process that transforms a standard ERP product into an operational system in an organization. By ERP implementation, we mean in this paper two major critical issues: configuration and customization [4,5,6,7]. Configuration is about assigning values to a number of parameters recorded as data in the ERP [8]. Customization is about extending ERP functionalities by adding new modules or changing code in the ERP software [9]. This is done to support a particular non-standard business process, to implement a business rule, to provide new features to the ERP users or to establish interfaces with other applications. The goal is to take into account the "specific" needs of the organization – specific in the sense that they cannot be achieved by ERP's standard and configurable features.

Product Line Engineering (PLE) is a new design and production paradigm that has proved extremely useful to reduce costs and time to market while developing systems families. As PLE addresses the domain level, it seems to be promising to address several challenges encountered with ERP systems, in particular the variability and complexity issues. A software product line is defined as a group of similar software applications within a market segment that share a common set of functionalities, but also exhibits significant variability in terms of requirements that can be satisfied [10,11]. Of course, as opposed to a software product line, an ERP system is not a family of applications, but a single application. However, just like a product line, configuration mechanisms are used to satisfy the various requirements from different companies. According to Clements & Northrop [11], the distinction between product lines and single adaptable system (such as ERPs) is twofold: building a product line implies the development of a family of products with often "choices and options that are optimized from the beginning" and not just one that evolves over time. Second, it implies a preplanned reuse strategy that applies across the entire set of products rather than ad hoc or one-time-only reuse [9]. At the same time, ERP systems and PLE concur on two concepts: variability management and the ability to be configured/customized and adapted to a potentially undefined number of environments [12]. However, variability and configuration management in PLE and ERP systems are treated differently. Variability in ERP systems is implemented by representing organizational data in operational tables and configuration parameters in strategic tables describing varying operational information. In PLE, configuration and variability management are handled differently. Configuration is based

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on a Product Line Model (PLM) representing the constraints of a particular domain and resolving the constraints of the PLM until having a valid solution.

These observations raise the research question: do PLE techniques contribute to ERP engineering? We seek an answer by reviewing the literature. A positive answer calls for further investigation of the extent of this contribution by analyzing how PLE techniques are used in ERP engineering methods, which variability models and software tools are used and how this usage has been applied and validated. The goal of the paper is to synthesize the knowledge available on these topics and discuss research issues. Our findings positively answer the research question; i.e., PLE techniques are indeed exploited for ERP configuration. However, the available literature is scarce: only six papers satisfied the search and inclusion criteria, and the extent of these contributions is restricted to a limited number of methods, models and tools.

The rest of this paper is structured as follows. Section 2 briefly presents the concepts needed to understand the rest of the paper. Section 3 gives an overview of the method that was employed to perform the literature review. Section 4 presents the process and results of the literature review that was conducted and section 5 discusses briefly these results. Finally, conclusions about the results, open issues and forthcoming challenges are presented in section 6.

II. Background

Product line engineering has long been described, adopted and reflected upon, as a promising approach for dealing with families of similar products [11]. In product line engineering, products are built from a collection of artifacts that have been specifically designed as a reusable core asset base [13]. Core assets include the software architecture, its documentation, specifications, tools and software components. These assets are gathered because they can be used throughout different combinations to generate products. Such products belong to the same family or "product line" in the sense that even though they show varying features (depending on the product) they still share some commonalities, in particular a common purpose or market segment. The assets are thus prescribed and reused in a preplanned fashion; for instance by using feature models [14], decision models [15], constraint-based variability models [16, 17] and orthogonal variability models [18]. PLE is, in fact, an essential medium to reduce the time to configure new products and to release them on the market.

Thus, variability is the ability of a product to be extended, changed, customized or configured for use in a particular context and PLE is an important tool for implementing it. Interestingly, variability is also a driven dimension of ERPs: not only ERPs are designed to address requirements that vary across the different customers that will purchase them, but also because it appears that user requirements show variability even within ERP implementation projects [19].

ERP Configuration is about balancing the way the customer wants the system to work, i.e., customer requirements, with the way it was designed to work, i.e., ERP configurable functionalities. ERP systems typically build many changeable parameters that modify system operation. For example, an organization can select the type of inventory accounting to employ —FIFO or LIFO, whether to recognize revenue by geographical unit, product line or distribution channel and whether to pay for shipping costs when a customer returns a purchase [20]. Moreover, ERP system relies on monolithic software architecture in which customer requirements are met by a large number of parameters, options and configurable functionalities. Organization information is represented in operational tables and configuration parameters are represented in strategic tables.

If ERP configurations do not respond to some customer requirements, companies tend to add on additional functionalities. Thus, ERP customization refers to interface development or code modification. ERP customization requires to be regularly updated and have an important impact on strategic alignment and system agility [7]. Some ERP vendors provide the customer with the program code that can be modified when desired. Some others have their own specific programming languages and tools that can be used by the customer to modify the system or add on additional functionality. This complexity of ERP systems is maybe the most important obstacle to using ERP systems in an efficient and predictable way. For instance, ERP systems configuration can take several months and no results, can be guaranteed at the end of this long and expensive period [21].

III. Research method

The literature review was conducted using Kitchenham's et al. methodological guidelines [22] [23]. Performing a systematic review is grouped into three stages: planning, conducting and reporting. A key element in systematic literature reviews is the explicit definition of a review protocol in the planning phase that guides its execution. It aims to reduce researchers' bias and helps in structuring the retrieved results. The protocol defines:

- the research questions for the literature review (focus),
- the search strategy (sources and timeframe for searching, rationale for choosing particular sources),
- the search strings (terms used for searching),
- the selection and quality assessment criteria's (general restrictions, inclusion and exclusion criteria for selecting a relevant subset of the publications found), and
- the data extraction process (storage procedures for retrieved files, data extraction forms).

The review protocol shall typically be validated by experienced researchers. In our case, the review protocol was conducted by one of the authors of this article and was validated by three senior researchers. Fig. 1 is an overview of the main stages of the research process.

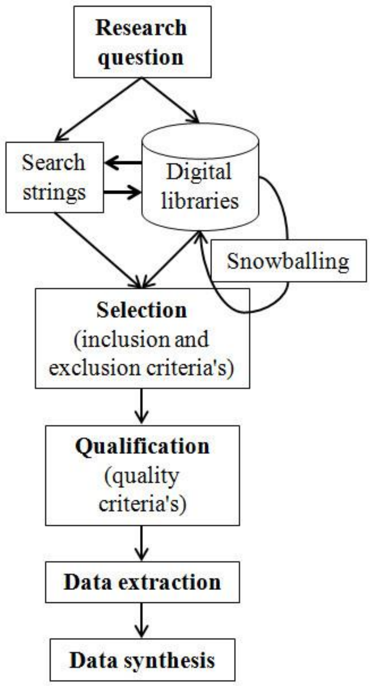

Fig. 1. Stages of the literature review process

IV. LITERATURE REVIEW CONDUCT AND RESULTS

A. Research questions

Our review was guided by the following research questions:

RQ.1 For which ERP implementation stage is the PLE approach applied?

RQ.2 What method (or approach) is proposed in the study?

RQ.3 Which variability model is used and what are the artifacts presented in the model?

RQ.4 Who is (are) the actor(s) that benefit from this method (supplier, Partner Company, end user, etc.)?

RQ.5 Which tool support is developed to automate software product line application in the system?

RQ.6 How is the method applied and validated and what are the results?

B. Search strings and digital libraries

We referred in the search string to the title and the abstract of the paper and we defined the following search strategy: the sources (see Appendix 2) were selected based on an analysis of product line and ERP domain literature. The authors collectively elaborated the reference lists of the most important journals, conferences and other venues. The review included literature published from 2000 to 2013 reporting on research issues for ERP configuration and customization using software product line techniques. We conducted the literature review in 50 relevant sources.

Starting from these sources we conducted three iterations. In the first iteration, we retrieved 45 publications. We began by manually browsing the DBLP digital library[1], year by year, the proceedings of 33 conferences and 7 workshops, the content of 6 journals and 2 series of university technical reports. Then, using Google Scholar and the free search feature of DBLP[2], the following search terms concerning both software product line and ERP systems were used and combined: "Software product line", ''product line engineering", ''software product family engineering", "product family engineering", "variability", "ERP", "enterprise resource planning", "ERP selection", "ERP configuration", "ERP customization", "enterprise systems", "BAAN", "Saas", "Software As A Service", "COTS", "component off the shelf".

We used keywords like "Enterprise System", "COTS" and "SaaS" because they were used in several publications to refer ERP systems:

- *Enterprise System* (ES): this term is more general than ERP as today's ES have architectures and functionalities of a greater variety than traditional ERP systems [19]. Using this term, one additional publication was retrieved.
- *Software As A Service* (Saas): companies can use SaaS connections to set up ubiquitous business management systems as it allows ERP to be constantly accessible. On-demand ERP solutions are commonly referred to as Software as a Service (SaaS) ERP systems. This keyword led us to retrieve four additional papers.
- *Commercial Off The Shelf* (COTS): ERP system is a commercial off-the-shelf product. "*COTS ERP systems are software packages offered by commercial vendors that support core administrative processes such as budgeting, accounting, procurement, performance and human resource management by integrating the data required for these processes in a single database*" [24]. Thus, if software product line approach can be applied on COTS, it can also be applied on ERP systems or COTS ERP package. Using this keyword, four additional publications were retrieved.

Then, we conducted a second iteration by searching in the DBLP library further publications published by authors of publications found in the first iteration. Five additional publications were retrieved. In the third iteration, as the total number of retrieved publications was limited, we used Google Scholar to browse publications that cited previously select papers, i.e., forward snowballing. Using this technique, four papers were added to our list.

In total, the search retrieved a total of 55 publications. Fig. 2 presents the number of papers retrieved per year of publication. The details of the library search are presented in Appendix 2. It is worth noting here that, separately, the numbers of publications concerning software product line and ERP are very large, but when the two subjects are combined, a remarkably small number of papers is obtained.

[1] http://www.informatik.uni-trier.de/~Ley/db/

[2] http://dblp.kbs.uni-hannover.de/dblp/

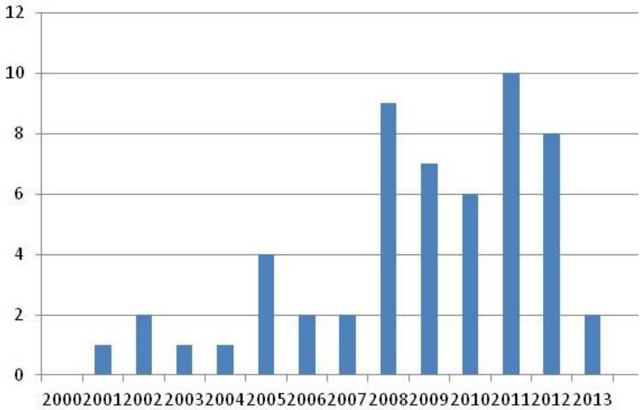

Fig. 2. Number of retrieved publications per year

C. Selection and qualification

As indicated in Fig. 1, the following exclusion criteria's were defined in the selection stage in order to narrow the current list of candidate papers:

- Criteria C1: we excluded papers that were not available in electronic form.[3]
- Criteria C2: the paper should be already published in a peer reviewed conference, journal, report or workshop. Tutorials and electronic books were excluded.
- Criteria C3: only publications written in English were kept. For example, papers written in Dutch or in Spanish were excluded.

Only papers where the proposed approach was applied in a case study, more precisely an ERP project, were qualified for inclusion in the study.

At the end of these stages, only 6 publications were left and constitute the primary studies that will be analyzed. They are presented in Appendix 1.

We note that in certain papers ERP and SPL keywords are mentioned but not in the same way as in our study. For example [25] describes and compares several industrial experiences with ERP system using product line engineering. This paper was not selected because its content is spread in two other papers that were already included: [S4] and [S5].

Based on the initial collection of publications retrieved, one could assume that there is a growing interest in the combination of software product line and ERP implementation. However in practice, only few software product line experiences are done in a real ERP engineering context. It is worth noting that when looking for papers on ERP selection by means of PLE techniques, we only found papers talking about COTS systems; none were actually about ERP selection.

According to our research, the earliest experience was in 2008 by supporting runtime system adaptation through product line engineering and plug-in techniques [S5]. Nevertheless there were no selected article published between 2000 and 2007. We can deduce that this topic is recent and there is an interest in this domain but there is no clear image to compare several studies despite the importance of this theme.

[3] Our University does not offer access to paper based publications in the Computer Science domain.

D. Data extraction

We extracted data from the primary studies according to the research questions. Table 1 summarizes the implementation stages at which SPL techniques are applied. It is worth noting that for study [S3], configuration and customization are considered as being identical.

TABLE I
DATA EXTRACTION FOR RQ1 : IMPLEMENTATION STAGE

Paper	Implementation stage
S1	ERP configuration
S2	ERP configuration
S3	ERP configuration (= ERP customization)
S4	ERP configuration and customization
S5	ERP configuration and customization
S6	ERP configuration and customization

Table II summarizes the various methods that exploit SPL techniques in ERP configuration and customization. As these methods are loosely structured and not systematically documented, their descriptions varies a lot.

TABLE II
DATA EXTRACTION FOR RQ2: PROPOSED METHOD

Paper	Proposed method
S1	▪ Mapping customization and configuration keys to the corresponding requirements ▪ Compiling these artifacts to a unified artifact called PL4X Feature Element ▪ Integrating artifacts with variability model and storing them in the Feature Model Store
S2	▪ The INVAR approach: Integrating and unifying heterogeneous variability models of different actors (vendor, supplier) stored in repositories ▪ Configuring through Web services which provide standard interface for different configuration front-ends
S3	▪ Using a decision-flow pattern as a variability resolution process which consist of a set of interrelated decisions for a suitable ERP configuration ▪ Further details unavailable
S4	▪ Decision-oriented software product line approach to support customization at three levels: derivation by suppliers, configuration by customers and customization by end-user
S5	▪ Integrating product line engineering and plug-in techniques to support system adaptation
S6	▪ Proposing a Variant Description Model that comprises all variants resolved and based on the variability defined in the feature model. ▪ Mapping between the feature model and the family model, which contains ERP configuration options and documentation. ▪ Deducting a Variant Result Model which means the concrete product configuration

Table III presents variability models and modeling tools used in each method, if any. Unsurprisingly, feature modeling and FODA notation are the most frequent notations. The only tool that is proposed explicitly for variability modeling in ERP engineering context is DOPLER in [S4] and [S5].

TABLE III
DATA EXTRACTION FOR RQ3: VARIABILITY MODEL

Paper	Variability model
S1	▪ Feature model ▪ Variability modeling tool not mentioned
S2	▪ Integrated variability models: Feature model, DOPLER models
S3	▪ Variability model not mentioned; in general, variations points are ERP functionalities according to users requirements ▪ Variability modeling tool not mentioned
S4	▪ Variability model not mentioned (architectural elements, software components, documentation, test cases, requirements, plug-ins, setting…) ▪ DOPLER tool for variability modeling
S5	▪ Feature model (plug-ins) ▪ DOPLER tool for variability modeling
S6	▪ Two layer feature model 'FODA' - First layer: business processes features - Second layer: configurations features for specific customers

Table IV presents the actors that are concerned with the variability model. End-users are often – if not systematically – implicated in the configuration process.

TABLE IV
DATA EXTRACTION FOR RQ4: ACTORS INVOLVED

Paper	Actors involved
S1	Partner company
S2	Stakeholders performing the configuration
S3	Partner company end users
S4	Supplier, customer and end-user
S5	End-user
S6	Partner company

Table V describes the tools proposed to support the proposed method and the variability modeling approach. Studies [S4] and [S5] propose a complete configuration tool suites to support variability modeling and to prepare and guide product derivation and customization. As a model-driven approach is developed in study [S6], the support tool includes a transformation engine to derive customizing parameters from the variability model.

TABLE V
DATA EXTRACTION FOR RQ5: VARIABILITY TOOL SUPPORT

Paper	Variability tool support
S1	▪ *PL4X ERP configurator* links ERP configuration to the answer option(s) of each question
S2	▪ *FaMa* and *DOPLER* tools for variability modeling ▪ INVAR service configuration interface to access the variability models by means of questions and configuration options
S3	▪ *Product Line Unified Modeller* (PLUM) tool suite for the design, implementation and management of Software Product Lines (SPL) following a Model-Driven Software Development approach (further details unavailable)
S4	▪ *DecisionKing* to support variability modeling and management ▪ *ProjectKing* to support preparing and guiding product derivation and customization ▪ *ConfigurationWizard* to support decision making in product derivation and customization, according to the role of each user
S5	▪ NET-based plug-in platform for dynamic loading, unloading and composition of components ▪ *DecisinKing*, *ProjectKing* and *ConfigurationWizard* (see [S4]) comprising the *DOPLER* tool
S6	▪ PURE: a variant tool shipped as Eclipse plug-ins ▪ Three plug-ins: - a model validation plug-in to enforce the correct structure while modeling - an import plug-in to build up the Family Model in an automated way - a transformation plug-in to set the ERP customizing parameters according to the Variant Result Model

Last, table VI presents the case studies in which the proposed methods were validated and the final results of the research work.

TABLE VI
DATA EXTRACTION FOR RQ6: CASE STUDY AND RESULTS

Paper	Case study and results
S1	▪ Concrete examples from Microsoft dynamic AX platform ▪ Support for sales consultants and customer application configuration ▪ PL4X approach boosts the sales activities by providing rapid prototype configuration
S2	▪ The approach is tested in a real world product line of the industrial partner *BMD Systemhaus GmbH* (BMDCRM solution, see [S4] and [S5]) ▪ Integrates three different models where an ERP vendor relies on two suppliers (3 scenarios) ▪ The approach and its implementation are feasible and can be integrated in and ERP system example
S3	▪ The experience was done in the *Reuse-Cluster Approach Project* with four ERP major companies in Egypt (further details unavailable) ▪ Approves the systematic reuse adoption potential to open new business opportunities ▪ Interest of companies to continue with this approach
S4	▪ A case study in collaboration with the industrial partner *BMD Systemhaus GmbH* (CRM solution) in which authors represent the different modules of ERP systems as elements of a feature model with different levels. ▪ The components are stored in repository containing all features available, i.e., assets. The variability model captures the components that need to be undertaken or not based on user decisions and leads to identify all possible ways in which the system can be managed. ▪ It also allows capturing the dependencies of the product line assets. In this case CRM solution and all the features that respond to the user need are activated and other features are deactivated.
S5	▪ Conducts a case study in collaboration with the industrial partner *BMD Systemhaus GmbH* (CRM solution) ▪ Develops 6 advanced usage scenarios ▪ Shows the feasibility and usefulness of the approach by means of these usage scenarios where the variability of the ERP system is represented by means of variability models. ▪ The elements of these variability models represent modules of the ERP system and the relationships among these modules

S6	▪ Applying the method in three European divisions of a metal forming company. Each company uses an SAP ERP system. ▪ Describing 3 scenarios ▪ Quantitative analysis to prove the feasibility of applying SPLE to ERP system

In the section below we discuss our observations concerning ERP configuration and customization in light of the literature review results.

V. Discussion

We notice that the product line paradigm was adopted to configure and/or customize ERP systems using different methods with varying approaches. For example Nobauer et al. [S1] and Dhungana et al. [S2] benefited from the advantages of software product line just to configure ERP systems, contrary to Wolfinger et al. [S5] who were interested in ERP customization (RQ2). On the other side, Rabiser et al. [S4A] and Leitner et al. [S6] have used this approach to both configure *and* customize the system, while Hamza et al. [S3] have seen that there is no differentiation between ERP configuration and customization.

The difference between the experiences reported in the papers collected in our study stands in the way variability is modeled, artifacts are represented and in how the method is automated, and depend on the organization goal. For instance, Leitner et al. [S6] represented business process features and configuration features in a two-layer FODA model in order to manage different ERP configuration variants whereas Wolfinger et al. [S5] represented plug-ins in a feature model to customize ERP system and support system adaptation at runtime. They use different tools to automate their method.

VI. Conclusion

The purpose of this paper is to identify the different ways to apply the software product line strategy to ERP systems. To realize this, a systematic literature review was carried out by following a search strategy and applying selection criteria and a qualification process. According to the data extraction process, we found that this approach has been recently applied for ERP configuration and customization.

Although the selected literature shows the importance of product line engineering methods, techniques and tools, there is still a lack of interest in addressing ERP engineering issues with the product line strategy.

In this context, compared to the vast amount of research works on developing and modeling product lines, only few approaches are proposed to deal specifically with ERP systems. Based on the literature on ERP configuration and implementations, this paper seeks to understand how ERP systems could be handled with the product line strategy: namely (a) configure and customize, (b) configure or customize, and (c) configure means customize.

According to our research, we found that in order to cope with ERP complexity, especially ERP configuration and customization, product line engineering seems to be promising in solving several challenges encountered in these systems. In particular, we found three results. The first result is that the product line strategy can be adopted both to configure and to customize ERP systems. This hypothesis is that of Rabiser et al. [S4], according to which *"product lines have mainly been used by software producers to derive and deploy customized products for different customers"* and thus, they seek to *"demonstrate that the use of product lines can be extended to provide personalization support for end users"* (p. 1). Indeed, their paper presents an approach to support both configuration and customization at three levels: supplier, customer and end-user. However, to implement this approach, support is needed to move from a level to another. The second result is that the software product line strategy can be adopted from one perspective only: configuration or customization. This result is in line with Nobauer et al. [S1] which applied the variability concept and product line approach on the organizational level to deal with ERP configuration. The third result is grounded on [S3] in which Hamza et al. asserted that there is no differentiation between customization and configuration: configuration means customization. From the point of view of ERP customers and users, it is difficult "*to differentiate between product variability*" and customization; thus, "*Given that they do not clearly differentiate between product configuration and customization",* they indeed tend to use the same pattern (p. 264).

Finally, we expected that PLE approach would be more integrated with the future ERP projects; we hope that our results are useful for researchers and practitioners when developing software product line applications in ERP systems or when evaluating existing approaches.

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Since 2012, he has been an Associate Professor with the Panthéon Sorbonne University and researcher with the Centre de Recherche en Informatique (CRI Research Lab). His research and teaching topics include: Web development with reusable components, Requirement Engineering, ERP systems, Model driven engineering and (Dynamic) Product line engineering. He has published more than 40 scientific works on these topics and regularly participates in several program commits of national and international conferences and journals on these topics. He co-organized three times the French-speaking workshop on product line engineering (JLP), and he creates the academic and industrial forum about software reuse and variability management (REVASOFT).

Mr. Mazo's awards and honors include the Order of merit of Carolina del Principe as Distinguished Citizen (summer 2008), the 70 years of the Engineering Faculty award, for outstanding graduate of the Computer and Systems Engineering Program of the University of Antioquia (summer 2013), and the Best Paper awards of the 5th IEEE International Conference on Research Challenges in Information Science (RCIS 2011), the 35rd International Computer Software and Applications Conference (COMPSAC 2011) and the International conference on Complex Systems Design & Management (CSD&M 2013).

Saïd Assar holds MSc and PhD degrees in Computer Science from Pierre & Marie Curie University, Paris. He is an Associate Professor of Information Systems at Institut Mines-Telecom, Ecole de Management, and is associate researcher at Centre de Recherche en Informatique (CRI Research Lab), Sorbonne University, Paris, France. In 2012, he was a visiting scholar at Lund University, Sweden, with the Software Engineering Research Group (SERG). His research and teaching interests include IS

modeling, method and tools for IS development, empirical software engineering, e-learning and e-government applications. His work has been published in various national and international workshops and conferences, e.g., INFORSID, COMPSAC, ICSOFT and RCIS. He has co-edited three books and took part in organizing many international scientific events, e.g., IFIP WG8.1 EISIC'02, AIM'04, RE'05, pre-ICIS’06, ICIS'08 and RCIS’13. Saïd Assar serves regularly on program committees for national and international workshops and conferences, e.g., IADIS, AIM, INFORSID, RCIS, ECIS, and track co-chair at ECIS’13 and ECIS’15. He is on the Editorial Board for *Information Technology for Development Journal* and *International Journal of Social and Organizational Dynamics in IT*.

Professor **Camille Salinesi**, is head of the Centre de Recherche en Informatique (CRI Research Lab) at Sorbonne University. He has over 15 years of experience as a researcher on Requirements Engineering and Information Systems. His current research are on a variety of topics such as innovation, sustainability, security, serious games, process mining, and self-adaptive systems. Prof. Salinesi was the director of over 15 PhDs, and he has published over 100 refereed papers in peer reviewed conferences and journals, mainly in the Requirements Engineering domain. Prof. Salinesi has collaborated with major French companies such as France Télécom (now Orange), SNCF, Renault, EDF, Rexel, or Alcatel Lucent and was principal investigator in several international and national projects. Prof. Salinesi was granted the best paper awards for several conferences, in particular COMPSAC’11, RCIS’12, RCIS’13, and CSDM’13. Recently, Prof. Salinesi was Program Chair of the CAiSE 2013 and REFSQ 2014 International Conferences. Prof. Salinesi is Vice Chair of the IREB International Board for Requirements Engineering Certification, and co-founder and current President of the SPECIEF association for the promotion of the Requirements Engineering discipline in France.

Noura Ben Hassen, received in 2009 her MSc degree in Computer Science applied to Management (MIAGE) from Economics and Management University in Tunisia, the subject of her thesis was document automatic summarization using latent semantic analysis. In 2013, she received her MSc degree in Decision and Information Systems from the Panthéon Sorbonne University. She is a member of AIESEC, a global youth network providing leadership opportunities, as exchange participant, and currently as an alumni. Her research interests include ERP, software engineering and software product lines.

APPENDIX 1: LIST OF SELECTED PUBLICATIONS (PRIMARY STUDIES)

[S1]	M. Nöbauer, N. Seyff, D. Dhungana, and R. Stoiber, “Managing variability of ERP ecosystems: research issues and solution ideas from Microsoft Dynamics AX”, Proceedings of the 6th Int’l Workshop on Variability Modeling of Software-Intensive Systems (VaMoS '12), Leipzig, Germany, p. 21-26, 2008.
[S2]	D. Dhungana, D. Seichter , G. Botterweck, R. Rabiser, P. Grünbacher, D. Benavides and J. Galindo, “Configuration of Multi Product Lines by Bridging Heterogeneous Variability Modeling Approaches”, SPLC conference, Munich, Germany, p. 120 – 129, 2011.
[S3]	H. Hamza, J. Martinez and C. Alonso, “Introducing Product Line Architectures in the ERP Industry: Challenges and Lessons Learned”, SPLC conference, Jeju Island, South Korea, pp. 263-266, 2010.
[S4]	R. Rabiser, R. Wolfinger, P. Grünbacher, “Three-level Customization of Software Products Using a Product Line Approach”, Proc. of the 42nd Hawaii Int’l Conf. on System Sciences (HICSS-42), Waikoloa, Hawaii, USA, IEEE Computer Society, January 5-8, 2009.
[S5]	R. Wolfinger, S. Reiter, D. Dhungana, P. Grünbacher, and H. Prähofer, “Supporting Runtime System Adaptation through Product Line Engineering and Plug-in Techniques", Proc. of the 7th IEEE Int. Conf. on Composition-Based Software Systems (ICCBSS), Madrid, Spain, p. 21–30, 2008.
[S6]	A. Leitner, C. Kreiner, “Managing ERP Configuration Variants: An Experience Report”, Proceedings of the 2010 Workshop on Knowledge-Oriented Product Line Engineering, (KOPLE’10), Article No. 2, 2010.

APPENDIX 2: DIGITAL LIBRARIES AND NUMBER OF PAPERS RETRIEVED AND SELECTED

Sources	**Digital library**	**Retrieved**	**Selected**
<u>Conferences</u>			
ACSAC--Asia-Pacific Computer Systems Architecture Conference	DBLP……………………...	0	0
ACSC--Australasian Computer Science Conference	DBLP……………………...	0	0
ACST --Advances in Computer Science and Technology	DBLP……………………...	0	0
ADVIS--Advances in Information Systems	DBLP……………………...	0	0
AHS--Adaptive Hardware and Systems	DBLP……………………...	0	0
AIM--Conference of the Association Information and Management	DBLP……………………...	0	0
AMCIS--Americas Conference on Information Systems	DBLP……………………...	5	0
APCCM--Asia-Pacific Conference on Conceptual Modelling	DBLP……………………...	0	0
APMS--Advances in Production Management Systems	DBLP……………………...	2	0
ARC--Applied Reconfigurable Computing	DBLP……………………...	0	0
ASAP--Application-Specific Systems, Architectures, and Processors	DBLP……………………...	0	0
SCM --System Configuration Management	DBLP……………………...	0	0
PFE--Software Product Family Engineering	DBLP……………………...	0	0
MDEIS--Model-Driven Enterprise Information Systems	DBLP……………………...	0	0
PRIMIUM--Process Innovation for Enterprise Software	DBLP……………………...	0	0
SSR--Symposium on Software Reusability	DBLP……………………...	1	0
SBCARS--Brazilian Symposium on Software Components, Architectures and Reuse	DBLP……………………...	0	0
ICSR--International Conference on Software Reuse	DBLP……………………...	1	0
AOSD--Aspect-Oriented Software Development	DBLP……………………...	0	0
VaMoS--Variability Modelling of Software-Intensive Systems	DBLP……………………...	4	1
SPLC--Software Product Lines	DBLP……………………...	13	2
CAiSE--Conference on Advanced Information Systems Engineering	DBLP……………………...	2	0
HICSS--Hawaii International Conference on System Sciences	DBLP……………………...	1	1
REFSQ--Requirements Engineering: Foundation for Software Quality	DBLP……………………...	0	0
COEA--Component-Oriented Enterprise Applications	DBLP……………………...	0	0
ICEIS--International Conference on Enterprise Information Systems	DBLP……………………...	0	0
CBSE--Component-Based Software Engineering	DBLP……………………...	0	0
CIAO!--Advances in Enterprise Engineering	DBLP……………………...	0	0
COMPSAC--Computer Software and Applications Conference	DBLP……………………...	0	0
ICRE--International Conference on Requirements Engineering	DBLP……………………...	0	0
PoEM--The Practice of Enterprise Modeling	DBLP……………………...	0	0
RE--Requirements Engineering	DBLP……………………...	0	0
SEA--Software Engineering and Applications	DBLP……………………...	0	0
<u>Workshops</u>			
Principles of Engineering Service Oriented Systems, 2009 (PESOS 200, ICSE Workshop)	IEEExplore………………...	1	0

Proceedings of the 2010 Workshop on Knowledge-Oriented Product Line Engineering (KOPLE'10) International Workshop on Software Product Management, 2006 (IWSPM'06) Workshop on Software Variability Management for Product Derivation International Workshop on Software Architectures for Product Families (IW-SAPF) International Workshop on Self-Adaptive Software (IWSAS) International Workshop on Self-Organizing Systems (IWSOS) **<u>Journals</u>** Journal of Intelligent Manufacturing IEEE Intelligent Systems Journal Advanced Engineering Informatics IEEE Intelligent Systems and their Application European Journal of Information Systems International journal of web information systems **<u>Reports</u>** University technical Report Software Engineering Institute technical report **<u>Others</u>** One page from the article 'Product Line Engineering in Enterprise Applications' Google scholar DBLP free search DBLP search author	http://www.esi.es/workshop/KOPLE2010/ IEEExplore………………... SpringerLink……………… DBLP……………………... DBLP……………………... DBLP……………………... SpringerLink……………… IEEExplore………………... Elsevier……………………. IEEExplore………………... DBLP…………………….... Emerald………………….. http://elib.uni-stuttgart.de/ http://sei.cmu.edu/ Available from publishers	1 1 1 0 0 0 1 0 1 0 1 1 0 1 1 4 7 5	1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
<u>Totals</u>		55	6