# IJISPM

SciKA - Association for Promotion and Dissemination of Scientific Knowledge

SciKA

## Mission

The mission of the IJISPM - International Journal of Information Systems and Project Management - is the dissemination of new scientific knowledge on information systems management and project management, encouraging further progress in theory and practice.

The IJISPM publishes leading scholarly and practical research articles that aim to advance the information systems management and project management fields of knowledge, featuring state-of-the-art research, theories, approaches, methodologies, techniques, and applications.

The journal serves academics, practitioners, chief information officers, project managers, consultants, and senior executives of organizations, establishing an effective communication channel between them.

## Description

The IJISPM offers wide ranging and comprehensive coverage of all aspects of information systems management and project management, seeking contributions that build on established lines of work, as well as on new research streams. Particularly seeking multidisciplinary and interdisciplinary perspectives, and focusing on currently emerging issues, the journal welcomes both pure and applied research that impacts theory and practice.

The journal content provides relevant information to researchers, practitioners, and organizations, and includes original qualitative or qualitative articles, as well as purely conceptual or theoretical articles. Due to the integrative and interdisciplinary nature of information systems and project management, the journal may publish articles from a number of other disciplines, including strategic management, psychology, organizational behavior, sociology, economics, among others. Articles are selected for publication based on their relevance, rigor, clarity, novelty, and contribution to further development and research.

Authors are encouraged to submit articles on information technology governance, information systems planning, information systems design and implementation, information technology outsourcing, project environment, project management life-cycle, project management knowledge areas, criteria and factors for success, social aspects, chief information officer role, chief information officer skills, project manager role, project manager skills, among others.

## Topics covered

The journal offers comprehensive coverage of information systems management and project management.

The topics include, but are not limited to:

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|---|---|---|
| ▪ information technology governance | ▪ project environment | ▪ project management knowledge areas |
| ▪ information systems planning | ▪ project management life-cycle | ▪ scope management |
| ▪ information systems design and implementation | ▪ project initiation | ▪ time management |
| ▪ information technology outsourcing | ▪ project planning | ▪ cost management |
| ▪ enterprise architecture | ▪ project execution | ▪ quality management |
| ▪ information systems governance | ▪ project control and monitoring | ▪ procurement management |
| ▪ information systems department | ▪ project closing | ▪ risk management |
| ▪ chief information officer role | ▪ criteria and factors for success | ▪ communication management |
| ▪ information technology leadership role | ▪ project manager role | ▪ human resources management |
| ▪ chief information officer skills | ▪ project manager skills | ▪ performance teams |
| ▪ information systems management tools | ▪ portfolio management | ▪ social aspects |
| ▪ management of complex projects | ▪ program management | ▪ conflict management |
| ▪ audits | ▪ managing organization - structure | ▪ managing organization - responsibilities |
| ▪ innovation | ▪ tools and techniques | ▪ project management office |
| ▪ ethics | ▪ project evaluation | ▪ contracts |

Special issues devoted to important specific topics will be evaluated for publication.

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Researchers and practitioners are encouraged to submit their manuscripts to the IJISPM. The guidelines for submission can be found at the journal's home page: www.sciencesphere.org/ijispm

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## Advertising information

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## Correspondence and questions

All correspondence and questions should be directed to João Varajão (Editor-in-Chief). E-mail: editor.ijispm@sciencesphere.org

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IJISPM

# Editorial

The mission of the *IJISPM - International Journal of Information Systems and Project Management* is the dissemination of new scientific knowledge on information systems management and project management, encouraging further progress in theory and practice.

It is our great pleasure to bring you the third number of the sixth volume of IJISPM. In this issue, readers will find important contributions on digital transformation and enterprise architecture management, decision to switch ERP systems, inter-team coordination in large-scale agile software development, and impact of business intelligence to organizational performance.

As Kaidalova Julia, Sandkuhl Kurt and Seigerroth Ulf state in the first article "How Digital Transformation affects Enterprise Architecture Management – a case study", Internet of Things (IoT), machine learning, cyber-physical systems and other recent technological innovations offer new opportunities for enterprises in the context of Digital Transformation but also cause new challenges for Enterprise Architecture Management (EAM), which traditionally deals with enterprise - Information Technology (IT) planning and coordination. Based on an industrial case of a power garden products manufacturer that is exploring potentials and facing challenges in Digital Transformation, this article investigates the integration of product-IT into EAM. Product-IT includes the embedded IT-systems in physical products and services, components for operations, maintenance or evaluation purposes. In this article the authors discuss product-IT and enterprise-IT integration in the context of EAM observed in the industrial practice.

The second article, "Decision-making to switch your ERP system: empirical Japanese evidence", is authored by Tingting Huang. A considerable research gap in the ERP (Enterprise Resource Planning) decline stage remains. Not only limited empirical evidence is found to support the decline stage, but also, the existence of this stage is not acknowledged by the majority. On the other hand, because that the decline stage is short of theory and data support, organizations which are or will be at this stage might have little help to deal with might happen. This research aims at presenting a practical decision model for organizations facing ERP switching/reversion. The process model of Rasmussen's Cognitive Control of Decision Processes was adopted as the theory lens to construct the decision model. Based on the survey results from eighteen organizations, a descriptive model - the A2O model - is proposed. This research fulfils the blank in the ERP life cycle, provides the empirical supports on exploring the critical issues, and enlightens vendors and consultants on product development and customer service.

Coordination of teams is critical when managing large programmes that involve multiple teams. In large-scale software development, work is carried out simultaneously by many developers and development teams. Results are delivered frequently and iteratively, which requires coordination on different levels, e.g., the programme, project, and team levels. Prior studies of knowledge work indicate that such work relies heavily on coordination through "personal" modes such as mutual adjustment between individuals or through scheduled or unscheduled meetings. In agile software development processes, principles and work structures emerge during the project and are not predetermined. The third article "To schedule or not to schedule? An investigation of meetings as an inter-team coordination mechanism in large-scale agile software development", authored by Nils Brede Moe, Torgeir Dingsøyr and Knut Rolland, studies how coordination through scheduled and unscheduled meetings changes over time in two large software development programmes relying on agile methods. The findings include transitions from scheduled to unscheduled meetings and from unscheduled to scheduled meetings. The transitions have been initiated both bottom-up and top-down in the programme organizations. The main implication is that programme management needs to be sensitive to the vital importance of coordination and the coordination needs as they change over time.

Business intelligence is an approach that includes processes and systems for the transformation of the raw data into meaningful and useful information which enables effective, systematic and purposeful analysis of an organization and its competitive environment. The fourth article, "Understanding impact of business intelligence to organizational performance using cluster analysis: does culture matter?", authored by Mirjana Pejić Bach, Jurij Jaklič and Dalia Suša Vugec, aims to analyze the impact of the level of business intelligence maturity on the organizational performance of the company. Moreover, since there is a rising awareness among practitioners of the role of the organizational culture for the successful functioning of the company, the role of the organizational culture is taken into consideration in the research. To meet the aim of the paper, a survey has been conducted. Data has been collected through questionnaires on a sample of 177 companies and analyzed through of the cluster analysis. The analysis identified two clusters. The results of the cross-tabulation analysis of the clusters reveal statistically significant differences concerning the company turnover and dominant organizational culture between them.

We would like to take this opportunity to express our gratitude to the distinguished members of the Editorial Board, for their commitment and for sharing their knowledge and experience in supporting the IJISPM.

Finally, we would like to express our gratitude to all the authors who submitted their work, for their insightful visions and valuable contributions.

We hope that you, the readers, find the International Journal of Information Systems and Project Management an interesting and valuable source of information for your continued work.

The Editor-in-Chief,

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João Varajão is currently professor of information systems and project management at the *University of Minho*. He is also a researcher of the *Centro Algoritmi* at the *University of Minho*. Born and raised in Portugal, he attended the *University of Minho*, earning his Undergraduate (1995), Masters (1997) and Doctorate (2003) degrees in Technologies and Information Systems. In 2012, he received his Habilitation degree from the *University of Trás-os-Montes e Alto Douro*. His current main research interests are in Information Systems Management and Information Systems Project Management. Before joining academia, he worked as an IT/IS consultant, project manager, information systems analyst and software developer, for private companies and public institutions. He has supervised more than 80 Masters and Doctoral dissertations in the Information Systems field. He has published over 300 works, including refereed publications, authored books, edited books, as well as book chapters and communications at international conferences. He serves as editor-in-chief, associate editor and member of the editorial board for international journals and has served in numerous committees of international conferences and workshops. He is co-founder of CENTERIS – Conference on ENTERprise Information Systems and of ProjMAN – International Conference on Project MANagement.

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# How Digital Transformation affects Enterprise Architecture Management – a case study

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# How Digital Transformation affects Enterprise Architecture Management – a case study

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**Abstract:**
Internet of Things (IoT), machine learning, cyber-physical systems and other recent technological innovations offer new opportunities for enterprises in the context of Digital Transformation (DT) but also cause new challenges for Enterprise Architecture Management (EAM), which traditionally deals with enterprise-IT planning and coordination. Based on an industrial case of a power garden products manufacturer that is exploring potentials and facing challenges in DT, this article investigates the integration of product-IT into EAM. Product-IT includes the embedded IT-systems in physical products and services, components for operations, maintenance or evaluation purposes. In this article we discuss product-IT and enterprise-IT integration in the context of EAM observed in the industrial practice. The main contributions are (1) positioning of the product-IT in the field of EAM, and (2) identification of the challenges from real-world case regarding integration of product-IT into EAM.

## 1. Introduction

Today's dynamic business environment with its rapidly advancing information technology (IT) capabilities evolving phenomena such as Internet of things (IoT), cyber physical systems (CPS), machine learning or self-organizing systems, presents enterprises with both new opportunities and new challenges. This opens up for new ways for enterprises to organize themselves in terms of business models, practices, and processes, how they communicate with their customers, deliver services, perform product development etc., which is often discussed in relation to digital transformation (DT) [1] and digitalization [2] of enterprises. In general, digital transformation describes the shift from traditional (often physical) creation and delivery of customer value, including the operational procedures related to this, into the massive use of digital technologies which enhance or replace the traditional product with smart, connected product [1]. At the same time as enterprises see new opportunities they do face several challenges.

The various aspects of an enterprise possibly affected by digital transformation include organizational structure, business processes, information systems, and infrastructure, which together form an Enterprise Architecture (EA). The management of EA is a discipline that seeks to address mutual alignment between these aspects by taking the embracing perspective on the overall EA [3]. When it comes to models representing these aspects, the quality and completeness of information often decreases when going from top to bottom [4]. The top layers of architecture models usually contain more complete and up-to-date information. For lower levels information about concrete IT services and applications is often difficult to collect and keep up-to-date. All IT solutions and application that are used at the enterprise to support its functioning and operation is what we refer to as *enterprise-IT* (E-IT). This part is sometimes addressed as Enterprise Information Systems (EIS) and can include various ERP components [5]. In addition, introduction of smart, connected products increase the amount of data on lower levels, which is technologically enabled by CPS and IoT. Within CPS and IoT, data is produced by numerous communicating entities. These entities are usually IT-components built into the products, which we refer to as *product-IT* (P-IT). In particular, enterprises in manufacturing industry, and in sectors where a lot of value creation is represented by IT-components built into the products, find a lot of new opportunities created by seamless and real-time integration of physical systems and IT. Use of real-time data for enterprise architecture analytics has been a challenge due to shortcomings of IT possibilities (limits in volume, variety and speed of data collection), and by the fact that P-IT has mostly been considered separately from EA. Advancement in the area of Big Data helped to overcome the first challenge [4], whereas overcoming the second challenge still requires finding a way to deal with E-IT and P-IT in an integrated manner, from managerial and operational perspective. Even though the areas of EA, and variants of P-IT attracted a lot of research during the last 10 years not much work has been done on their integration, i.e. positioning P-IT into EAM consideration. Similar deficiencies can also be found in the area of enterprise modeling techniques that are used to represent various aspects of EA and support EA Management (EAM) [6, 7].

In this context, it is observable that in industrial practice, digital transformation can have different shapes and cause diverse types of challenges. There are for instance many examples of new start-ups who have managed to embrace the digitalization wave. On the other hand, there is also evidence that more traditional enterprises with established and legacy IT-architectures have a much harder time to embrace and to take advantage of digitalization and move their business forward into this era [6, 8]. More knowledge is needed on what methods and approaches can reliably support DT in industrial practice.

The main purpose of our work is to present experiences from integration of P-IT and E-IT as an expansion of current EAM. Our main research question is: *How can product-IT and enterprise-IT be integrated in the context of enterprise architecture management?*

In this ongoing research work, the main findings presented in this article are (1) positioning of P-IT in the field of EAM, and (2) identification of challenges from real-world cases regarding integration of P-IT into EA. The rest of the article is structured in the following way: Section 2 presents related work and Section 3 the research method. In Section 4 an industrial case study provides empirical evidence of the current challenges. In Section 5 we discuss the case study from

the perspective of our research questions and digital business models. The article ends with conclusions and ideas for future research in Section 6.

## 2. Related research

The background for our work is primarily related to EAM which is summarized in section 2.1. Furthermore, this section discusses possible implications for the EAM caused by P-IT integration in enterprise architectures in section 2.2.

### 2.1 EAM of today (AS-IS)

In general, an EAM captures and structures all relevant components for describing an enterprise, including the processes used for development of the EA as such [9]. Research activities in EAM are manifold. The literature analysis included in [10] shows that elements of EAM [11], process and principles [12], and implementation drivers and strategies [13] are among the frequently researched subjects. Furthermore there is work on architecture analysis [14], decision making based on architectures [15] and IT governance [16]. However, there is no specific focus on the integration of P-IT and EAM. Of specific relevance for P-IT integration are EAM frameworks identifying recurring structures in EA. In this context, TOGAF [17] is considered by many researchers as industry standard and defines three different architectural levels which are visible in many other frameworks: *The Business Architecture* defines the business strategy, governance, organization and key business processes. *The Information Architecture* often is divided into two sub-layers: Data Architecture and Application Architecture. The Data Architecture describes the structure of an organization's logical and physical data assets and data management resources. The Application Architecture provides a blueprint for the individual application systems to be deployed, for their interactions and their relationships to the core business processes of an organization. *The Technology Architecture* describes the physical realization of an architectural solution. The logical software and hardware capabilities, which are required to support the deployment of business, data, and application services, are also defined in this dimension [17]. In addition to EAM frameworks there are also different modeling languages to support different EAM activities. One such language is ArchiMate which is widely used for these purposes. The shortcomings of ArchiMate and its ability to address dimensions needed for digitalization has also been pointed out [7]. In their study they show how existing enterprise modeling approaches does not really work for modeling digital enterprise ecosystems. In the effort of modeling enterprise ecosystems they argue: *"The described example elaborates that we have to improvise for modeling such a simple scenario using ArchiMate"* [7].

### 2.2 EAM of tomorrow (TO-BE)

Ahlemann et al. [9] define EAM as a management practice that establishes, maintains and uses a coherent set of guidelines, architecture principles and governance styles to achieve enterprise's vision and strategy. Facing opportunities and challenges derived from the digital revolution, business leaders need new ways to conduct effective strategic decisions related to the increased digital enterprise [18]. With the huge diversity of IoT technologies and products enterprises have to leverage and extend previous EA efforts to enable business value by integrating the concept of digital into their business environment [19].

The impact of digitalization on enterprise systems in modern manufacturing is discussed in [20], which claims that IoT can support information systems of next-generation manufacturing enterprises effectively. Data acquisition systems are suitable to be applied in collecting and sharing data among manufacturing resources. However, they argue that the application of IoT in enterprise systems are at its infant stage, more research is required in modularized and semantic integration, standardization, and the development of enabling technologies for safe, reliable, and effective communication and decision-making. On the way towards IoT-inclusive EAM, [19] and [21] consider integrating the growing IoT architectural descriptions into a consistent enterprise architecture as a significant challenge.

In [21] an approach for the IoT application development is proposed, which includes a role-specific development methodology, and a development framework for the IoT. Architecture evolution approach proposed in [22] relies on the idea of integrating small EA descriptions (for each relevant IoT object) into a coherent EA description. EA-IoT-Mini-Descriptions include partial EA-IoT-Data, partial EA-IoT-Models, and partial EA-IoT-Metamodels that are associated with main IoT objects defined by the approach. Another initiative that tries to overcome these challenges is the lightweight EAM framework for digital transformation by [23]. This framework has its origin in TOGAF 9.1 with a focused customization.

One challenge that is apparent today in the digital transformation is the to handle the bimodal dimensions of the IT lifecycle [24]. The E-IT dimension (Mode1), designed for stability, efficiency, and low cost, which is closely related to traditional EAM. P-IT on the other hand (Mode 2) is constituted by development projects that help to innovate or differentiate the business. This requires a high degree of business involvement, fast turnaround, and frequent update, the so-called rapid path to transform business ideas into applications. In the literature this is acknowledged through that there is a need to handle "A two speed architecture for the digital enterprise" [8]. For digitally native enterprises and startups such as for example Netflix this is not a problem [8], since they have had the benefit of starting with a "clean slate" and think "digital" and take the advantage of this from the beginning without considering any legacy. This does however not work for more established enterprises. They have many years of delivered technology, architectures, governance, decisions structures, etc. The objective of the two-speed architecture is to differentiate the systems, architectures, and structures that must be flexible and agile (P-IT) from those that have to be more reliable and deliver the highest quality (E-IT) [8]. This approach will have to cut through the different layers of the technology stack and is as much about organizational architecture and process architecture as it is about technology architecture. Some researchers have proposed an architecture aiming at information system agility and scalability, for example [25]. In addition to this [1] have suggested to handle modern digital informed infrastructure through a new technology stack. In this structure they suggest an integration of P-IT and E-IT through three interrelated layers that include Product Cloud, Connectivity, and Product. We find this approach promising but we argue for that there still is a need for further elaboration of integration of P-IT and E-IT. Even if we have a two-speed architecture these two requires elaborated and systematized interconnectivity and they should have the ability to deliver a collaborative support for different business- and customer activities.

The increased adoption of digitalization through IoT, data analytics (big data), and cloud computing has opened new ways of thinking in many dimensions; customer involvement, optimized processes, and business models. In terms of business models [26] has presented a new business model that can be more suitable for organizing business in an IoT age. This and other new business models emerging in the digitalization age will have impact on the EAM practice. Furthermore, our observation is that there is neither a common understanding of the scope and content of the main activities in EA management and IoT or P-IT integration, nor has a commonly accepted reference method been developed [27]. EAM currently concentrates on E-IT side including number of its layers, whereas P-IT, i.e. what is built into the products or supporting industrial automation, is mostly outside of EAM consideration.

## 3. Research method

From a method perspective, the work followed the case study research approach. In addition to the case study we reviewed existing publications using *digital product* and *enterprise architecture* as a search terms. There are several relevant studies available published between 2014 and 2017, which are described above in the Related Research section. During the analysis of existing literature, we observed that there is not much work on the integration of P-IT into EA, however we could clearly see that the interest in this integration is growing. Thus, our investigation of an industrial case in this subject area aimed to better understand the challenges, hinders and potential integration paths.

Qualitative case study is an approach to research that facilitates exploration of a phenomenon within its context using a variety of data sources. This ensures that the subject under consideration is not explored from only one perspective, but rather from a variety of perspectives which allows for multiple facets of the phenomenon to be revealed and understood. Yin differentiates various kinds of case studies [28]: explanatory, exploratory and descriptive. The case study can be

classified as exploratory. We explore the phenomenon of P-IT in its natural organizational context. As focus of the case study, we decided to address the P-IT/EA integration from an architectural and a management perspective. The architectural perspective addresses commonalities in structure and components of P-IT and enterprise architecture. The management perspective concerns procedures for architecture development, implementation and maintenance. The aim of the case study was to see how the existing EAM practice was affected and challenged by implementing new type of products – physical products with built-in software. More concrete, the case study explores the following research questions:

*Does the architecture of product-IT in the case study show similar levels as known from traditional EA?*

If it is possible to either discover such levels or to assign existing components to these levels, an integration could be discussed using established EA layer thinking. If not, more substantial changes to enterprise architectures would be required to facilitate an integration.

*Are there existing or potential commonalities between product-IT architectures and EA?*

Existing commonalities could be existing services developed for both parts or processes running "across" both architectures. Potential commonalities are functionally similar or equivalent services or structures.

*What are the central roles in product-IT management and are these roles comparable to the roles in EAM?*

P-IT management is in this context supposed to include product management, architecture definition and integration into the overall architecture.

*What are the cooperation processes between EA and product-IT architecture management?*

If cooperation is established and common practice, how do the processes look like, and do they cover all architecture levels?

In the case study, we analyzed documents of the case study company, performed interviews, and modeling activities to describe the current AS-IS situation. The analyzed documents provided information regarding the existing architectural and managerial practices related to digital products and services at Husqvarna. Eight interviews were performed as part of the case study, all having semi-structured character. Semi-structured interviews enabled in-depth investigation the focus area and allowed capturing the respondents' perspective on a situation and event under study [29]. Semi-structured interviews imply using a predefined list of questions but allows the interviewer to follow up on leads provided by participants for each question (ibid). The interviews were carried out at Husqvarna Group AB, one of the respondents takes a top management position in of architecture and digital solutions at Husqvarna, whereas the other respondents were project managers, product owner, enterprise architects, and squad leaders. The chosen respondents were key stakeholders within a project of developing a new digital product at Husqvarna, part of them were representing P-IT side, whereas another part - E-IT side. The interviewer followed prepared interview guide connected to the four research questions outlined above. The questions in the interview guide aimed to explore the challenges that the respondents have faced and observed in relation to EAM practice and digitalization demands/opportunities, as for instance, increasing number of P-IT entities that companies need to deal with, the considerable influence these P-IT entities have on the amount of data produced, ability to manage and analyze the produced data, and the ability to manage it in an integrated way with an E-IT.

During the modeling activities we together with the different roles at Husqvarna have created descriptions (interaction models) of how these roles (project managers, product owner, enterprise architects, technical architects, and squad leaders) interact with each other, what the interactions objects are, and the interaction logic. This way of working with models have elucidated several challenges in their work with taking a substantial step into the digitalization age. An example of such an interaction model can be seen in the Figure 1.
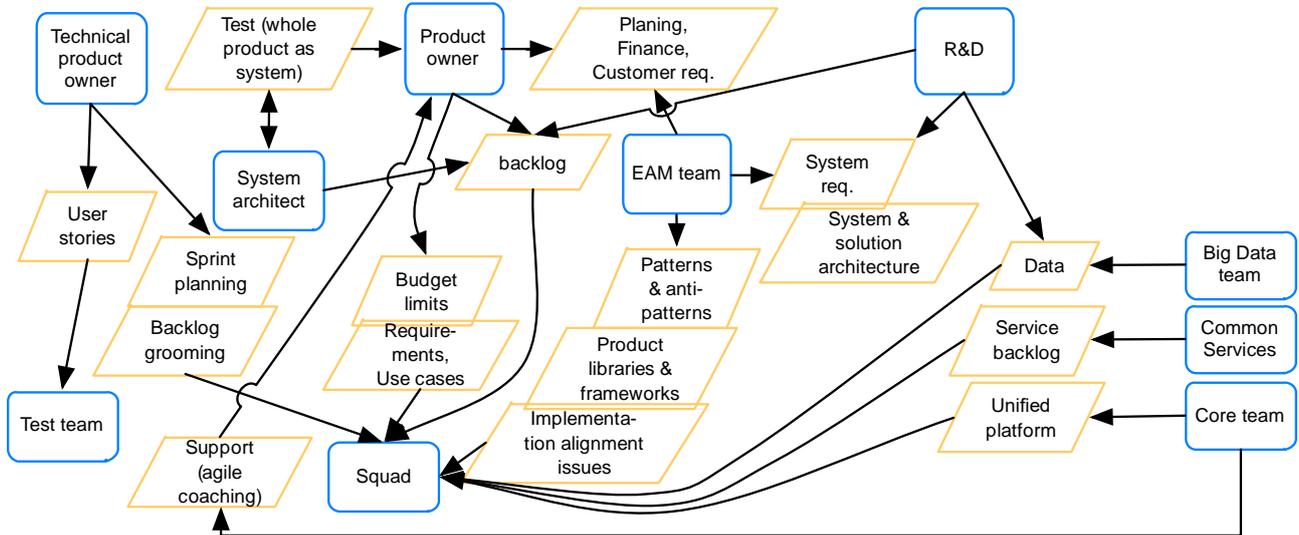
Figure 1: Overall interaction model

## 4. Industrial case study

The industrial enterprises considered in the case study is Husqvarna Group AB. Husqvarna is a world-leading producer of outdoor power products including chainsaws, trimmers, robotic lawn mowers, garden tractors, watering systems, cutting equipment, and diamond tools for the construction and stone industries. Husqvarna is multinational and offers products and services for both the private and industrial market. Husqvarna is right now in a transformation process where they see it as a necessity to embrace the digitalization trends that is been presented above to stay competitive and to deliver improved value to their stakeholders.

Many of the Husqvarna products for professional customers do not only have built-in electronics or embedded systems but also networking and communication capabilities. The built-in IT is in many cases used for controlling the different mechatronic components of the product and for collecting data when the product is in use, either performance parameters or used product features, or the environment of the product. The networking features are used for communicating usage statistics, license information or location information (if anti-theft features are activated) to either the product owner or the back-office of the manufacturer. Other functions are software upgrades and functionality add-ons implemented by configuration changes (e.g. for optimizing energy consumption).

Figure 2 illustrates a typical scenario from a customer perspective. Different Husqvarna products are installed for supporting maintenance of the garden, all of them equipped with wireless communication. Among them is a fleet of robotic mowers (1) and a lawn watering system (5). The robotic mowers and the watering system communicate with each other to synchronize mowing and watering, but they also provide operations data to the base station (2) and receive software updates or schedules from it. The base station is connected to the cloud by using the customer's Internet access. In the cloud, Husqvarna backend and customer services are available (3). Thus, the owner of the garden has access to services for operating, supervising and planning garden maintenance using mobile devices (4).

Since many of the products offer similar functionality regarding networking and communication, Husqvarna designed and implemented reusable services and components for either the product or the back-office infrastructure which comprise an IT and service architecture for the P-IT. To support all P-IT development teams Husqvarna introduced a team that is responsible for tools and standards for software development. This team is providing so called common development platform for all P-IT development teams.
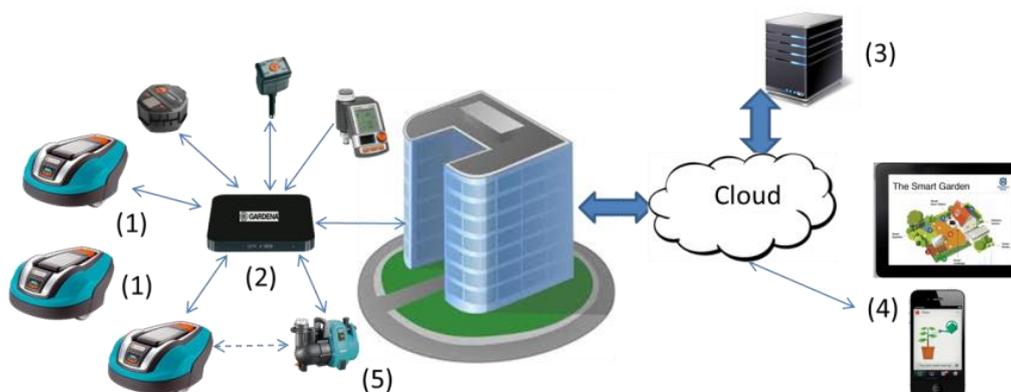
Figure 2: Scenario illustration

*"Me and my team we are responsible for the common parts that all the teams are using for the development. For example, task management tools like JIRA and Confluence, build server, address verification system, source code management. We are also managing cloud infrastructure. All the teams are responsible for their own environments, but if they for some reason fail or need support they come to me and my team for help. We also try to outline common patterns, so they don't have to reinvent the wheel all over again, a lot of the things they want to do are common among all the teams." (Respondent 2)*

One example of a common development platform component is a task management system JIRA. The decision to make this ticket management system "standard" originated from different product teams and their shared choice. This helped to avoid using several instances of JIRA and prevent situations when one person had to work in multiple instances of JIRA or use different task management systems for different projects.

*"E-IT is obviously responsible for the IT environment and infrastructure, but it happens now and then that we also have some "shadow IT". Development teams are using IT off the radar, sort to say." (Respondent 3)*

Similarly, the common development platform dealt with the issue of multiple servers for source code management. Establishing the common development platform allowed to optimize software development and maintenance in terms of supportive tools and methods, and to avoid having isolated development infrastructures with overlapping functionality for different P-IT development teams.

Another important issue is license management services - to take one example - for product licenses (in P-IT) and software licenses (in E-IT) is. Can both service types be based on the same technical infrastructure and use the same encryption and logging services (to take just two examples)? If so, why not define common EA elements on application architecture level for P-IT and E-IT?

A core challenge for Husqvarna to handle the integration of P-IT and E-IT is to handle the bimodal dimensions of the IT lifecycle which is closely related to the concept of bimodal architecture.

*"Product owners are sometimes caught in their traditional way of working. They have their product model, you have to pass those all the toll gates in that model. That is an obstacle I think." (Respondent 1)*

*"Historically we have a product-centric organization where we have a planning period of one year at a time, with a specified budget each year. At the end of the year we are expected to have a product out on the market. With the new types of products, the development team is developing a service or system that is always available, which is different from when you develop a product: you put it on the shelf with more or less no cost. You could fire the entire development team after that if you like, as you still have it on the shelf. Doing that for a service or system that you have*

*to operate with the whole backend is not working. Especially when we are talking about mobile apps, for which people are expecting updates. Therefore, even for a minimum level of maintenance for a system we need to calculate for that. The way that this has been done before is that the maintenance would be included in the next year project, which therefore most of the times will not be budgeted correctly." (Respondent 2)*

The E-IT dimension (Mode1), designed for stability, efficiency, and low cost, which is closely related to traditional EAM. P-IT on the other hand (Mode 2) is constituted by development projects that help to innovate or differentiate the business. This requires a high degree of business involvement, fast turnaround, and frequent update, the so-called rapid path to transform business ideas into applications. To handle this Husqvarna is implementing DevOps Teams designed for agility, rapid development and short time to market. In Husqvarna these two modes (Mode 1 & Mode 2) are closely related to the concept of two speed architecture as presented earlier.

*"It is quite a pain when we have this funding process that goes in collision to our agile way of thinking. So, if we are talking about this bi-modal development process – we (P-IT development team) are working in mode 2. But almost every process is defined for mode 1 so we have to come up with creative solutions every time. We try to find a way to fund our way of working agile and follow the guidelines for the Husqvarna process, the funding process." (Respondent 4)*

Today Husqvarna experience a clear tension between Mode 1 and Mode 2 and they give testimony of several more specific challenges in relation to the bimodal dimensions of IT, such as governance and responsibilities between research and development and IT, how to increase speed and suitable methods to support agile teams. Also, how to balance governance and support between P-IT and E-IT, lack of frameworks to describe IT technology stacks for IoT and digitalization.

*"There is a reference architecture on our enterprise level, but it is not so concrete: there are a lot of boxes and names right now, but there are not much that are useful for implementation." (Respondent 1)*

There is also a need to handle legacy systems during the transformation into the digitalized enterprise. An example here is using certain technological solutions or parts of systems, which are not optimal for the current or planned P-IT.

*"VPN has been one of the parts of legacy discussion. We have discussed that we shall not have any VPNs but due to legacy we needed to set it up." (Respondent 2)*

## 5. Discussion

In this section, we discuss the research questions in connection to the empirical data. Our reflections are occasionally supported with interview quotations.

### 5.1 Elaboration on research questions

*Does the architecture of P-IT in the case study show similar levels as known from traditional EA?* The TOGAF levels previously introduced will in this section be considered as "traditional" EA levels. On the technology architecture level, we found different hardware/software architectures which define platforms and reuse concepts for electrical/electronic control units in the products, sensors and actuators connecting to them and communication or networking components. Furthermore, the communication networks connecting the products to the backend network or the Internet could also be considered as part of the technology architecture.

One issue on technical level is related to the technical decisions that affect several actors involved in P-IT development. This is particularly related to software components embedded into the physical products. Here it might become problematic for P-IT development team if Research & Development (R&D) takes the lead and takes the complete responsibility for decision making regarding protocols and implementation of details in the product software. There is obviously a need to establish a more active dialog between these teams.

*"R&D decides what protocols and communication standards they would like to use for the products (lawn movers). When we (P-IT development team) get involved we want to have more to say what kind of software we want to use on the movers, because it would make it easier for us in the IT solution and if they disagree we might have a clash." (Respondent 1)*

One example of the existing E-IT not being able to provide suitable support for P-IT is identity management software solution, as it was not planned for customer accounts created to use the app.

*"We have an internal enterprise identity access management suite from, for example, IBM. We manage all our consultants and employees there. We also have included dealers accounts to that system that are our customers. As long as we have limited scope of the number of identities, the financial model scales good enough. But if we introduce consumers entities then the volumes will take off and we will not be able to use that system from financial standpoint, I do not think technically either." (Respondent 3)*

On the data architecture level, we found different data structures present in usage scenarios of P-IT, but not all of them are fully stored in the product. The most prominent data structures are configuration and license information for the actual product in use, usage data collected during operations (operation time, operator ID, temperature, power consumption and other usage information of the device) and data structures for representing evaluation results of the operations data (indicator development statistics, triggered alarms and notifications, rules, etc.). Parts of the data are captured in the physical product or base stations made for forwarding the data. Other parts are stored in the cloud. Future scenarios also include streaming of real-time data via the base station to the cloud.

*"The data from the product is collected and transferred into the development team's back-end. So far there is no BI level, so it is more or less raw data. Based on the data, they have some mechanism in place for giving suggestions on predictive maintenance." (Respondent 2)*

The application architecture showed a separation between external services made for customers, the back-end services for the physical products and the services built-into the physical products. While external services are quite unified across the different product categories (ownership and warranty registration, archive for manuals and technical documentation, statistics and alerts), the back-end and built-in services are dependent on product categories. An example is to lock/unlock the physical product using an app on the smartphone or smartwatch. This requires a corresponding backend and built-in services which is not appropriate for all types of products.

The business architecture basically is defined as soon as the customer value and the use cases that have been designed and implemented to deliver the customer solutions. These values and use cases have been documented and are maintained, but in the conventional meaning of the business architecture they do not cover the functions and processes of Husqvarna Group for their customers.

One aspect of business architecture that requires further consideration and integration between P-IT and E-IT is customer support. Customer support is currently managed in a quite fragmented way and the actors involved are not interconnected. There key questions to answer in this respect are *Who owns customer experience?* and *How customer experience should be handled?*

*"We have a Brand and Marketing department that is responsible for branding on public sites and in social media. They have graphical guidelines for how the brand should be communicated through colors, fonts, designs and everything like that. But that is for marketing and for public websites. Then there is another department that is responsible for design of our products. You would expect those two departments to be aligned on what should be the overarching brand experience, they should agree in this. However, when it is a digital product or digital interface that needs to be defined, it is closer to the brands and marketing team but that is not the typical kind of delivery they do. But at the same time, it is product deliverable, so it is a clash with product development team and user interface designers."(Respondent 3)*

Table 1: Summarizes the results from discussion of the first research questions.

| Architecture Layer | Content |
|---|---|
| Business architecture | Not explicitly defined as architecture; made up by customer value and supporting IT solutions |
| Application architecture | External customer services, backend services, services built into the physical products |
| Data architecture | Operations data, evaluation and statistics, configuration data |
| Technology architecture | Embedded systems architecture, communication components, infrastructure components |

*Are there existing or potential commonalities between product-IT architectures and EA?* On the technology architecture level, most parts of the product's technology, i.e. the hardware/software architecture and communication interface, seem not to be relevant for an EA integration. However, when it comes to the communication infrastructure it can be expected that we will move from point-to-point to mobile edge computing (MEC) which would affect even the enterprise architecture. MEC basically adds additional functionalities to 4G mobile networks which basically deploys computing services at the access nodes.
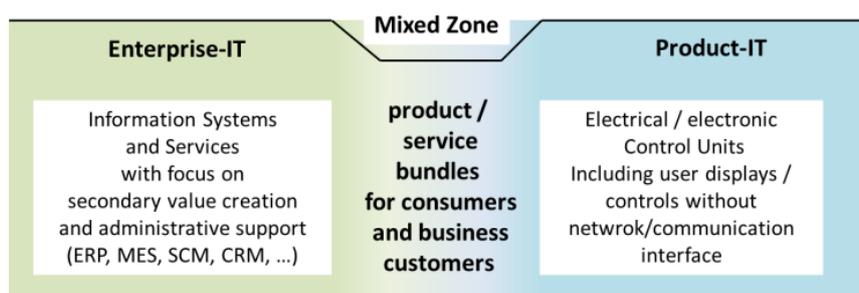


Figure 3: Summary of results for research question 2

*What are the central roles in product-IT management and are these roles comparable to the roles in EAM?* The roles identified in the analysis are product owner, enterprise architect, system architect and service delivery manager. The product owner is responsible for managing the feature of a product for the different target groups, the version and roadmap planning for implementing the features and the operation planning. The service delivery manager takes care of operations, maintenance and transition between service versions. Enterprise architect and system architect design the overall system, one with the focus on backend and enterprise integration, the other with focus on IT components in the product. The enterprise architect has as a part of his role to coordinate the enterprise architecture integration. Although this pragmatic arrangement works well, it is considered by the use case partner as not pro-active enough, i.e. a general road mapping for joint E-IT and P-IT development is missing.

The data revealed the importance of an "insider" role working with enterprise architecture questions in close dialog with digital product teams. This role would be providing architectural guidelines, reference architecture to the digital product teams for implementation. The risk of reference architecture being too abstract should be avoided by facilitating an open dialog with the product team.

*"Enterprise Architect would like to think ahead of things, but it is really good to understand that we have to focus in a short time, we have to deliver. That is the gap which needs to be closed to succeed." (Respondent 1)*

*"When it comes to the reference architecture and what the teams are implementing, it is a big gap. So far there is no way to make the reference architecture more concrete. For example, what are the different domain services that we need to build our services, that is somewhat missing." (Respondent 2)*

*What are the cooperation processes between EA and P-IT architecture management?* The cooperation processes in the case study data so far do not give a complete picture. We found processes directed to those embedded systems in the product including electrical and mechatronic parts which only communicate with other internal components in the product by internal bus systems or other mechanisms. Parts of this process are outsourced. These "P-IT only" processes are in the case study not considered as interesting for the overall EA, maybe except for the architecture for the control units.

The cooperation process between E-IT and P-IT calls for new financing mechanisms.

*"The traditional way of dealing with IT cost would be to have the balance in the different divisions and on top of that to take IT cost and split it. Then it would be subtracted from all the divisions. Now we are trying to allocate the cost directly back to the product owner for everything, so product owners take the cost for the IT infrastructure for their services. That will also make the product owners willingly to pay for development efforts and improvement efforts and would reduce the cost." (Respondent 2)*

Furthermore, we found processes for components in the physical product connected via radio networks, e.g. for communication to the base station or other devises. Here, the process of developing new P-IT components, versions or features is well-defined at the use case partner. This process also includes steps aiming at the coordination of the development of services on an enterprise level with the responsible enterprise architect involved. Many of these processes are following the DevOps procedure model which includes the development of components and services and operations tasks. As there are services which have the potential to be shared with administrative parts of the EA, they can be considered as part of the "mixed zone" in the figure above.

## 6.  Conclusions and future work

Based on an industrial case from a manufacturer of power garden products, this article discussed the issue of integrating P-IT into EAM. The literature study performed as part of this work indicates that this subject is widely unexplored in academic literature but very important for industry. The Husqvarna case shows that industry implemented pragmatic solutions for dealing with different dimensions of P-IT integration into EA. Although these solutions work in an acceptable way there is a clearly expressed demand for improvements and the statement that many of the EAM standards do not work in this context.

Furthermore, our investigation showed that traditional enterprise architecture layers are suitable for structuring P-IT but not optimal for this purpose. More refinement layers are required, e.g. by identifying a "mixed zone" between P-IT and E-IT which is structured differently. The borderline between E-IT and "mixed zone" disappears more and more by integration of mixed zone and E-IT services. In P-IT some architectural parts remain non-connected which essentially are the isolated control systems for the outdoor power products with their machine-focused use interfaces. The mixed zone can roughly be divided into layers according to the enterprise architecture but should considered from a more fine-grain structure. Customer support should be considered as one of the central aspects when defining services for a "new" business layer, as the customer point of view is crucial for P-IT generating business value. Here, issues like customer onboarding, customer support and taking an end-to-end view for enabling a joined-up customer experience can be named as important.

In addition to the EA layers, there is a need to refine the EAM and included governance mechanisms. New financing mechanisms and processes of working would need to be defined, considering the new value generating role of IT, which originates from P-IT side and goes beyond the traditional supportive role that E-IT has.

The Husqvarna case has clearly shown how they in a pragmatic way have dealt with bi-modal processes and two speed architecture and the implications of this. It is quite evident in this study that a more systematic approach to handle this would be appreciated, and especially in relation to the traditional EA layers. Smart, connected products require enterprises to build and support an entirely new technology infrastructure [1] and where their suggestion of a new technology stack looks promising. In this structure they suggest an integration of P-IT and E-IT through three interrelated layers including, Product Cloud, Connectivity, and Product. These three layers are then interrelated with three dimensions of digitization, Integration with Business Systems, External Information Sources, and Identity and Security.

The main limitation of this work obviously is that it is based on only one industrial case. We performed an exploratory case study meant to contribute to a better understanding of the problem. From this perspective, this limitation is not severe at this early stage of the work. More case studies are of course required to get a more complete picture. Future work will include continued data collection in the Husqvarna case study. Interviews with more actors involved in the garden power products and on the E-IT side are planned. Furthermore, we will start a second case study in cooperation with the second industrial partner in the research project, Skye Consulting, which will be directed towards turbine manufacturing of one of the world leading companies in this field. On the theoretical side, future work will include an extended literature research.

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# Decision-making to switch your ERP system: empirical Japanese evidence

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# Decision-making to switch your ERP system: empirical Japanese evidence

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**Abstract:**
A huge research gap in ERP life cycle, the Decline stage, remains. Not only limited empirical evidence is found to support the Decline stage, but also, the existence of this stage is not acknowledged by the majority. On the other hand, because that the Decline stage is short of theory and data support, organizations which are or will be at this stage have little help to deal with what might happen. This research aims at proposing a practical decision model for organizations facing ERP (Enterprise Resource Planning) switching/reversion. The process model of Rasmussen's Cognitive Control of Decision Processes was adopted as the theory lens to construct the decision model. Based on the survey results from eighteen organizations, a descriptive model - A2O model - is proposed. This research fulfills the blank in the ERP life cycle, provides the empirical supports on exploring the critical issues, and enlightens vendors and consultants on product development and customer service.

## 1. Introduction

The roots of Enterprise Resource Planning (ERP) systems may go back to half a century ago. With the development of information technology (IT) and the demands of organizations, ERP which originated from manufacturing cores had covered nearly all essential processes and functions of organizations two decades ago. As one of the most rapidly spreading terms, ERP has gotten various definitions in which three common factors - integration, packages, and best practices - are usually included [1]. The whole ERP software market has experienced rapid growth since the 1990s. Although some shifts happened during these years, according to Columbus [2], in spite of the worldwide ERP software market share in 2012 shows that the SAP is still leading the worldwide market with 24.6% market share, new ERP vendors with tremendous growth indeed pose a potential threat. Meantime, the worldwide ERP market experienced slow growth of 2.2%, yet quoted from Columbus [2] "Software-as-a-Service (SaaS), financial management and Human Capital Management (HCM) applications showed potential for breakout growth." The ERP report of Panorama Consulting Solutions [3] pointed out that the traditional ERP software was chosen by the majority of 61% with an increase of 3% over 2012 and 26% of respondents selected software as a SaaS and cloud ERP. The modern trends in ERP are also concluded by scholars. Powell et al. [4] identify ten key trends, such as Customizable ERP, Collaborative ERP, SaaS and Cloud Computing, Web-enabled ERP, Mobile ERP, and Real-time ERP, etc. To put it bluntly, traditional ERP in organizations, such as on-Premise ERP, has already been increasingly impacted by emerging information technology, such as cloud services and social media technologies. A recent survey conducted by Gartner group in 2013 reveals that 47% of the organizations planned to move to cloud-based systems within the next five years [5]. They also made some ERP predictions in 2014 [6] to highlight that a shift towards SaaS model to be unstoppable.

In general, ERP implementation project contains three major phases - the pre-implementation phase, the implementation phase, and the post-implementation phase. The post-implementation phase, in which ERP system is operating in the organization, can be divided into four stages: the Diffusion stage, the Utilization stage, the Enhancement stage, and the Decline stage [7]. In the previous studies, the post-implementation phase had been identified but very little attention had been paid on the real return on investment of such big projects [8]. Problems associated with ERP implementations become more rampant during the post-implementation phase [9]. As Chang [10] pointed out, the ongoing management and support of the ERP system remain a challenge beyond "go live". However, almost every scholar that studied the literature of ERP along with the ERP Life Cycle has stressed the fact that there is no research in the last stage of ERP Life Cycle. There may be two reasons lead to this result. First, there are not enough organizations that reach this stage. As a matter of fact, in a recent research, Huang [11] can only find forty organizations experienced ERP switching out of 869 cases. It is hard to get the data since organizations tend to deny any negative information about them. There is also no standard for estimation. Second, there are bigger issues in other stages. Admittedly, the Implementation phase has been the center of worldwide researchers' attention since two decades ago. As many researchers stressed repeatedly, the post-Implementation phase, the longest period, is considered to accompany the organization for more than twenty years. It is impossible that the issues in this phase are less or less important than other phases.

Hence, a huge research gap in ERP life cycle, the ending stage, remains. Not only limited empirical evidence is found to support the Decline stage, but also, the existence of this stage is not acknowledged by the majority. On the other hand, because that the Decline stage is short of theory support and data support, organizations which are or will be at this stage have little help to deal with what might happen. Hence, during the Decline stage of ERP Life Cycle, organizations will face one big issue about how to deal with the current system. Nevertheless, as the most important event in the Decline stage of ERP Life Cycle - making decisions on switching the ERP system, there is no research as well. In ERP field, most studies focus on the decision-making of ERP system selection [12, 13] for the first time. It is considered that there are strong linkages between ERP selection and ERP success [14]. However, after the first ERP system implemented in organizations, there will be another important key decision-making point which usually occurs in the Decline stage. Based on the findings of Huang [11], there are two considerable choices, Life extension and Decommission. The first one means organizations will try to prolong the life of current systems. The other one presents for abandoning the existing system. The previous decision models cannot be adopted directly, and no decision model is

proposed for this particular event. In this regard, it is worth efforts to focus on the transformation that both ERP software and the organizations are going to go through it. As long as we focus on the Decline stage, the following question should be solved eventually.

RQ1: How to make decisions on switching ERP system during the Decline stage?

Contributions of this research consist of fulfilling the blank of ERP life cycle theory, exploring the critical issues in the Decline stage, revealing the reality of ERP switching/reversion, providing a practical decision model for organizations, and building the foundation for researchers interested in this period. As an extended study of Huang [11], this research is able to explore the above shifting period in organizations empirically by conducting a survey within the organizations that have experienced the Life extension or Decommission, and build tool for decision-making in the Decline stage in order to prepare and assist organizations in advance.

The remainder of the paper is organized as follows: Section 2 presents the related background literature, followed by the research methodology in section 3. Section 4 includes the results of the survey. In section 5, the proposed decision-making model is explained in detail. In section 6, a discussion of the research findings and implications is provided. Finally, a conclusion is presented in section 6.

## 2. Background

### 2.1. Decline stage of ERP Life Cycle

Over the last decade, research referred to ERP Life Cycle has been in full flourish. The dominant research method of ERP Life Cycle is process model deduction. Usually, there are three ways to construct the process model of ERP Life Cycle. The first one is deducting from the traditional Systems Development Life Cycle (SDLC) model since ERP system is one of the information systems (IS). The second way is modifying previous ERP Life Cycle models. The third way is analyzing empirical data from case study or survey to build the process model. Apparently, the last way is used frequently by vendors and consulting companies and the others are more common in the academy. In general, the traditional ERP life cycle model covers the pre-implementation phase, the implementation phase, and the post-implementation phase. Although most research efforts are still focusing on the implementation phase [53, 54, 58], we can see that the study on the post-implementation phase [54, 55, 56, 57] is increasing these years. In order to give the longest period - the post-implementation phase - the attention it deserves, a conceptual model of ERP Life Cycle [7] from go-live to withdrawal is proposed to specify the post-implementation phase. The Diffusion stage starts at the go-live point, which means the staffs can recognize and use the ERP system through their computers and ends at the Stabilization point. The Utilization stage is expected to begin once the performance reaches its first steady state. Staffs can use the ERP system as any other usual software. The Enhancement stage is accompanied by the first reform action. People are familiar with the ERP system and try to explore more value. The Decline stage will happen when the performance of the current system cannot reach a higher level; it starts at the turning point and ends at the withdrawal point. Huang and Yasuda [15] have conducted a comprehensive literature review related to the models of ERP Life Cycle, in which twenty-six models are accumulated and discussed. Among the twenty-six original models, there are even two models [16, 17] that do not cover the post-implementation phase. Comparatively, there are only four out of twenty-six original ERP models that contented the Decline stage. Esteves and Pastor [18] make some conjectures in the Decline stage. They point out that although most organizations were in or just after the implementation stage, there are cases that ERP systems had been abandoned or replaced for some reasons. Regretfully, they could not find any published data during the survey of literature review in 2001 and 2007. Ahituv et al. [19] compare the step of system termination to the termination activity of the traditional SDLC and stress that it is more complex and difficult to replace ERP system than normal applications. As a practitioner, Klee [20] makes his points through four keywords. They are ability, business, technology, and cost. When the current ERP system becomes old with a bad solution and costly, new business requirements are rising, and new technologies are emerging, there is no reason to not join the new life cycle of new ERP system. Bento and Costa [21] also discuss and agree on above opinions. Additionally, the descriptions of the

Decline stage in previous research are very poor without any empirical evidence, and the critical issues at this stage are only based on speculations.

In fact, the Decline stage is an essential stage and the mutual stage of ERP system both in success and failure. When the ERP no longer responds to the organizations' new demands as well as the appearance of new technologies or the inadequacy of the ERP system [18, 19, 21], the performance drops quickly; the needs of organizations cannot be satisfied although the system itself has little errors. The users will begin to complain about the system, and new arrangement will be scheduled gradually. Upgrading is now nearly as costly as implementing a new ERP solution [20, 21], the current system will be reformed completely at the end which can be recognized as the Withdrawal point. However, the high costs inherent in the updating ERP's process is certainly also an opportunity to evaluate other vendors and other technologies [21]. The support from the third party increases and the consultants' support will be more important if facing changing vendors. When the organization cannot recognize this variation, this stage may be last long, and causes unexpected loss; when the organization already has a reform plan, this phase will be the period of preparing for the next ERP system. DeLone and McLean [22] pointed out that IS success is a multidimensional and interdependent construct. Many scholars such as Markus and Tanis [23] and Ross and Vitale [24], tried to explore the success metrics or to define the obstacles to success. On the contrary, IS failure is considered to be another angle to understand the IS system. Lyytinen and Hirschheim [25] defined four types of failure; they were Correspondence Failure, Process Failure, Interaction Failure, and Expectation Failure. Again, the term of IS success/failure can be ambiguous as well. The IS success/failure may mean the IS implementation project success/failure, the IS post-implementation success/failure, the IS project success/failure, etc. In this research, the success/failure of ERP presents the post-implementation success/failure in organizations in the period from go-live to withdrawal. As a matter of fact, to verify an ERP system's success/failure, a specific period is indispensable. During the ERP Life Cycle, the common scenario is that not all the four stages will happen. For instants, when the utilization stage is estimated to be a success, keeping the success seems to be the right way to choose; whether the enhancement activities are done or not, the decline stage will definitely come. When the failure is the result, there are two choices. One is to replace the current system with a new system or to abandon it directly. The other is to solve the problem to achieve success again. In the first scenario, the existing of the decline stage is confirmed by the failure result. In the second scenario, the above same things happen.

Comparatively, there were few studies referred to the Decline stage. Haddara and Elragal [26] conclude many reasons of early ERP retirement when the ERP adaptation goes wrong. However, the answer is insufficient through a single case study. Nicolaou and Bhattacharya [27] classify decommission into two categories - switches and abandonment. They think late switches and abandonment represent the worst-case scenario and conclude both early and late abandonments lead to apparent differential performance deterioration. You et al. [28] also consider abandon as an option when the project goes badly from the financial perspective. Apparently, the financial possibility of pursuing new IS has not been considered or hard to be evaluated yet. Instead of replacing with a new system, major enhancement or upgrade is another option. Holland et al. [29] predict organizations may need other 'beyond ERP systems' to capture information about competitors, customers, and suppliers. Some similar conceptual frameworks for next generation of ERP system can be found in prior literature which is usually called as ERP II or ERP III. Frank [30] introduces a method to migrate from a traditional ERP system to a distributed modular ERP system. Similarly, life extension of current ERP system - a third way to deal with the declining system - refers to adopt any possible method to extend the lifespan of the current information system. Nicolaou and Bhattacharya [27] analyze the 'late' enhancements in ERP-adopted organizations. Although 'Late' here only refers to a relatively long post-implementation period after the go-live of ERP system, they did conclude that late enhancements have an overall negative impact on ERP-enabled firm performance. Although the existence of the Decline stage has already been proved [11] - forty organizations in Japan have switched or upgrade majorly their ERP systems, current research is more focus on the potential risk or benefit of switching to a new system, but less focus on when to make a decision and how.

*2.2. Decision theory*

It comes to no doubts, that decision-making is a typical human activity. However, the roots of classical decision-making conception may go back to the economy and mathematics [31-33]. Based on the principle of optimization developed by mathematician and pioneer of modern computer science John von Neumann and economist Oskar Morgenstern in the book Game theory and economic behavior, classical decision theories boomed as an important psychological subject since the 1950s [31, 33]. Polič [33] quoted the research of Collyer and Malecki (1998) to distinguish three periods of the development of decision-making theory: Rational decision-making models, Descriptive models, and Decision models in natural settings. Rational decision-making theory began from 1955 to 1975. Classical decision theory tended to focus on the decision event, which was "choosing from among a fixed set of known alternatives based on stable" [34]. As classical decision theory, such as Subjective Expected Utility (SEU), rational decision theory is a normative decision theory which means a theory about how decisions should be made in order to rational [35]. Theoretically, all consequences should be considered before decision-making for optimized decision. Since people are not like computers, the stress on abstract rationality and the neglect of complexity caused the failure of classical decision theory [33]. During the period between 1965 and 1985, the descriptive theory - a theory about how decisions are actually made [35], also known as behavioral decision theory, rose with Herbert Simon's influential concept of bounded rationality. He thought that people will not be able to estimate all the possible values; instead, they choose the first satisfied one. Naturalistic decision making, a dominating field in psychology, was starting in the 1980s. It stemmed from the awareness that daily decision-making activities cannot be simulated in fixed conditions of a laboratory. Natural settings involve more people, more uncertain dynamic environment, more goals, time stress, and high stakes as well, which means that the aim is not making a decision but achieving a broader goal [34]. Many influential models of naturalistic decision-making [32] emerged, such as Noble's Situation Assessment model, Klein's Recognition-Primed Decisions model, Beach and Mitchell's Image Theory, Rasmussen's The Cognitive Control of Decision Processes, etc. Polič [33] also referred the concept of macro cognition which the field of naturalistic decision making and related concepts during the last years.

In this research, the process model of Rasmussen's Cognitive Control of Decision Processes [36] was adopted as the theory lens to construct the decision model for the organizations to switch the current ERP system. The reason is that this model is for the decision-making processes of human operators of complex systems [32], which is a tool for reliable prediction of human performance [36]. Since the decision-making of switching ERP system involves people familiar with information systems, and to predict and refine the decision process is the main purpose of this research. There are three critical concepts in this model: Skill-based behavior, rule-based behavior, and knowledge-based behavior. Rasmussen distinguishes between those three types of behavior that are controlled by qualitatively different cognitive mechanisms through extensive analysis of actual accidents and think-aloud protocols obtained by means of simulators [32]. According to Rasmussen's theory, the skill-based behavior occurs without conscious control, which follows an automated, smooth statement of an intention; the rule-based behavior follows the certain rules and know-how; and the knowledge-based behavior requires deeper understanding of the nature of the situation and explicit consideration of objectives and options, whereas skill-based and rule-based behaviors characteristic of expertise and familiarity with the situation. The skill-based, rule-based, and knowledge-based behaviors allow very detailed analysis of decision-making activities in particular events or situations. This theory will be used to organize and simplify the major activities during the decision-making event.

## 3.  Methodology

A questionnaire survey was adopted by this research. The online questionnaire survey was sent by email or message broad on the official website at first. Then, two reminders were sent through telephone and email every two weeks. The survey period is five weeks from October to November in 2016. The research sample contains thirty-eight organizations which have experienced ERP switching/reversion [11]. The source of secondary data is the files of case studies provided by ERP vendors. The case studies conducted by Japanese vendors are interviews with CEOs and IS/IT managers in those organizations. The contents of each case study generally insist of organization's information, status

before and after the ERP switching, the aims and requirements of organizations, the specific process of implementation, and the information of the selected ERP product. The questions are designed mainly in the form of the 5-point Likert rating scale, single textbox, and ranking. The aim of this survey is to explore the reality of organizations in the Decline stage and to form a practical process decision model. Based on the secondary data [11], four major parts of the questionnaire are set up (Figure 1). By accumulating important items of all thirty-eight case studies about the ERP switch/reversion project, the questionnaire insists of the basic information of organizations, the information of the project, the preparations for the decision-making, and the decision-making period. 'The Basic information' contains the information of responders and their organizations. 'The Experienced ERP projects' contains the information of the last ERP implementation project. 'The Preparations for decision-making' contains what organizations did when they prepared for the decision-making. Finally, the Decision-making period' contains the reasons and issues that organizations have faced and the common procedure of conducting a decision-making.

Data from the Basic information section and the Experienced ERP projects section can be analyzed for learning the difference between SMEs and Large Enterprises (LEs) or various businesses when facing ERP switching/reversion. Questions in these two sections are in the form of a single textbox. In the Preparations for decision-making section, the major purports are to find the tendency of the decision-making group selection, evaluation both in system and management before the decision, goals of the decision-making, strategy of decision-making, and the assessment of each potential decision. The 5-point Likert rating scale is adopted in this section. The section of Decision-making period is set for identifying the specific detail of the decision-making in organizations, such as the reasons, the critical issues, and the procedures. Questions in this section are in the form of the rating scale and ranking. The secondary data is complementary to the survey data. It provides detailed information and exploration narratively for each survey item, such as what has been done during the planning and project period, what are the causes and outcomes of a certain issue, etc.
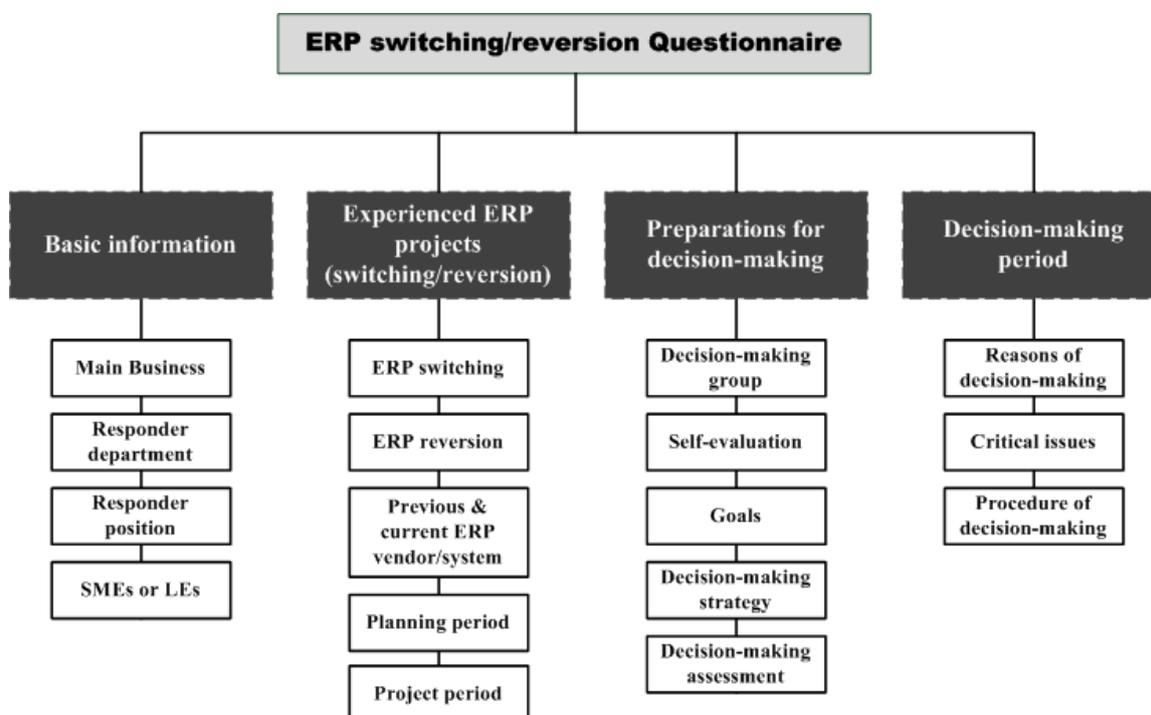


Fig. 1. ERP switching/reversion questionnaire.

## 4. Results

In the end, eighteen responses were accumulated through the online survey tool, in which sixteen responses were complete and usable (one response misses the answers of the forth section). The response rate is 42%.

### 4.1. Basic information

Eleven out of sixteen organizations belong to the manufacturing industry, and other five organizations have various businesses in the service industry. Ten organizations are LEs, and other six are SMEs. Six responders come from the IS department, others belong to the Management department, Production Division, Business department, Sales department, Accounting department, etc. Within all the responders, nine responders declared their positions are all at the management level.

### 4.2. Experienced ERP projects

One organization (SMEs) only experienced major ERP reversion. Eleven organizations (three SMEs and eight LEs) only experienced ERP switching. Four organizations (two SMEs and two LEs) experienced both ERP switching and reversion. Half of the sixteen organizations adopted the foreign ERP package at the first time; however, in the second time, the domestic ERP packages are more popular, and only two organizations chose to switch to the foreign ERP package. The average planning period is nearly eight months, and the average project period for ERP switching and reversion is twelve months and eight months. Additionally, there is a small difference between SMEs and LEs related to the planning and project period. For LEs, the average planning period and project period are seven months (two to eighteen) and thirteen months (three to twenty-seven). For SMEs, the average planning period and project period are nearly nine months (zero to twenty) and ten months (six to thirteen). As we can see, the planning period of SMEs and the project period of LEs distribute more dispersed.

### 4.3. Preparations for decision-making

Preparations for decision-making usually occur during the planning period. Five major activates can be concluded as organizing the decision-making group, conducting self-evaluation, identifying goals, choosing decision-making strategy, and assessing decisions. As the Table 1 shows, top and IS/IT managers play a big role in decision-making group; managers of other departments, third-party, and end-users are not so necessary; customers and stakeholders do not participate in this process. Self-evaluation before decision-making refers to that organization particularly assesses the current status of business and system. The findings show that most organizations consider the system performance and the IT-business alignment most important during the self-evaluation. Other major parts of evaluation are the assessment of the business performance and the current issues. The business environment and users/stakeholders/customers' opinions are usually not considered to be relevant. Four important elements of goals are budgets, issues-solving, optimizing the long-term and short-term performance. Most organizations consider the budget control should be the most important one, after which are solving the current issues and increasing the long-term performance. The short-term performance is not so urgent from the organizational perspective. The decision-making strategy refers to the tendency of the decision-making. There is no absolute best strategy for everyone, but a proper strategy for every desire. The tendency of ERP switching/reversion mostly reflects the focus on the cost-benefit, system or business performance, and time-saving, in which perusing the higher cost-benefit is the acknowledged tendency for most organizations. On the other hand, the other tendencies are also chosen by organizations with particular purposes. Finally, the decision-making assessment is the process for organizations with multiple decision plans to determine the final plan. The results indicate that most organizations will prepare and assess possible decisions, but not the potential impacts of each decision.

From the perspective of LEs, the weighted average of IS/IT managers (4.70) is the highest when assembling the decision-making group, as well as the IT-business alignment (4.50) related to the self-evaluation before decision-making. On the other hand, from the perspective of SMEs, IT-business alignment (3.83) is below the System

performance, the Business performance, and the Current issues. Meanwhile, the Time-saving (4.17) gets more attention by SMEs.

Table 1. Summary of decision-making preparations.

| | | Lest imp. | Less imp. | Imp. | More imp. | Most imp. | Weighted Average | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Total (16) | SMEs (6) | LEs (10) |
| Members of the Decision-making group | Top managers | 0.00% 0 | 0.00% 0 | 0.00% 0 | 50.00% 8 | 50.00% 8 | 4.50 | 4.33 | 4.60 |
| | IS/IT managers | 0.00% 0 | 0.00% 0 | 0.00% 0 | 50.00% 8 | 50.00% 8 | 4.50 | 4.17 | 4.70 |
| | Other managers | 0.00% 0 | 0.00% 0 | 25.00% 4 | 68.75% 11 | 6.25% 1 | 3.81 | 3.33 | 4.10 |
| | Third-party (Consultant or vendor) | 0.00% 0 | 0.00% 0 | 68.75% 11 | 31.25% 5 | 0.00% 0 | 3.31 | 3.17 | 3.40 |
| | End-users | 0.00% 0 | 12.50% 2 | 68.75% 11 | 12.50% 2 | 6.25% 1 | 3.13 | 3.00 | 2.90 |
| | Customers | 31.25% 5 | 62.50% 10 | 6.25% 1 | 0.00% 0 | 0.00% 0 | 1.75 | 1.83 | 1.70 |
| | Stakeholders | 25.00% 4 | 75.00% 12 | 0.00% 0 | 0.00% 0 | 0.00% 0 | 1.75 | 1.67 | 1.80 |
| Self-evaluation before decision-making | System performance | 0.00% 0 | 0.00% 0 | 0.00% 0 | 75.00% 12 | 25.00% 4 | 4.25 | 4.33 | 4.20 |
| | IT-business alignment | 0.00% 0 | 0.00% 0 | 12.50% 2 | 50.00% 8 | 37.50% 6 | 4.25 | 3.83 | 4.50 |
| | Business performance | 0.00% 0 | 0.00% 0 | 0.00% 0 | 81.25% 13 | 18.75% 3 | 4.19 | 4.17 | 4.20 |
| | Current issues | 0.00% 0 | 0.00% 0 | 6.25% 1 | 81.25% 13 | 12.50% 2 | 4.06 | 4.17 | 4.00 |
| | Business environment | 0.00% 0 | 18.75% 3 | 75.00% 12 | 6.25% 1 | 0.00% 0 | 2.88 | 2.67 | 3.00 |
| | Users/stakeholders/ customers' opinions | 12.50% 2 | 62.50% 10 | 18.75% 3 | 6.25% 1 | 0.00% 0 | 2.19 | 2.83 | 1.80 |
| Goals of ERP switching/reversion | Budget (cost, time, manpower, etc.) | 0.00% 0 | 0.00% 0 | 0.00% 0 | 25.00% 4 | 75.00% 12 | 4.75 | 4.83 | 4.70 |
| | Solving current issues | 0.00% 0 | 0.00% 0 | 12.50% 2 | 43.75% 7 | 43.75% 7 | 4.31 | 4.67 | 4.10 |
| | Long-term performance | 0.00% 0 | 0.00% 0 | 12.50% 2 | 81.25% 13 | 6.25% 1 | 3.94 | 4.00 | 3.90 |
| | Short-term performance | 0.00% 0 | 18.75% 3 | 75.00% 12 | 0.00% 0 | 6.25% 1 | 2.94 | 3.00 | 2.90 |
| Decision-making strategy | Cost-benefit | 0.00% 0 | 0.00% 0 | 0.00% 0 | 50.00% 8 | 50.00% 8 | 4.50 | 4.33 | 4.60 |
| | Increasing system performance | 0.00% 0 | 0.00% 0 | 25.00% 4 | 56.25% 9 | 18.75% 3 | 3.94 | 4.33 | 3.70 |
| | Increasing business performance | 0.00% 0 | 6.25% 1 | 25.00% 4 | 62.50% 10 | 6.25% 1 | 3.69 | 3.83 | 3.60 |
| | Time-saving | 0.00% 0 | 6.25% 1 | 43.75% 7 | 31.25% 5 | 18.75% 3 | 3.63 | 4.17 | 3.30 |
| Assessment | Possible decisions | 0.00% 0 | 0.00% 0 | 0.00% 0 | 81.25% 13 | 18.75% 3 | 4.19 | 4.00 | 4.30 |
| | Potential impacts | 0.00% 0 | 0.00% 0 | 43.75% 7 | 43.75% 7 | 12.50% 2 | 3.69 | 3.83 | 3.60 |

## 4.4. Decision-making period

Decision-making period refers to the time period of executing the decision plan. Major topics in this period consist of the reasons of decision-making, critical issues, and procedures of decision-making. As Table 2 illustrated, the top three common reasons for ERP switching/reversion are the existing critical issues in the management processes, old ERP system, and ERP vendor. From the perspective of LEs, the existence of critical issues in the ERP vendor (4.11) is considered as the most important reason. The Needs of business innovation/restructuring (3.83) is considered as the third important reason by SMEs, meanwhile, Top management focuses on the new ERP trends (3.50) is considered as important as the Critical issues in the old ERP vendor (3.50).

Based on the findings of Huang [37], twelve critical issues are provided for participants to rate. The rating result from the highest to the lowest is in Table 3. There are a few differences in the view of SMEs and LEs separately. Overall, the issue of Integrate needs and the New system ability evaluation have the same ratings, however, from the perspective of SMEs and LEs, the latter is higher than the former. SMEs consider the New system ability evaluation issue (4.17) as the second important issue followed by the issues of Misfit (4.00) and Limited customer support (4.00). On the other hand, LEs only consider the issues of Limited customer support (3.11) as the eighth critical issue.

Ten important events during decision-making period are identified based on the secondary data in the following. Participants were requested to choose and sort those events based on their own experiences. The overall result is showed in Table 4, which is as same as the results of LEs.

From the perspective of SMEs, the procedure is "DAEFBCGIHJ", some difference occurs from step two to step six.

- (A) Build the decision-making group.
- (B) Evaluate the internal environment to understand the capacity (time, finance, people) of the organization and the budget.
- (C) Evaluate the external environment to understand the capacity (time, finance, people) of the organization and the budget.
- (D) Identify the current issues of the organization.
- (E) Identify the goals of the organization.
- (F) Recognize the tendency of the organization on IS and business to choose the suitable decision strategy.
- (G) Proposition of multiple decisions.
- (H) Proposition of one single decision.
- (I) Assess potential impacts of every considerable decision.
- (J) Compare potential impacts to principles, goals, capacity, etc. to decide the final adoption.

Table 2. Summary of the reasons of decision-making.

| | Lest imp. | Less imp. | Imp. | More imp. | Most imp. | Weighted Average | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Total (15) | SMEs (6) | LEs (9) |
| Critical issues in the management processes | 0.00% 0 | 0.00% 0 | 20.00% 3 | 66.67% 10 | 13.33% 2 | 3.93 | 4.33 | 3.67 |
| Critical issues in the old ERP system | 0.00% 0 | 0.00% 0 | 26.67% 4 | 60.00% 9 | 13.33% 2 | 3.87 | 4.33 | 3.56 |
| Critical issues in the old ERP vendor | 0.00% 0 | 0.00% 0 | 20.00% 3 | 73.33% 11 | 6.67% 1 | 3.87 | 3.50 | 4.11 |
| Needs of business innovation/restructuring | 0.00% 0 | 0.00% 0 | 46.67% 7 | 46.67% 7 | 6.67% 1 | 3.60 | 3.83 | 3.44 |
| Required by headquarters/collaborating organizations | 0.00% 0 | 0.00% 0 | 93.33% 14 | 6.67% 1 | 0.00% 0 | 3.07 | 3.17 | 3.00 |
| Top management focuses on new ERP trends | 0.00% 0 | 13.33% 2 | 66.67% 10 | 20.00% 3 | 0.00% 0 | 3.07 | 3.50 | 2.78 |

| | Lest imp. | Less imp. | Imp. | More imp. | Most imp. | Weighted Average Total (15) | SMEs (6) | LEs (9) |
|---|---|---|---|---|---|---|---|---|
| Recommendations from the consultant/vendor | 0.00% 0 | 60.00% 9 | 40.00% 6 | 0.00% 0 | 0.00% 0 | 2.40 | 2.83 | 2.11 |
| Required by the stakeholder/end-users | 40.00% 6 | 40.00% 6 | 20.00% 3 | 0.00% 0 | 0.00% 0 | 1.80 | 2.33 | 1.44 |
| Pushed by the pressure coming from the industry | 33.33% 5 | 60.00% 9 | 6.67% 1 | 0.00% 0 | 0.00% 0 | 1.73 | 1.50 | 1.89 |

Table 3. Summary of the critical issues related to the ERP switching/reversion.

| | Lest imp. | Less imp. | Imp. | More imp. | Most imp. | Weighted Average Total (15) | SMEs (6) | LEs (9) |
|---|---|---|---|---|---|---|---|---|
| Top management support | 0.00% 0 | 0.00% 0 | 0.00% 0 | 73.33% 11 | 26.67% 4 | 4.27 | 4.50 | 4.11 |
| Misfit | 0.00% 0 | 0.00% 0 | 26.67% 4 | 46.67% 7 | 26.67% 4 | 4.00 | 4.00 | 4.00 |
| Integration needs | 0.00% 0 | 0.00% 0 | 26.67% 4 | 73.33% 11 | 0.00% 0 | 3.73 | 3.83 | 3.33 |
| New system ability evaluation | 0.00% 0 | 0.00% 0 | 33.33% 5 | 60.00% 9 | 6.67% 1 | 3.73 | 4.17 | 3.44 |
| Limited customer support | 0.00% 0 | 0.00% 0 | 53.33% 8 | 46.67% 7 | 0.00% 0 | 3.47 | 4.00 | 3.11 |
| Vendor lock-in | 0.00% 0 | 0.00% 0 | 60.00% 9 | 40.00% 6 | 0.00% 0 | 3.40 | 3.67 | 3.22 |
| Data migration | 0.00% 0 | 0.00% 0 | 73.33% 11 | 20.00% 3 | 6.67% 1 | 3.33 | 3.50 | 3.22 |
| New business logic | 0.00% 0 | 0.00% 0 | 73.33% 11 | 26.67% 4 | 0.00% 0 | 3.27 | 3.33 | 3.22 |
| Issues from implementation strategy of old system | 0.00% 0 | 0.00% 0 | 86.67% 13 | 13.33% 2 | 0.00% 0 | 3.13 | 3.17 | 3.11 |
| New technology prevalence | 0.00% 0 | 0.00% 0 | 93.33% 14 | 6.67% 1 | 0.00% 0 | 3.07 | 3.17 | 3.00 |
| New risks | 6.67% 1 | 53.33% 8 | 26.67% 4 | 13.33% 2 | 0.00% 0 | 2.47 | 3.17 | 2.00 |
| Stakeholder/end-user management | 6.67% 1 | 73.33% 11 | 20.00% 3 | 0.00% 0 | 0.00% 0 | 2.13 | 2.50 | 1.89 |

Table 4. Summary of the procedures of the decision-making.

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| D | 86.67% 13 | 13.33% 2 | 0.00% 0 | 0.00% 0 | 0.00% 0 | 0.00% 0 | 0.00% 0 | 0.00% 0 | 0.00% 0 | 0.00% 0 | 15 |
| E | 0.00% 0 | 53.33% 8 | 46.67% 7 | 0.00% 0 | 0.00% 0 | 0.00% 0 | 0.00% 0 | 0.00% 0 | 0.00% 0 | 0.00% 0 | 15 |
| A | 13.33% 2 | 33.33% 5 | 33.33% 5 | 6.67% 1 | 13.33% 2 | 0.00% 0 | 0.00% 0 | 0.00% 0 | 0.00% 0 | 0.00% 0 | 15 |
| B | 0.00% 0 | 0.00% 0 | 13.33% 2 | 46.67% 7 | 20.00% 3 | 6.67% 1 | 6.67% 1 | 0.00% 0 | 0.00% 0 | 6.67% 1 | 15 |
| C | 0.00% 0 | 0.00% 0 | 0.00% 0 | 13.33% 2 | 46.67% 7 | 20.00% 3 | 6.67% 1 | 6.67% 1 | 6.67% 1 | 0.00% 0 | 15 |
| F | 0.00% 0 | 0.00% 0 | 6.67% 1 | 26.67% 4 | 6.67% 1 | 60.00% 9 | 0.00% 0 | 0.00% 0 | 0.00% 0 | 0.00% 0 | 15 |

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| G | 0.00%<br>0 | 0.00%<br>0 | 0.00%<br>0 | 6.67%<br>1 | 13.33%<br>2 | 0.00%<br>0 | 73.33%<br>11 | 6.67%<br>1 | 0.00%<br>0 | 0.00%<br>0 | 15 |
| I | 0.00%<br>0 | 0.00%<br>0 | 0.00%<br>0 | 0.00%<br>0 | 0.00%<br>0 | 6.67%<br>1 | 6.67%<br>1 | 60.00%<br>9 | 26.67%<br>4 | 0.00%<br>0 | 15 |
| H | 0.00%<br>0 | 0.00%<br>0 | 0.00%<br>0 | 0.00%<br>0 | 0.00%<br>0 | 0.00%<br>0 | 0.00%<br>0 | 26.67%<br>4 | 53.33%<br>8 | 20.00%<br>3 | 15 |
| J | 0.00%<br>0 | 0.00%<br>0 | 0.00%<br>0 | 0.00%<br>0 | 0.00%<br>0 | 6.67%<br>1 | 6.67%<br>1 | 0.00%<br>0 | 13.33%<br>2 | 73.33%<br>11 | 15 |

## 5. The A2O decision model

Based on the process model of Rasmussen's Cognitive Control of Decision Processes [32] and the survey results, a descriptive model with a rational process - A2O model - is proposed (see Figure 2). The name of 'A2O' is constructed with the first letter of three constituent parts of the decision model - the Action, the Object, and the Outcome. This decision model covers all the main actions, objects, and outcomes during a decision-making of ERP switching/reversion in the Decline stage, and indicates the logic interaction among them. The A2O model refined multiple decision-making related behaviors accumulated from the empirical survey into three categories which are the skill-based, rule-based, and knowledge-based behaviors proposed by the Rasmussen's Cognitive Control of Decision Processes. The information of real ERP switch/reversion projects provided by the organizations gives rich and firm details about the Action, Object, and Outcome. The Rasmussen's theory helps to concentrate and simplify all the details. As we can see in Figure 2, three actions, Self-evaluate, Assess, and Adopt, as major linkages connect and push the decision-making process. The objects of actions consist of Business & IT/IS, Internal & External Environment, Tendency, and Considerable Decisions, which generate four outcomes - Issues & Goals, Status & Capacity, Decision-making Strategies, and Potential Impacts. All the terms are selected or concluded from the empirical information of real ERP switch/reversion projects.
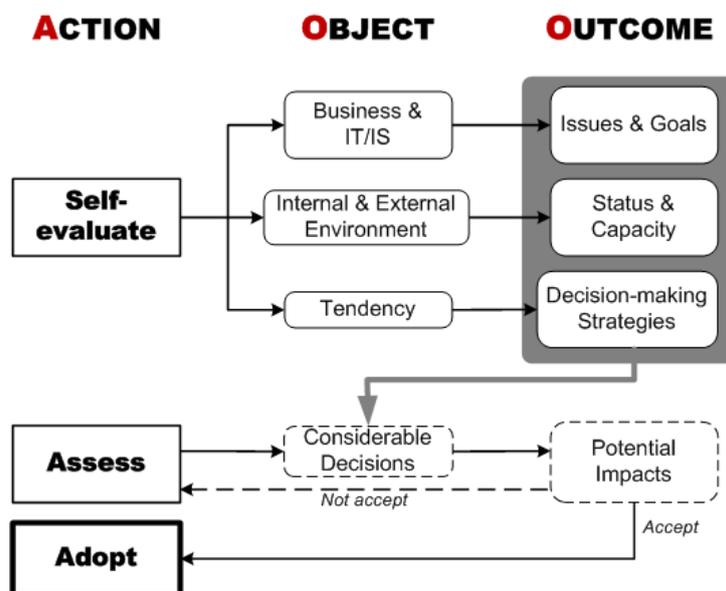


Fig. 2. The A2O decision model.

The flow of the A2O decision model starts at organizations' self-evaluation. The skill-based, rule-based, and knowledge-based behaviors are all indispensable during this event. The problems and needs of the business or IT/IS were usually accumulated during the operating period by regular staffs. The process of identifying the issues and goals belongs to the skill-based behavior. The process of evaluating the status and capacity of internal and external environment belongs to the rule-based behavior, which usually is done by specialists. Recognizing the tendency of decision-making strategies is the knowledge-based behavior, which requires a certain deeper understanding of the whole picture. The outcomes of self-evaluating determine the goals and principles of decision-making. According to the image theory of Beach [38], principles were defined as 'how things should be and how people ought to behave'. With the considerable decision plans, the next action - Assess - is for organizations to rethink and assess them to find the most suitable decision. The final action, the Adopt, represents the decision-making point, which is the ending of a decision-making process but also a beginning of implementing the decision.

*5.1. Action*

The action of Self-evaluate can be divided into three sub-actions - Identify, Evaluate, and Recognize. These terms originated from the Rasmussen's model. The sub-action of Identify underlines the specific facts people already noticed. The survey results indicate the top manager - one or multiple managers - who is in charge of the whole organization usually leads this action since after which the decision-making group is assembled in most organizations. The object of this sub-action is the business and IT/IS performance, of which the outcome is to identify issues and goals. In addition, there is a balance between 'what would I like to be' and 'what am I expected to be'. The former is the organizational perspective in which ideal visions and ambitions can be seen. On the contrary, the latter is the social perspective in which responsibility and contribution are required. This thinking requires a long-range perspective and more attention on long-term performance. Most importantly, all should under the feasible budget (cost, time, manpower, etc.) plan.

The sub-action of Evaluate is seeking conclusions from the phenomenon. According to the survey results, the subject of this action is usually the decision-making group. The object is the internal and external environment. The outcome is to pinpoint the current status and to list all possible inputs (capacity) to back up the upcoming changes. Organizations are surrounded by enormous data and information which reflect the condition of the internal and external environment. In this category, the business strategy and IT/IS strategy are the core thinking. Finding the limitation of organizations is a critical task in this action, such as manpower, capital, know-how, weakness, etc. By monitoring the variation of data and information, organizations can make the diagnosis of challenges and problems they are facing.

The sub-action of Recognize is an action that organizations try to assure the tendency on the decision-making strategy. The subject of this action is decision-making group. The object is the organization's tendency - a faster way to quantify the organization for measurement. The outcome is choosing the proper decision-making strategy. In order to make the best decision-making plan, it is necessary to understand the latest status of both system and business. A decision-making strategy consists of people, money, method, time, and most important - focus.

The action of Assess, contrarily, focuses on the potential possibility in the future which is also a key action to select optimal decision. The object is considerable decisions. The outcome is the possible impact of each decision's adaptation. After previous steps, organizations already have clear pictures about what are the problems, what do they want, and what can they devote. By comparing each potential impact of a decision to the principals, goals, and possible inputs, the best match as the outcome of this action is expected to be found. Until an acceptable match appears, the final action will not start.

The action of Adopt is a time point of agreement in organizations. All the members in decision-making group agree to one final decision, and the specific implementation plan of the decision is being prepared. This time point is considered to be the decision-making point.

*5.2. Object*

**Business and IT/IS**. In the organizational context, it represents both the visible and invisible side of an organization which organizations should review for identifying current issues and goals. The visible side refers to the business performance and the system performance. Current issues can be observed from this side. The invisible side, in other words, refers to the organizational culture. Some of the cultures are the rules that organization is based on, and some of the cultures are the habits of doing things for a long time. As large as the scale of organization is, the more diversity of organizational culture is getting into, which has a great impact on generating the goals.

**Internal and External Environment**. Ward et al. [39] summarized the stimuli that may affect aims of planning into four categories: the External Business Factors, the External Technology Factors, the Internal Business Factors, and the Internal Technical Factors. Specific activities were instanced in the External Technology Factors and the Internal Business Factors, which indicates that the internal factors dominate the business environment and the external factors dominate the technology environment. The internal and external environment, in general, includes the IT-business alignment, business environment, and the users/stakeholders/customers' opinions. The survey results indicate LEs consider the IT-business alignment most important. One reason is that a better IT-business alignment in LEs is more different to reach than in SMEs since the larger scale of both IS and the organization will increase the complexity.

**Tendency**. According to this research, there are usually two kinds of tendency involving the decision-making in the decline stage related to ERP switching/reversion. First, the business-based internal adjustment, which refers to organizations focus more on internal business. By using IS/IT as an auxiliary, they intend to make business innovations to achieve long-term success. Second, the technology-based external adjustment, on the contrary, focuses on external technological development. Technology-based innovation - adjusting the business to fit into new IS/IT - is the main source to gain competition. No matter organizations tend to prefer the business gain or the technological advantage; in spite of having successful decision-making consciousness, a rational cost of the decision-making should also be taken into consideration.

**Considerable Decisions**. Based on organizations' self-evaluation, organizations should have listed their own considerable decision(s) related to ERP switching/reversion. Huang [11] suggests the terms of the Decommission and the Life Extension describe this period in the Decline stage. Overall, besides the actual case of decisions, other considerable decisions go into the following categories (Table 5).

Table 5. Considerable decisions.

| | Considerable Decisions | Description |
|---|---|---|
| Decommission | New system old vendor | Retire the old system and implement the new system with the old vendor. |
| | New system new vendor(s) | Retire the old system and implement the new system with the new vendor(s). |
| | Home-made system | Retire the old system and build a new system from the scratch on one's own. |
| | Returning to the former system | Retire the old system and return to the former system. |
| | No system | Retire the old system with no new system implementation or new technological outbreak in another level. |
| Life Extension | Working with the current vendor | Prolong the life of the current system with old vendor. |

It is hard to image organizations which have experiences of using IS system choose to not use any information system at all. However, as long as the percentage of possibility is not zero, it is still worth to look into. Two possible thinking of no system which is completely opposite is the traditional thinking and the Big-Bang thinking. The former one has its advantages, after all, the history of business with IS/IT is way shorter than the traditional business history. The later one

has its possibility, which higher technology, such as Cognitive Radio [40], Brain-Computer Interfacing [41], Brain to brain communication system [42], etc., will end the current era of IS/IT.

*5.3. Outcome*

**Issues and Goals**. There are two types of goals and issues in organizations - the short-term ones and the long-term ones. In this context, the goals and issues here tend to be the long-term ones, which are harder to be achieved and solved. Generally speaking, business strategy and IT/IS strategy are considered to be an essential core in organizations [43]. The goals can be seen as a simplified result that organizations can get by using those strategies. Organizations can choose any strategies as long as the desired result can be achieved. Goals also contain the aims of solving the current issues in business and IT/IS. According to the results of this survey, we have an overall image of issues and goals of organizations facing ERP switching/reversion. Cost reduction is the primary goal which also contains refining the accountant processes. Beside of solving various issues, the expected long-term performance by SMEs and LEs is a little different. In particular, based on the secondary case data, SMEs focus more on the flexibility of new ERP system to deal with the variation of the market; LEs, on the other hand, focus more on internal management control/reconstruction and overseas expansion.

**Status and Capacity**. By evaluating the internal and external environment, the status and capacity of organizations can be estimated. The status refers to the business and system performance, the IT-business alignment, opinions of the various end-users, business environment, etc. the capacity represents the financial/managerial/technical strength of organizations. During the survey, LEs considers the status of IT-business alignment should be paid the most attention to. However, a qualified tool for assessing it is missing in nearly all cases, and only critical issues related to the system and business performance are usually used. The survey results also point out that organizations pay less attention to the business environment and end-users' thoughts in the Decline stage.

**Decision-making strategies**. It means how do organizations tend to make decisions. Generally, organizations can use the most common decision-making method to get the destination. However, the costs will vary. Apparently, organizations should put more efforts on self-evaluation, and build specific decision-making strategy based on what they have got. Indeed, the survey results also confirmed that most organizations put the cost-benefit first, and then choose the tendency of technology-focused or business-focused. For some SMEs, the time-saving also takes a large part in their decision-making strategies.

**Potential Impacts**. Since choosing one decision means giving up other possibilities, calculating potential impacts is one kind of risk management. In order to find out the optimal decision, a pre-analysis on potential results is expected. Although organizations may have their own checkpoints, common items are including of budget, human resource, time, benefit, productivity, competitiveness, flexibility, vendor's strength, etc. According to the case data, only four organizations had a single option from the beginning, and other eleven organizations all experienced the assessing process to assess multiple ERP packages from two to ten vendors.

## 6. Implications

*6.1. Fulfill the blank of ERP life cycle theory*

A decade before, when most organizations are in the implementation, use, or maintenance stage, the existence of the Decline stage is not even in the consideration by the majority both in practice and academy. Even now, there are IS professionals who still question the authenticity of the Decline stage. Hence, one of the implications of this research is finally fulfilling this blank in the ERP life cycle. Different from the expectations of most IS professionals that the ERP life cycle ends with contentiously improvement and transformation [7], the coming of the Decline stage is unavoidable. In fact, an unsuccessful ERP implementation project is rarely the main reason of ERP abandonment [18], organizations make decisions about ERP switching/reversion in the Decline stage based on unsolvable critical issues in the management processes, the ERP systems, the ERP vendor, the needs of business innovation, etc. The benefits and features of new ERP trends, such as Cloud ERP and Mobile ERP, also play important parts during this accelerated

process. In the Decline stage, organizations conduct various self-assessments to pinpoint the critical issues before and to plan the new goals for the future, prepare themselves for the next ERP life cycle, and make decisions to choose, design, adopt, or perfect the new ERP systems. It is far more complicated than the pre-implementation phase for the first time. As a matter of fact, the pre-implementation and implementation phase in the traditional ERP life cycle theory are occurring and finished during the Decline stage, according to the empirical evidence. In other words, the pilot test of new ERP system usually starts in parallel with old ERP systems, and then the new ERP system officially goes live at the beginning of the new ERP life cycle.

*6.2. Explore the critical issues in the Decline stage*

In general, single research issue of ERP management in organization context disperses in independent research, and only is combined with literature reviews [44]. One major serial studies focused on implementation, management, support, and impact issues of ERP [45-51] was conducted through a Delphi method, in which ten major issue categories along with traditional ERP life cycle were highlighted. However, the high-count issues [49] show that the focus of researcher is still concentrating on the pre-implementation and implementation stage of ERP life cycle [44]. On the other hand, although many researchers have shown their concerns on the post-implementation phase, only two studies have paid attention to the issues in the Decline stage. As a research agenda seventeen years ago, Esteves and Pastor [18] suggested five issues in the Decline stage. Huang [37] pinpointed thirty-seven critical issues of seven categories in the Decline stage theoretically through a Delphi survey. Hence, another important implication of this research is to provide the empirical supports on exploring the critical issues in the Decline stage. As we can see from the results, Top management support, as a classical IS key issue, is still considered by organizations as the most critical issue. The next critical issues focus on the alignment between system and business. The evaluation of new ERP system is considered more important by SMEs. Issues related to the vendors are also in the top five critical issues. On the contrary, new trends [18, 37] and new business logic [37] which are considered as top issues, in theory, are not given much more value by organizations. Key issues identified can help organizations shaping their way of management in the Decline stage and choosing the next ERP system wisely.

*6.3. Reveal the reality of ERP switching/reversion*

One reality of ERP switching/reversion is that the average implementation period is about one year which is far more short than the first ERP implementation. Organizations, consultants, and vendors have more experience than before is one important reason, and another reason is the technological development which provides less cost and more efficiency. Although the time period varies due to the different size and business of organizations, another reality is that culture factor plays a more important role in ERP switching in non-English-speaking countries. Findings of this research show that most organizations chose domestic ERP system for the second time in Japan due to various reasons, such as the language problem, the different financial rule, the unique business practice, the inconvenient customer support, etc. With the rapidly technological developing, the difference of technological strength between traditional major foreign ERP vendors and domestic ERP vendors is shrinking. Also, organizations of ERP reversion not only adopt the newest version of the ERP system, more of them choose the new types of platform, such as cloud and private cloud. Those realities in the Decline stage might enlighten ERP vendors on product development and customer service. For consultants, it is more helpful to know the real needs of organizations for suggesting suitable products. For the organizations that have not introduced any ERP system yet, realize the experiences of other organizations can also help to conduct a rational plan.

*6.4. Provide a practical decision model for organizations*

The A2O decision model is based on the empirical experiences of organizations that have already gone through the whole process of ERP switching/reversion. As a process model, organizations and consultants can easily adopt the A2O model in practice or for reference. The part of self-evaluation is usually done without systematic method or procedure. Generally speaking, various issues in the system and routine business were accumulated in the managers of each department from time to time, which will become the primary goal in the end. This research also points out the insufficiency of internal and external environment evaluation, especially the lack of tools for continuously self-

evaluating on IT-business alignment, such as the Issue-based ERP Assessment Model [52]. Meanwhile, a definite and efficient decision-making strategy is also rare in most cases. All of these provide more research opportunities for researchers to look deeper.

*6.5. Build the foundation for researchers interested in this period*

This research is the only first step in exploring the Decline stage of ERP life cycle. Contrary to the number of organizations adopted ERP system for the first time, the sample is relatively small, and only in one country. Is there any difference in the Decline stage in English-speaking countries or between developing and developed countries? Are there other utility decision-making models? Are there other critical issues in this period and how they vary with time, region, or industry? What are the critical factors that lead to the ERP switching/reversion? What about the third time? Does the Decline stage exist in the SaaS? There are still many unsolved research questions might interest researchers. As the first example, this research explores one side of this period and builds a certain theoretical and practical foundation for other researchers who may interest in this topic.

## 7. Conclusion

By adopting the questionnaire survey and secondary data, this research aims to explore the reality of organizations in the Decline stage of ERP life cycle and to form a practical process decision model for organizations faced ERP switching/reversion. In order to cover the key events in the Decline stage, the survey is designed to consists of Basic information, Experienced ERP projects, Preparations for decision-making, and Decision-making period, of which the data is also analyzed for learning the difference between SMEs and LEs. Based on the process model of Rasmussen's Cognitive Control of Decision Processes and the survey results from eighteen experienced organizations, a descriptive model with a rational process - A2O model - is proposed. The A2O decision model covers all the main actions, objects, and outcomes during a decision-making of ERP switching/reversion in the Decline stage, and indicates the logic interaction among them. In regarding to the research question, the proposed model provides a sound method for making decisions related to switch the ERP system. Three actions - Self-evaluate, Assess, and Adopt, as major linkages, connect and push the decision-making process. The objects and outcomes of Self-evaluate action need more attention and time period to be thought about regardless the sequence of them. To Assess the Considerable Decisions and get the Potential Impacts before decision-making is also very crucial.

One of the theoretical implications of this research is fulfilling this blank in the ERP life cycle. Another important theoretical implication of this research is to provide the empirical supports on exploring the critical issues in the Decline stage. Key issues identified can help organizations shaping their way of management in the Decline stage and choosing the next ERP system wisely. Organizations and consultants can easily adopt the A2O model in practice or for reference. From the practical perspective, the revealed realities in the Decline stage might enlighten ERP vendors on product development and customer service. For consultants, it is more helpful to know the real needs of organizations for suggesting suitable products. For the organizations that have not introduced any ERP system yet, realize the experiences of other organizations can also help to conduct a rational plan. Some limitations of this research remain. One of them is the scope of the survey sample. Similarly, the sample with geographical limitation also restrained the possible variety. The questionnaire was responded by one staff of each organization, which might bring certain subject opinions related to the decision-making period. Nevertheless, as the first example, this research explores one side of this period and builds a certain theoretical and practical foundation for other researchers who may interest in this topic. There are still many unsolved research questions might interest researchers and more research opportunities for researchers to look deeper.

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# To schedule or not to schedule? An investigation of meetings as an inter-team coordination mechanism in large-scale agile software development

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**Abstract:**
Coordination of teams is critical when managing large programmes that involve multiple teams. In large-scale software development, work is carried out simultaneously by many developers and development teams. Results are delivered frequently and iteratively, which requires coordination on different levels, e.g., the programme, project, and team levels. Prior studies of knowledge work indicate that such work relies heavily on coordination through "personal" modes such as mutual adjustment between individuals or through scheduled or unscheduled meetings. In agile software development processes, principles and work structures emerge during the project and are not predetermined. We studied how coordination through scheduled and unscheduled meetings changes over time in two large software development programmes relying on agile methods. Our findings include transitions from scheduled to unscheduled meetings and from unscheduled to scheduled meetings. The transitions have been initiated both bottom-up and top-down in the programme organizations. The main implication is that programme management needs to be sensitive to the vital importance of coordination and the coordination needs as they change over time. Further, when starting a program, we recommend to early identify the important scheduled meetings, as having enough scheduled meetings is important to develop a common understanding of domain knowledge.

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## 1. Introduction

Coordination of work teams are of critical importance when managing large projects that involve multiple teams. Multi-team projects are used in many domains, often to "achieve high quality innovations in a satisfactory time-to-market" [1], and in such programmes "hundreds of people may be required to develop components of a new product simultaneously" (ibid). In large innovative projects, the degree of complexity and uncertainty is high, as the work executed in teams is influenced by the work and inputs from other teams. As a consequence, choosing the right coordination practices is important, as they have significant influence on information sharing, work flow fluency between teams, efficiency of the project, and learning outcomes [2]. In an editorial in the Journal of the Association for Information Systems arguing for research on programme management, Jiang et al. [3] raise the question of how interdependencies among projects can be leveraged to improve coordination.

Much of the resources used on innovations today are used on software development. Coordination was early identified as a particular challenge in software development projects. In the 1990s, software projects were often associated with overruns on time and cost, and many referred to a "software crisis". As Kraut and Streeter [4] state, "While there is no single cause of the software crisis, a major contribution is the problem of coordinating activities while developing large software systems". Since then, new methods for software development have been suggested, what is referred to as agile software development [5, 6]. The practices in this field have also inspired the project management discipline [7]. These methods were, however, intended for small, self-managing and co-located teams. Nevertheless, the popularity of these methods has spurred their use also in large development programmes [8].

Coordination in large-scale software development is of paramount importance, since the work is carried out simultaneously by many developers and development teams. Delivering results frequently and iteratively requires work and knowledge coordination on different levels, e.g., the programme, project, and team levels. Additional supporting roles are critical in large-scale projects for managing the exponential growth of interdependencies and mitigating associated risks [9]. In such projects, interdependencies are more uncertain than in small projects; therefore, teams need to know who the experts are and which experts to coordinate work with, particularly when they are outside the team or even at a different site. Dingsøyr et al. [10] describe 14 mechanisms for inter-team coordination in a large-scale software project. Further, agile methods are emergent [11], which means that processes, principles, and work structures emerge during the project rather than being predetermined. As a consequence, how an agile project is coordinated changes during a project. Therefore, to understand coordination in large-scale agile projects there is a need to study coordination over time.

Van de Ven et al. [12] propose three coordinating modes: by programming or codification (impersonal mode), and coordination by feedback on the individual (personal mode) or on a group level (group mode). In the case of high uncertainty in multi-team projects, the work relies heavily on coordination through group mode [2]. This article examines the use of the scheduled and unscheduled meetings (group mode) in large-scale agile development programmes. We analyse how coordination through scheduled and unscheduled meetings change over time in two large software development programmes that make use of agile development methods. We ask the following research question:

*How do inter-team group mode coordination mechanisms change over time in large-scale agile development?*

In answering this research question, this paper presents results from two case studies on large-scale agile software development programmes. In both cases, albeit, in different ways, coordination mechanisms break down, are tested, and become established over time. In this sense, based on our study, coordination mechanisms are not stable but dynamic and are always in the making through the lifetime of a project. Especially in terms of coordination mechanisms for the group mode, this is important in large-scale agile software development programmes. In more practical terms, for project managers, we argue that it is not only important to be aware of how to organize a project in a start-up phase but also to continuously evaluate and change coordination mechanisms over time as the project is progressing. As such, new coordination mechanisms may emerge out of the practise of project participants in a bottom-up fashion, or they

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may be established top-down by project managers. Our cases show that different strategies are followed at different stages or phases in the project depending on the problem situation at hand.

The remainder of the paper is organized as follows. Section 2 outlines related work. In Section 3, we describe our research methodology. In Section 4, we present our findings from the cases and cross-case analysis, which are further discussed in Section 5. Finally, Section 6 concludes the paper with a summary of major findings. This article is a revision and extension of Dingsøyr et al. [13].

## 2.    Coordination in large-scale agile software development

### 2.1    Coordination in agile project management

Software development projects are often complex undertakings that involve multiple interdependencies between resources, tasks, teams, roles and various software components and systems [14]. IT projects as a particular category of projects often imply blurred boundaries with other projects that require specific coordination [15]. Therefore, it becomes essential for project managers to pay attention to and implement means for efficient coordination. Important in relation to coordination, is the difference between traditional project management approaches and more agile approaches. Whereas traditional approaches typically focus on formal coordinating mechanisms through a pre-defined process, precise and in-depth documentation, and high levels of specialization in role assignments [16], agile approaches tend to favour self-management (teams determine the best way to handle work), emergent processes (processes, principles, and work structures emerge during the project rather than being predetermined), and more informal coordinating mechanisms [11]. Coordination in agile projects will therefore change over time. Although software development today is primarily conducted using agile methods [6], also agile approaches to project management involve coordination challenges – especially in larger projects and programmes [17]. As shown in recent literature on agile project management, agile projects involve specific challenges related to coordinating and communicating with multiple stakeholders as agile development often require frequent releases and collaboration with customers [18]. Also, in large-scale agile projects the more informal approach to coordination can become challenging [23]. Moreover, recent studies suggest that organizing projects in larger programmes may help solving some of the coordination problems across different projects [15].

### 2.2    Coordination and coordination modes

Software development teams must coordinate the efforts of those who are part of the process, as well as ensure coordination with suppliers, clients, and other groups both outside and inside the organization. The team has to make sure that the work is complete and fits together, there is no duplication and components of the work are handed off expeditiously [4].

A widely used definition of coordination is Malone and Crowston´s: "Coordination is managing dependencies between activities" [19], published in computer science. This definition emphasize dependencies, which are the constraints on action in a situation.  Van de Ven et al. [12], from the field of sociology, define coordination as "integrating or linking together different parts of an organization to accomplish a collective set of tasks". Because Van de Ven et al. focuses on the coordination of different parts of an organization (e.g., linking teams), their model is highly suitable in this case study, where the focus is coordination in multi-team programmes.

Coordination in large-scale projects is exercised through several mechanisms [2]. Van de Ven et al. [12] propose three coordinating modes: by programming or codification (impersonal mode), and coordination by feedback on the individual (personal mode) or on a group level (group mode). Once implemented, the impersonal coordination mechanisms are codified and require minimal verbal communication between people. Examples include pre-established plans, process documentation, intranet pages and roadmaps. Coordination by mutual adjustment or feedback is based on informal communication. In the personal mode, individual role occupants serve as the mechanism for making mutual task adjustments through either vertical or horizontal channels of communication. The mechanisms for vertical communication are usually line managers. In the group mode, the mechanism for mutual adjustment is vested in a group

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of role occupants through scheduled or unscheduled meetings. In projects with high task uncertainty (like in a software development project) there is a need for an extensive and dynamic knowledge exchange between and within teams to solve problems and adjust for emerging changes [20]. The scheduled meetings are therefore effective because physical proximity allows richer communication, which enables swifter and more flexible coordination [21]. Dietrich [2] also points to prior studies that found that technological novelty relates to a higher rate of group meetings instituted by management. As a consequence, planned and unplanned meetings (group mode) are important in large complex projects. Scheduled meetings are typically used for routine meetings, involving planned communication, while unscheduled meetings are used for unplanned communication between more than two participants.

### 2.3 Group mode in large agile projects

Relying on group mode for coordination is challenging when scaling a project. In large software projects, group mode can take part within teams, between group of managers or groups of team representatives acting on behalf of their teams. Through a project hierarchy it is possible to achieve a kind of layered mutual adjustment, but only with strong elements of hierarchy and bureaucratic control [21]. A key challenge with layered mutual adjustment is that it is not always clear who should be involved in which coordination activities.

In agile software development, group mode coordination by scheduled meetings at the team level is ensured through practices like iteration planning meetings, daily meetings, iteration demonstration meetings and retrospectives [22-24]. Scrum, a project-management-oriented agile development method, was inspired by a range of fields, such as complexity theory, system dynamics, and Nonaka and Takeuchi's theory of knowledge creation [25]. In Scrum, a self-managing team develops software in increments (sprints); each sprint starts with a planning meeting and ends with a retrospective and a review meeting. The team coordinates on a daily basis through a 15-minute daily Scrum (a daily reporting and discussion meeting) [26, 27]. Features to be implemented are registered in a product backlog, and a Product owner decides which backlog items should be developed in the following sprint. The product backlog comprises a prioritized and constantly updated list of business and technical requirements for the system being built or enhanced. Multiple stakeholders, such as clients, project teams, architects, designer, marketing and sales, management, and support, can participate in the planning phase (usually through meetings) to identify the product backlog items. During the planning meeting (usually every second, third or fourth week), the Product owner is responsible for presenting a prioritized product backlog to the team. The highest priority items from the product backlog are then detailed in a sprint backlog during a team-planning meeting. Because the team and the Product owner is responsible for defining and improving coordination practices, agile can be understood as a bottom-up approach to coordination.

Group mode coordination by unscheduled meetings is ensured at the team and inter-team level by team members and teams sitting together in the same office. Strode et al. [22] found both unscheduled cross-team talks and backlog specification meetings emerged as a result of co-location. Similarly, Nyrud and Stray [28] observed that informal and ad hoc conversations emerged in a large-scale web-program as a result of teams being co-located in an open office. While open office is an enabler for unscheduled meetings and many scheduled meetings and forums increase the amount and frequency of communication between teams, Smite et al. [29] found that it was difficult to have unplanned meetings because of too many scheduled meeting and a lack of meeting rooms.

In a large-scale setting the most common strategy for coordination across several teams is Scrum of Scrum. Scrum of Scrum is a scheduled meeting were one team-member acts as "ambassador" to participate in a daily meeting with ambassadors from other teams. However, Scrum of Scrum has been found to be inefficient in larger projects [30, 31]. As a consequence, agile consultants have created several frameworks for scaling agile, such as the Large-Scale Scrum (LeSS) [32] and Scaled Agile Framework (SAFe) [33]. The LeSS framework offers less structure and gives suggestions, tools and tips of practices that can be used for coordination, such as communities of practice and scheduled multi-team meetings. In the LeSS, any team or team member should be able and expected to reach out to another team if there is an issue to be solved (both through scheduled and unscheduled meetings). The LeSS can be understood as a bottom-up coordination approach of coordination. The SAFe is a more structured way of organizing the work, this includes, e.g., a common release calendar with joint programme increment planning days. Thus, the SAFe seems to

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create a structure with more organizational control, which might leave less flexibility for meetings to emerge and for teams to take the initiative for coordination. The SAFe can be understood as a more top-down approach to coordination.

## 2.4 Coordination over time

In large-scale projects coordination mechanisms seem to change over time as involved actors need to solve new problems implicating previously unknown interdependencies [31]. In conceptualizing such dynamic processes of coordinating, Jarzabkowski et al. [34] suggests that new coordination mechanisms are gradually established through existing social practices of coordinating. Hence, all elements of a coordinating mechanism do not exist prior to coordinating – but is rather bootstrapped out of coordinating itself. So, for example, in a large-scale agile project using meetings to coordinate activities in different developments teams (Scrum of Scrums), new forms of coordinating may emerge out of participants' practices when they discover absences in the current coordinating mechanism. Arguably, this is what often happens in large-scale agile projects that start off with simple coordinating mechanisms in Scrum (daily meetings, demos, sprint planning, Scrum of Scrum, etc.) only to discover that multi-team projects (e.g., [30, 31]) often require additional mechanisms for coordinating, for example architecture meetings across teams, upfront meetings involving both customer and software provider, and communities-of-practice. Moreover, the complexity of large-scale agile projects typically involves unintended changes, twists and turns that may "disrupt" existing coordination mechanisms making them obsolete. More concretely, based on their qualitative study of coordination mechanisms, Jarzabkowski et al. [34] develop a process model consisting of five cycles that describe how coordinating mechanisms are 1) disrupted by external events, 2) absences are discovered, 3) new elements of coordinating are created, 4) new patterns of coordinating are established, and 5) stabilizing patterns of coordinating.

## 3.  Method

This study builds on two broad case studies of large-scale development programmes, Alpha and Beta, which investigates how agile methods were adapted in the very large scale. Changing or introducing new ways of coordinating work requires changes at the procedural, structural and even strategic level. Such organizational changes take a relatively long time [35]. Therefore, to understand coordination in a large-scale agile project we have studied how coordination changes over time in the two case studies. Previous studies [17, 36] show how large development programmes dealt with method tailoring, technical architecture, customer involvement and inter-team coordination. We have taken material from two cases and further analysed our data material on coordination, focusing on the use of the group mode (see characteristics of the programmes in Table 1).

Alpha was chosen because practitioners described it as a successful, very large programme that used agile development methods to a large degree. The whole programme was co-located, and coordination mechanisms could be studied in a setting that is well suited for agile methods. The Alpha programme developed a new office automation system for a public department. The programme was managed by the department and involved two main consulting companies as subcontractors in the project development.

Beta was selected as one of Norway's largest IT-programme with an extensive use of agile methods and was partly co-located. The programme involved complex integration among a wide variety of internal and external information systems, involving various stakeholders with divergent interests. Moreover, before starting Beta, the supplier, an international consulting company, had been part of Alpha.

Our study draws on the established tradition with theoretically informed interpretive case studies in information systems [37, 38] and hence aims at following relevant guidelines for such research [39, 40].

## 3.1 Programme context and delivery model

Both programmes were planned according to a model based on PRINCE2 [41] with distinct phases. The programmes included projects for architecture, business, development and test with project managers. At Alpha, the development

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project was split into three subprojects, two managed by external consulting companies and one managed by the customer itself. An external consulting company was managing the Beta programme, and there was less involvement from the customer. In both programmes, the software development was conducted using the agile development method Scrum with an iteration length of three weeks. This meant that there would be a demonstration of the product every three weeks, and teams made detailed plans for three-week iterations. Each team was physically placed around a table, with a board showing progress on one side and with space for making notes during discussions on the other side. In both programmes, the teams were physically co-located. The delivery model included the following four phases:

- *Analysis of needs* - This phase started with a walkthrough of the target functionality of a release and identification of high-level user stories. Product owners prioritized the product backlog.

- *Solution description* - The user stories were assigned to epics, and the user stories were described in more detail, including design and architectural choices. User stories were estimated and assigned to a feature team.

- *Construction* - Development and delivery of functionally tested solutions from the product backlog, with five to seven iterations per release.

- *Approval* - A formal functional and non-functional test to verify that the whole release worked according to expectations. This included internal and external interfaces as well as interplay between systems.

To keep the schedule, solution descriptions needed to be ready in time for the teams. This meant that releases were constantly being planned, constructed, and tested (Approval phase). Thus, a team would constantly be engaged in construction for release n, approving delivered functionality in release n-1, and analysing needs for the next release (n+1).

Table 1. Characteristics of the *Alpha* and *Beta* programmes.

| Characteristic | Alpha programme | Beta programme |
|---|---|---|
| Number of people involved at the most | 175 | 120 |
| Number of development teams | 12 | 5 |
| Employees in customer organization | 380 | 7 000 |
| Duration | 5 years | 4 years |
| Product releases | 12 | 3 |

## 3.2 Data collection

Our data collection started when the programmes were finished, using individual interviews in Beta, group interviews in Alpha and internal and external documents for both cases as shown in Table 2. We analysed the material in a tool for qualitative analysis, focusing on reporting findings related to group mode coordination and how it changed over time.

Table 2. Data collection from the Alpha and Beta programmes.

| Data source | Alpha programme | Beta programme |
|---|---|---|
| Individual interviews | 0 | 27 |
| Group interviews | 9 two-hour interviews with a total of 24 participants | 0 |
| Documents | External experience report | Tender documents |
| | Internal experience report | Project documents such as plans and scope |
| | | IT-strategy documents |

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*3.3   Data analysis*

We imported all interview transcripts and documents into tools for qualitative analysis and did a descriptive and holistic coding [42] of the topic coordination. Units of text ranged from sentences to whole pages and were coded into topics such as "Scrum of Scrums", "daily meetings", "table discussions", "ad hoc conversations" and "coffee breaks". The results were presented and discussed with the rest of the research team. Given the various topics and backgrounds of the researchers, the level of detail in the coding varied between the research teams.

## 4.   Results

In both Alpha and Beta, group mode coordination took place through a number of scheduled meetings as well as unscheduled meetings shown in Table 3. Both types of meetings were seen as important, as one said,

*"I think the combination of scheduled and unscheduled coordination that just appeared was very important" (Scrum master and developer, Alpha).*

We first describe scheduled meetings at the programme and project levels. The programme consisted of several sub-projects. We report on scheduled meetings common for both Alpha and Beta, and those that only existed in one of the programmes. Then, we repeat the structure for unscheduled meetings. We do not describe meetings that only included one team (e.g., Daily Scrum, Retrospective, and team coffee breaks).

Table 3. Examples of scheduled and unscheduled meetings in programmes Alpha and Beta.

| Examples of meetings | | Alpha | Beta | Description |
|---|---|---|---|---|
| Scheduled | Metascrum | X | X | A regularly meeting with project managers from the development, architecture, test and the business projects, as well as subproject managers from the development projects. |
| | Scrum of Scrums | X | X | Scrum of Scrum meetings several times a week. One team-member act as "ambassador" to participate with ambassadors from other teams. Scrum masters and project manager attended, and sometimes stakeholders such as product owners and test managers. |
| | Bug board | X | X | Meeting to discuss errors identified and agree on which to correct, and which team should be assigned to do the correction. Test manager, test responsible and sometimes also developers participated. |
| | Architecture meeting | X | X | A regularly meeting for the architects discussing the overall software architecture, establishing architectural guidelines, and for coordinate work between the teams. |
| | Product owner meeting | X | X | A regularly meeting for the Product owners. |
| | Lunch seminars | X | | Seminar where 2–3 people gave short presentations during lunch on topics such as new architectural components, project management or on how to follow up on a team. |
| | Subproject meetings | X | | Meetings within the subproject. |
| | Open Space | X | | A process where all participants suggested topics for discussion, which is made into an agenda and participants are free to join discussion groups of interest. Used per release during parts of the project. |
| | Experience forum | X | | A meeting forum at one subcontractor for Scrum masters, development manager and agile coach focusing on development method. |
| | Ready-to-sprint meeting | | X | Members from different teams to coordinate and uncover interdependencies involved in the following sprint. |

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| Examples of meetings | | Alpha | Beta | Description |
|---|---|---|---|---|
| | Task force | | X | Individuals grouping together across teams in order to solve technical problems. |
| Unscheduled | Coffee breaks | X | X | Unscheduled meetings at the coffee machine. |
| | Discussions on team tables | X | X | The teams were organized around tables. Many discussions emerged at the team tables both with team members and team-external people. |
| | Spontaneous Discussions in open work area | X | X | The project with all teams and project management was situated in an open-plan office space. Many of the decisions made in the project were discussed between relevant stakeholders informally in the open work area and then and then officially decided upon in one of the scheduled meetings. |
| | Group chat tool | X | | Instant messaging to all participants was set up after a need was identified in an open space session. Was used for open technical questions but also for social activities such as wine lottery. |

## 4.1 Scheduled meetings

At the programme level, the only arena where everyone would meet was at the demonstration meetings, which were held every three weeks. In addition, the programme management met two times a week in a forum, which was called "Metascrum". The Metascrum included managers from the main projects and the central programme management, giving attention to "high-level" obstacles to progress and the assessment of risks in the programme. At Alpha, a new arena was introduced well into the programme, the "open space technology". Open space was a way to motivate the whole programme to discuss challenges and improvement initiatives. This included both technical and business topics that people thought «we need to discuss». One result from the open space sessions was that the programme started using a group chat tool, Jabber, described under unscheduled meetings.

In addition, there were separate meetings to identify dependencies in tasks before work was assigned to teams. At Beta, the meetings varied over the nearly four years of development, but meetings concerning overall software architecture, project managers meeting, and project owners meeting were conducted regularly. These meetings involved participants from both the Consultant Company and the Customer. In the later part of the programme, a meeting referred to as the "Bug Board" was also established to coordinate actions for solving critical problems on technical issues, mercantile issues or processual issues.

In Alpha and Beta, at the project level, there were three main types of scheduled meetings: meetings prescribed by the agile method Scrum, meetings in the main projects in the programme, and meetings in fora at the project level to share experiences across the development teams.

Scrum of Scrums were held in the three development subprojects at Alpha and in the main programme at Beta with Scrum masters and subproject managers from 3-6 development teams. Project managers sometimes participated in these meetings. One subproject at Alpha had daily Scrum of Scrum meetings in the beginning but reduced the frequency to three times per week. In this meeting strategic decisions were taken, e.g., on resources. One subproject manager gave an example of a typical discussion in the Scrum of Scrum meeting:

*"Now we have two people who are ill in the team, and we have given away a person to the environment team, how shall we manage to deliver our stories in the iteration?"*

In addition, retrospectives were sometimes held across teams in the subprojects, but overall this was an activity within each team.

In Alpha, the projects architecture, business and test had meetings with their own staff and the people who held roles in the development teams. In the business project, much of the work concentrated on managing dependencies, "there were

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dependencies throughout the program" (technical architect). One of the participants in meetings in the business project said,

*"When we talked to the product owner, the product owner said, 'we need you to do this', but then we had to explain that to achieve that we first need to do these tasks" (functional architect).*

The meetings in project architecture focused on establishing architectural guidelines but also focused on coordinating work amongst the development teams to reduce the number of teams working on the same part of the codebase. "This was to reduce the possibility of making trouble for each other - which we did". The codebase was organized to reduce these challenges and in meetings teams declared that "this is our central area of work this period, so please limit work in that area" (technical architect).

In Beta, several other meetings for coordinating across teams and roles were also established in the later parts of the programme. Most profoundly, some members from different teams, to coordinate and uncover interdependencies involved in the following sprint, first practised a meeting referred to as "ready-to-sprint". This meeting turned out to be crucial to distribute work in a way that made the different teams work as autonomous units as far as possible. These meetings had different participants as roles and individuals relevant for uncovering and analysing interdependencies varied from sprint to sprint. These meetings first grew out of the pressing need for coordinating across teams experienced by individual team members and were later sanctioned by project managers as a practice to adopt in a more systematic manner.

Another example of how coordinating mechanisms for groups changed over time in Beta is what was referred to as 'task forces'. As the project progressed, individual team members experienced that existing coordinating mechanisms like Scrum of Scrums and architecture meetings were not enough for solving especially complex problems involving interdependencies across teams. These were often highly technical problems relating to for instance security issues, integration with legacy systems, and performance issues. Hence, there was an absence of coordinating mechanisms for handling such emerging problems. The coordinating mechanism referred to by participants as 'task forces' emerged out of individuals grouping together across teams to solve these technical problems. The group meeting could last for several days until a solution was found. As explained by the project manager in the later phase of the project:

*"We had a special task force for solving issues on performance where we had experts how hunted down components that had poor performance" (Project manager, Beta).*

The project also experienced situations where existing coordinating mechanisms that used to work out well collapsed. One example of this was a specialized architecture meeting referred to as the 'Service Oriented Architecture forum'. As explained by the one architect, this suddenly stopped working as a coordinating mechanism:

*"We had a group called the Service Oriented Architecture-forum during the whole project, but over time, it did not work. In the beginning, it worked as a meeting for making decisions regarding the software bus [used in the customer organization], but after a while it stopped working because we were waiting for information – and hence we had poor progress" (Solutions architect, Beta).*

Experience-sharing across teams were the focus of several scheduled meetings at the sub-project level: "Experience forum", "Lunch seminars" and "Technical corner" are examples of meetings that existed during the Alpha programme. A topic discussed at the experience forum was how to liven up the retrospectives. This was then a topic discussed amongst all participants in the development teams in one project. Participation in these meetings was voluntary.

### 4.2 Unscheduled meetings

Unscheduled meetings were easy to organize due to the open workspace. Unplanned meetings frequently took place around the boards that were available for each team. These were used to "discuss solutions, draw and make sketches" (subproject manager, Alpha). These discussions spanned development teams and roles. The project management was placed on tables so that they could see most of the boards and thus quickly obtain an overview of status of the teams.

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If the project managers noticed discussions, they could inquire about the issue and say that,

*"This problem I know was addressed by another team two iterations ago, let us get 'Ola' over here and see if he can help" (Subproject Manager, Alpha).*

A Scrum master and developer stated that they learned "very much" in the programme during these discussions around the boards, but it was important to have sufficient coordination arenas so that people realize that "we need to talk". The programme also started to use the group chatting tool (Jabber) to ease informal coordination, what we can see as a type of unscheduled virtual meetings. This tool was introduced during the programme, which enabled asking several people for help without interrupting them. This channel was used for several purposes, as a technical architect from Alpha expressed:

*"It was used ad hoc...to whatever people wanted to use it for...technical things, wine lottery...and to ask «can anyone tell me about a certain topic» - when you do not know exactly who to ask..."* (Technical architect, Alpha).

In the Beta project, as most of the project was co-located, some of the early coordinating mechanisms like the Service Oriented Architecture forum collapsed, and project participants began to 'know the organization', the role of unscheduled meetings increased. Additionally, as the project progressed, more interdependencies were discovered, and thus more coordinating was needed. In this situation, a primary coordinating mechanism emerged in terms of situational unscheduled meetings between only a few project members for a relatively short time (less than an hour). As explained,

*"By and large [coordination] is ad hoc. It was common practice to just walk over to each other [other teams] to discuss and solve issues there and then. And it was also a common understanding that such issues needed to be solved at once. And if [everyone] did so, this would certainly reduce the frictions between teams" (Developer, Beta).*

## 5. Discussion

We have described the use of group mode coordination in two large-scale software development programmes using the agile development method Scrum and planned according to PRINCE2 with distinct phases. We have presented how interdependencies are managed using scheduled and unscheduled meetings at different levels in programme organizations, partially answering one of the questions raised by Jiang et al. [3]. The programmes included projects for architecture, business, development and test. We have relied on Van de Ven et al. [12], who define coordination as "integrating or linking together different parts of an organization to accomplish a collective set of tasks". We found that the group mode (scheduled and unscheduled meetings) was extensively used in the two large-scale agile programmes.

In large-scale agile software projects, a common strategy for coordination across several teams is Scrum of Scrum, in which one team-member acts as "ambassador" to participate with ambassadors from other teams. We found 15 examples of scheduled and unscheduled meetings, which include Scrum of Scrum, backlog meeting, sprint related meetings and workshops (Table 3). These are the same types of multi-team meetings that are recommended by the large-scale agile framework LeSS [32]. In their study of six multi-team projects, Dietrich et al. [2] found the use of 11 coordination mechanisms in the group mode. One explanation that Dietrich et al. reported fewer coordination mechanisms could be that their projects were product development or organizational development projects, which from their descriptions seem less complex than Alpha and Beta. Another explanation could be that both Alpha and Beta are large programmes while five of the six cases studied by Dietrich et al. were smaller projects with a maximum of 40 people. There is a distinct difference between managing a project and managing a programme in that the latter involves more coordination that the former [3].

We now discuss our research question *"How do inter-team group mode coordination mechanisms change over time in large-scale agile development?"* through emphasizing how coordination changes over time, and if changes are initiated bottom-up or top-down in the programme organisation.

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## 5.1 Inter-team Group mode coordination over time

While some coordination mechanisms changed over time, the meetings related to the agile method Scrum were kept throughout the programme (e.g., Scrum of Scrums, Meta Scrum, demonstrations and meetings at team level). Furthermore, the iteration length remained at three weeks for both programmes, resulting in many synchronized meetings (e.g., in the Scrum of Scrum, and ready-for-sprint meeting). In addition, people in the programmes were co-located; therefore, coordination could easily emerge (coffee breaks and walking over to other teams). Organizing meetings at the same interval throughout the programme (synchronization) and co-location (structure) was found to support coordination effectively as described by the members of the programme. This is consonant with Strode et al. [22] who found synchronization and structure enhance coordination effectiveness.

We have described two main transitions over time within the group mode: at Alpha, there was a high number of scheduled meetings initially, but a gradual transition to unscheduled meetings. Informants stated that the initial scheduled meetings were very important for the efficient use of unscheduled meetings later and that the unscheduled meetings became more important than the scheduled meetings. The importance of unscheduled meetings is consonant with Van de Ven [12] who found that unscheduled meetings are used to a greater extent than scheduled meetings in larger units and when task uncertainty is high. At Beta, we found a transition from unscheduled to scheduled meetings over time. The main reason for the transition at Beta was that the programme management identified the importance of these unscheduled meetings, and therefore formalized them. Several of the scheduled and unscheduled meetings emerged during the lifetime of the two programmes. Our findings are consistent with those of Jarzabkowski et al. [34], who argue that coordinating mechanisms do not arise as ready-to-use procedures but are constituted as actors go about the process of coordinating. Further, coordinating mechanisms are not stable entities, but emerge through their use in ongoing interactions. Letting coordination mechanisms emerge is also recommended in the LeSS framework. In the LeSS any team or team member should be able and expected to reach out to another team if there is an issue to be solved. Dietrich et al. [2] did not distinguish between scheduled and unscheduled meetings.

We believe that having many meetings was important for inter-team group mode coordination mechanisms to change over time. Many meetings enabled building knowledge and relations among the team early in each of the programmes. Our findings are consonant with the finding of Smite et al. [29] in that many meetings and forums increase the amount and frequency of communication between teams outside of the meetings. Frequent participation in forums and meetings increases the size of a team's social networks and gives the team a good overview of what is going on in the project (ibid). Our findings are also in agreement with Strode et al. [43] who argue that 'knowing who is doing what' and 'knowing who knows what' are two important components of coordination effectiveness.

## 5.2 Group mode changes; top-down and bottom-up

Group mode coordination mechanisms changed over time in the two programmes. We found both a top-down approach to coordination (mechanisms identified by the programme management) in addition to mechanisms that emerged bottom-up by teams and members in teams. Examples of top-down mechanism were Meta Scrum and Scrum of Scrum. Examples of mechanism that emerged bottom-up was the group chat tool identified in the open space, lunch forums and technical meetings. Top-down initiatives defined by managers were important to establish many group mode coordination mechanisms, which were important for new mechanisms to emerge.

Top-down initiatives can also 'disrupt' existing forms of coordination, and thereby kick off a process of establishing something new. In the current literature on project management this issue is often debated under the heading of 'project governance' [44]. A study by Klakegg et al. [45] argues that approaches to governance of large-scale projects varies from top-down approaches using frameworks from the Association for Project Management to more bottom-up approaches. Both Alpha and Beta are complex agile projects, and therefore need more flexible forms of management focusing on facilitating collaboration and communication, rather than pure top-down approaches to governance. Our findings are consonant with previous research on project management [46].

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## 6. Conclusion

Our study supports the finding that group mode coordination is central to achieving inter-team coordination in large programs. In particular, we highlight the role of scheduled and unscheduled meetings to achieve effective coordination. We have shown that the use of these meetings changes over time in two large-scale agile development programs. The transitions have been initiated both bottom-up and top-down in the programme organizations.

When starting a program, we recommend to early identify the important scheduled meetings, as having enough scheduled meetings are important to develop a common understanding of domain knowledge. An answer to the question of "to schedule or not to schedule" would be to ensure a sufficient number of scheduled meetings initially, and then reduce as the coordination needs are handled more informally. When identifying which scheduled meetings to start with in a program, the meetings reported in table 3 can be used as a starting point.

While starting with enough scheduled meetings is important, we believe the unscheduled meetings are of great importance in knowledge work and programme managers should strive to facilitate these meetings. Programme management needs to be sensitive to the vital importance of coordination as well as the coordination needs as they change over time in large programs. Further, program managers need to balance top-down and bottom-up coordination initiatives when changing, terminating and identifying new scheduled and unscheduled meetings.

In future work, we plan to develop a further understanding of the "layered mutual adjustment" we have identified in large-scale software development programmes, and how coordination mechanism emerge, terminate and how they are connected in an ecology of coordinating mechanisms.

### Acknowledgements

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# Understanding impact of business intelligence to organizational performance using cluster analysis: does culture matter?

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**Abstract:**
Business intelligence is an approach that includes processes and systems for transformation of the raw data into meaningful and useful information which enables effective, systematic and purposeful analysis of an organization and its competitive environment. This paper aims to analyze the impact of the level of business intelligence maturity to organizational performance of the company. Moreover, since there is a rising awareness among practitioners of the role of the organizational culture for the successful functioning of the company, the role of the organizational culture is taken into consideration in this research. In order to meet the aim of the paper, a survey has been conducted. Data has been collected through questionnaires on a sample of 177 Croatian and Slovenian companies and analyzed by means of the cluster analysis. The analysis identified two clusters. The results of the cross-tabulation analysis of the clusters reveal statistically significant differences in terms of the company turnover and dominant organizational culture between them.

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## 1. Introduction

In the new global economy and in the conditions of growing number of data provided by the technology development, business intelligence (BI) can be considered as a central approach for successful management of the relevant business data in order to provide support to the decision-making processes. BI encompasses all processes and systems (e.g. data warehouses, data marts, analytical tools such as reporting tools, ad hoc analytics and OLAP, in-memory analytics, planning, alerts, forecasts, scorecards, data mining) that transform raw data into meaningful and useful information and enable effective, systematic and purposeful analysis of an organization and its competitive environment [1], [2], [3]. It is highly important for organizations to be able to recognize and exploit relevant and important information among enormous amount of data generated in business world each day. Only if BI is used to enhance decision making [4] or to improve business processes [5], it can affect the organization's performance. Therefore, BI can be an important means of competitive advantage for the company, if properly applied and utilized.

One of the ways of measuring the success of BI usage within the company is assessing the BI maturity. Although there is a number of BI maturity models developed over time (e.g. Watson et al. [6], Aho [7], Tan et al. [8]), according to our knowledge, there is no BI maturity model that would be commonly accepted and widely used for researches. Furthermore, most maturity models [9] only address certain aspects of technological maturity or system quality (such as data integration and analytical capabilities) and output quality, which refers to information quality and as such they are not comprehensive.

Besides dealing with the large amounts of information, there is also a rising awareness among practitioners of the role of the organizational culture for the successful functioning of the company. Moreover, this topic is being in the scope of many researchers in the last few decades, resulting in growing body of literature dealing with examining organizational culture and its impact on organizational functioning and performance (e.g. Balthazard et al. [10], Jacobs et al. [11], Naranjo-Valencia et al. [12]).

In the light of organizational performance (OP), current researches also reveal BI to be of a great importance in achieving higher business performance (e.g. Sparks [13], Wieder and Ossimitz [14], Daneshvar Kakhki and Palvia [15]). However, to our best knowledge, there is no research that would investigate the combined impact of both BI and organizational culture to OP. Therefore, the goal of the paper is to analyze the impact of BI to OP and the role of organizational culture in that impact by using cluster analysis for analyzing the data collected through questionnaires.

In order to fulfill the goals of this paper, its structure is as follows. After this introduction, a brief literature review is given, concentrating on previous research of the impact of BI and organizational culture on OP as well as the previous research on the usage of cluster analysis in information systems research. Third part of this paper focuses on the methodology used for this study, providing the overview of the research instrument, sample characteristics and k-means clustering procedure. Fourth part of the paper presents the results of the data analysis, followed by the discussion in the fifth part. At the end, a short conclusion with limitations and plans for future research is presented.

## 2. Literature review

This section of the paper presents short literature review on previous researches concentrated on the impact of BI on OP and the impact of organizational culture on the usage of information systems and OP. Also, the short overview of the usage of cluster analysis in previous information systems research is presented.

### 2.1 Previous research about impact of business intelligence on organizational performance

For the purpose of this study and in order to revise previous researches on the impact of BI on OP, the definition of BI given by Moss and Atre [16] has been accepted. They define BI as "an architecture and a collection of integrated operational as well as decision-support applications and databases that provide the business community easy access to business data" [16]. Bosilj Vuksic et al. discuss that integration of BI with other systems in the company [17].

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When it comes to the previous researches of the impact of BI on OP, Elbashir et al. [18] emphasize the need of examining that impact on the two levels of performance, which are (1) business process performance and (2) OP, indicating that measuring BI benefits on organizational level can be viewed as a tool for evaluation of the understanding of OP benefits within the company. On the other hand, a number of researches on BI reveal its effects to the OP. For example, Sparks [9] provides empirical confirmation of BI usage resulting in OP benefits. Moreover, Wieder and Ossimitz [14] also deliver evidence of direct and indirect impact of BI to decision support improvements. Based on the secondary data analysis from public companies in the USA, Daneshvar Kakhki and Palvia [15] report positive relationship between the implementation of BI and OP.

Previous research of BI often implies measuring the BI maturity in order to investigate its impact to other aspects of the company. So far, in the field of BI, there has been a number of maturity models developed. Lahrmann et al. [19] conducted a literature review on BI maturity models resulting with an overview of twelve different maturity models developed from 2001 to 2009. This literature review has recently been updated by Raber et al. [20], who propose yet another instrument for measuring BI maturity. For the purpose of this study, the focus is put on the BI maturity model proposed by Dinter [21], as this is one of the most comprehensive and systematic BI maturity models that covers all important aspects, organized in three dimensions: functionality, technology, and organization. Addressing only functionality and technology issues of BI cannot result in improved organizational performance. Pejić Bach et al. [22] show the importance of some organizational factors on BI successful implementation. Therefore, it is crucial that BI maturity model includes also the organizational dimension when used in such a study. The Dinter's model development with the focus on comprehensiveness and was based on an extensive analysis of previously existing models. It is a conceptual BI maturity model based on the original work of Steria Mummert Consulting in cooperation with universities from 2004 which suggests five stages of BI maturity, respectively: (1) individual information, (2) information islands, (3) information integration, (4) information intelligence, and (5) enterprise information management.

### 2.2 Previous research on the usage of cluster analysis in information systems research

Cluster analysis is a well-known statistic method for analyzing data. It is one of the multivariate statistical methods in which the data structure for grouping multivariate observations in clusters is sought. Therefore, it has been previously used in many studies by numerous authors. Both information systems research and BI research are no exception to that, as it is visible from few examples listed in continuation.

For example, Doherty et al. [23] used cluster analysis for identification of different classes of approach to the application of strategic information systems planning based on ten key planning dimensions. The results of the analysis of 267 responses collected from different companies revealed four clusters indicating four alternative approaches to the strategic information systems planning application [23]. Another example is the work of Wallace et al. [24] who used cluster analysis in analyzing the data collected from 507 software project managers through questionnaires. By employing k-means cluster analysis, they identified the trends in risk dimensions across three clusters, being low, medium and high risk projects [24]. The impact of project scope, sourcing practices and strategic orientation on project risks has been examined as well in the same research [24]. In their work, Balijepally et al. [25] reviewed the usage of cluster analysis in information systems researches published in four information system journals and provided guidelines for future improvement of the application of cluster analysis in information systems researches.

When looking at the usage of cluster analysis in BI research, one of the examples is the work of Fourati-Jamoussi and Niamba [26] who performed a cluster analysis to identify the different profiles of the users of the BI tools, highlighting the importance of user perception in designing BI tools. Also, Raber et al. [27] used cluster analysis in order to construct already mentioned Capability Maturity Model for BI [20].

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*2.3   Impact of organizational culture to usage of information systems and organizational performance*

Organizational culture is the way of life within the organization. According to Schein [28], an organizational culture is "a pattern of basic assumptions invented, discovered, or developed by a given group as it learns to cope with its problems of external adaptation and internal integration, that has worked well enough to be considered valid and, therefore is to be taught to new members as the correct way to perceive, think, and feel in relation to those problems". Another definition, as provided in Economic lexicon [29], defines organizational culture as set of values and behaviors which contribute to the unique social and psychological environment of the organization. Organizational or enterprise culture is based on shared attitudes, beliefs and customs, as well as written and unwritten rules that have evolved over time and are considered valid by all employees within a company. It is mainly invisible, but very powerful social force [30], which can be relevant in various areas, such as e-service research [31].

Existing literature offer a number of different typologies of organizational culture. For the purpose of this research, an organizational culture typology given by Cameron and Quinn [32] has been accepted. It classifies organizational culture into four types, being: (1) clan, (2) adhocracy, (3) market and (4) hierarchy [32].

The role of organizational culture in achieving higher business results and better OP has intrigued researchers for a few decades (e.g. Deal and Kennedy [33], Denison [34], Marcoulides and Heck [35], Barney [36]). In recent period, there are also a number of studies dealing with organizational culture influence on the performance of the organization. Based on extensive correlational analysis, Balthazard et al. [7] argue that constructive organizational culture has a positive impact on OP, while dysfunctional defensive organizational culture has a negative impact on OP. Jacobs et al. [11] examined the associations between organizational culture and performance in healthcare organizations and concluded that organizational culture has a significant role in achieving higher performance. Naranjo-Valencia et al. [12] report clan and adhocracy organizational culture to have a positive impact on OP, while hierarchy and market organizational culture resulted with a negative impact.

## 3.   Methodology

This section presents the methodology used for this research, giving the overview of the research instrument and sample characteristics as well as the presentation of the k-means clustering procedure.

*3.1   Research instrument*

This study is based on the questionnaire developed by the PROSPER research group. The designed questionnaire is comprised out of 12 parts referring to: (1) BPM maturity, (2) usage of social BPM, (3) BI maturity, (4) CPM, (5) BPM/CPM alignment, (6) BPM/BI alignment, (7) BI/CPM alignment, (8) process performance assessment, (9) OP assessment, (10) organizational culture assessment, (11) company characteristics and (12) demographic respondents' characteristics. For the purpose of this paper, besides the company characteristics, three parts were taken into further analysis: (1) BI maturity, (2) organizational culture assessment, and (3) OP assessment.

*3.1.1   Measurement of business intelligence maturity and organizational performance*

BI maturity part of the questionnaire has been developed based on the BI maturity model proposed by Dinter [21]. However, for the purpose of this research, Dinter's original model has been reduced to ten questions, providing that all the relevant maturity aspects have been included in the measurement instrument. For each question, two opposite statements (A and B) are provided as answers. Respondents state their level of agreement for each question using the 5-points Likert scale, with 1 representing total agreement with the statement A, while the 5 is representing total agreement with the opposite statement B. The questions refer to: (1) the scope of BI systems use, (2) the level of data architecture maturity, (3) the relevance of BI for the organization, (4) the level of technical architecture maturity, (5) the level of data management maturity, (6) type of BI tools used within the organization, (7) organizational structure related to BI, (8) the level of BI processes maturity, (9) the level of BI profitability assessment and (10) BI strategy.

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The constructs for assessing the OP within the organizations are being designed based on the research conducted by Law and Ngai [37]. This section of the questionnaire consists of five statements referring to: (1) level of customer satisfaction with products/services, (2) customer retention rate, (3) sales growth rate, (4) profitability of the organization and, (5) competitive position of the organization. Respondents expressed their level of agreement with each statement on the Likert scale from 1 to 5, where 1 represents total disagreement while 5 represents total agreement. The OP assessment is based on the method of self-evaluation which has been proven in previous researches as a valid method of assessing OP [37].

### 3.1.2 Measurement of dominant organizational culture

In the designed questionnaire, organizational culture assessment is based on the Organizational Culture Assessment Instrument (OCAI), developed by Cameron and Quinn [32]. It contains six groups of statements referring to: (1) dominant characteristics, (2) organizational leadership, (3) management of employees, (4) organizational glue, (5) strategic emphasis and, (6) criteria for success. Each of these groups of statements contains four statements representing one of the four organizational culture types, as stated earlier. In each group of statements, respondents are supposed to divide total of 100 point among the four proposed statements, based on the similarity with the situation in surveyed company. The dominant organizational culture type is the one with the highest average of collected points. Originally, OCAI assesses both current and preferred organizational culture of the surveyed company. However, for the purpose of this research, only the current organizational culture has been assessed.

### 3.2 Sample characteristics

This research has been conducted in companies operating in Slovenia and Croatia between March and December of 2016. These two neighbor countries have been selected based on the similar history and characteristics. Moreover, there have already been some researches based on the combined data collected in Slovenia and Croatia (e.g. Škrinjar et al. [38], Buh [39], Hernaus et al. [40]). The sample selection frame for this research has been the Registry of business entities in Croatia and business directory bizi.si in Slovenia where all middle-sized and large companies have been alphabetically sorted and chosen in the random sample by method of steps with the help of random number table. The questionnaires have been distributed in paper forms and as an online survey. Within the companies, the request for participation has been sent to the members of top management or person in charge of BI and BPM. In Slovenia, the questionnaires have been sent to 1394 organizations out of which 171 responses have been received, which makes 12.27% response rate. In Croatia, the questionnaires have been sent to 500 organizations out of which 101 responses have been received, making response rate of 20.2%. Further, before the analysis, the collected data has been checked for missing values and revised for possible outliers and response illogicality.

Final sample consisted of overall 177 responses out of which 109 responses were from Slovenia and 68 responses were from Croatia. When it comes to the size of the respondent's company in terms of the number of employees, most of them (47.5%) are medium-sized companies, while minority of the companies participating in the study are small companies (10.2%). When looking at the turnover, majority of the surveyed companies had the turnover between 10 and 50 million euros (36.7%), followed by those which had turnover more than 50 million euros (31.6%), while 23.2% of the surveyed companies had turnover lower than 10 million euros. The complete overview of sample characteristics is given by table 1.

When looking at the sample with the regards to the industry sector, following Gelo and Družić [41] we grouped the surveyed companies into five economy sectors. Therefore, in our sample there is a minority of 2.8% of the surveyed companies from the primary sector, while the majority of them are from the secondary sector (35.0%). Table 2 gives the complete overview of the sample structure according to the industry sector.

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Table 1. Country of origin and size of the companies in the sample, n=177

| Characteristic | Category | Number | Share (%) |
|---|---|---|---|
| **Country** | Slovenia | 109 | 61.6% |
| | Croatia | 68 | 38.4% |
| **Number of employees** | 0-50 employees | 18 | 10.2% |
| | 51-249 | 84 | 47.5% |
| | 250-1000 | 47 | 26.6% |
| | 1000+ employees | 28 | 15.8% |
| **Turnover** | 0-10 mill. EUR | 41 | 23.2% |
| | 10 mill. EUR-50 mill. EUR | 65 | 36.7% |
| | 50 mill. EUR+ | 56 | 31.6% |
| | N.A. | 15 | 8.5% |

Source: authors' work; Note: N.A. – not available

Table 2. Main industry sector of the companies in the sample, n=177

| Characteristic | Category | Number | Share (%) |
|---|---|---|---|
| Industry sector | Primary | 5 | 2.8% |
| | Secondary | 62 | 35.0% |
| | Tertiary | 53 | 29.9% |
| | Quaternary | 30 | 16.9% |
| | Quinary | 20 | 11.3% |
| | N.A. | 7 | 4.0% |

Source: authors' work; Note: N.A. – not available

### 3.3 K-means clustering procedure

Cluster analysis provides the means for identification of homogenous groups of observations, cases, units or objects [42]. It assumes that it is possible to find a natural way of grouping that is meaningful to the researcher, although there are no known groups or their number previous to the analysis. The objective of the cluster analysis is to find an optimal way of grouping where observations within each cluster have similar characteristics. Contrariwise, different clusters are mutually different meaning that observations belonging to different clusters have different characteristics.

Cluster analysis begins with selecting the variables for the analysis, followed by the selection of clustering procedure which governs the way clusters are formed. For the purpose of this study, k-means clustering procedure has been selected. According to Hartigan and Wong [43], it is a procedure which divides "$M$ points in $N$ dimensions into $K$ clusters so that the within-cluster sum of squares is minimized". The procedure iteratively observes means of the clusters in a way that observations are simultaneously relocated into the cluster with the closest mean [44]. K-means cluster analysis continues to recalculate clusters' means and relocate observations in as many steps as needed until no observation is relocated into a different cluster.

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## 4. Results

This section presents the results of the study of impact of business intelligence to OP, with the regards to the organizational culture.

### 4.1 Descriptive analysis

In order to gain a better insight and as a basis for cluster analysis, the descriptive statistical analysis of individual indicators of BI maturity, OP and organizational culture for 177 observed companies from Croatia and Slovenia has been conducted. Moreover, the descriptive statistical analysis of summary indicators of BI maturity, OP and organizational culture has also been conducted. Table 3 presents the explanation of the research instrument indicators.

Table 3. Research instrument indicators

| Indicator group | Indicator code | Indicator |
|---|---|---|
| Business intelligence maturity (BI) | BI1 | The scope of business intelligence systems usage |
| | BI2 | The level of data architecture maturity |
| | BI3 | The impact of business intelligence |
| | BI4 | The level of technical architecture maturity of BI |
| | BI5 | The level of data management maturity |
| | BI6 | Type of BI tools used within the organization |
| | BI7 | The organizational structure related to BI |
| | BI8 | The level of maturity of BI processes |
| | BI9 | The level of the profitability assessment of BI |
| | BI10 | The level of BI strategy |
| Organizational performance (OP) | OP1 | Value for money |
| | OP2 | Customers retention rate |
| | OP3 | Sales growth rate |
| | OP4 | Profitability of the company |
| | OP5 | Overall competitive position |
| Organizational culture assessment (OC) | OC1 | Dominant characteristics |
| | OC2 | Organizational leadership |
| | OC3 | Management of employees |
| | OC4 | Organization glue |
| | OC5 | Strategic emphases |
| | OC6 | Criteria of success |

Source: authors' work

### 4.1.1 Business intelligence maturity and organizational performance

The analysis of the collected BI maturity and OP data has begun with descriptive statistics of the individual indicators of BI maturity and OP, as shown by table 4. Results reveal that the indicator BI4 indicating the level of technical architecture maturity of BI has the highest mean of 3.67 with the standard deviation of 1.241. On the contrary, the

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lowest mean is present with the indicator BI9 representing the level of the profitability assessment of BI with the mean of 2.70 and the standard deviation of 1.355, which is also the highest standard deviation among BI maturity indicators. The lowest standard deviation of 1.097 is visible with the BI5 indicator, representing the level of data management maturity. Among OP indicators, the highest mean of 3.93 and at the same time the lowest standard deviation of 0.761 is present with the OP1 indicator, representing the level of customer satisfaction with products/services of the company. On the other hand, the lowest mean of 3.27 with the highest standard deviation of 1.024 among OP indicators is visible at OP4 indicator, representing the profitability of the organization.

Table 4. Descriptive statistics of individual indicators of business intelligence maturity and organizational performance, n=177

| Indicator | N | Min | Max | Mean | St. Dev. |
|---|---|---|---|---|---|
| Business intelligence maturity | | | | | |
| BI1 | 177 | 1 | 5 | 3.21 | 1.265 |
| BI2 | 177 | 1 | 5 | 3.38 | 1.107 |
| BI3 | 177 | 1 | 5 | 3.50 | 1.114 |
| BI4 | 177 | 1 | 5 | 3.67 | 1.241 |
| BI5 | 177 | 1 | 5 | 3.62 | 1.097 |
| BI6 | 177 | 1 | 5 | 3.28 | 1.243 |
| BI7 | 177 | 1 | 5 | 3.20 | 1.267 |
| BI8 | 177 | 1 | 5 | 3.12 | 1.099 |
| BI9 | 177 | 1 | 5 | 2.70 | 1.355 |
| BI10 | 177 | 1 | 5 | 3.02 | 1.263 |
| Organizational performance indicators | | | | | |
| OP1 | 177 | 1 | 5 | 3.93 | 0.761 |
| OP2 | 177 | 1 | 5 | 3.84 | 0.845 |
| OP3 | 177 | 1 | 5 | 3.28 | 0.993 |
| OP4 | 177 | 1 | 5 | 3.27 | 1.024 |
| OP5 | 177 | 1 | 5 | 3.45 | 1.005 |

Source: authors' work

In order to test convergent validity, a factor analysis has been conducted. Table 5 represents the factor loadings of individual indicators of BI maturity and OP. As it is visible from the table 5, all indicators of BI have been classified as factor 1, comprising BI variable. Similar, all indicators of OP have been classified as factor 2, comprising OP variable as OP. In case of BI, indicator BI6 representing the type of BI tools used within the organization has the most powerful influence to BI, while indicator BI9 representing the level of the profitability assessment of BI has the least powerful influence. In case of OP, the most powerful influence is visible with indicator OP5 representing the overall competitive position of the company, while the least powerful influence is present with indicator OP1 representing the level of customer satisfaction with products/services of the company. All of the calculated factor loadings indicate positive influence of indicators to overall variables for both BI and OP.

Figure 1 represents the plot of two-factor rotated solution and the plot of eigenvalues of individual indicators of BI maturity and OP. As it is visible from the figure 1, there are no critical outliers which should be left out of the further analysis. The plot of eigenvalues shows that the most of the variance in data can be accounted for by two eigenvectors. The plot of two-factor rotated solution of factor loadings for BI and OP indicators demonstrates the two independent factors, as it was already shown also by table 5.

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Table 5. Factor loadings of individual indicators of business intelligence maturity and organizational performance, n=177

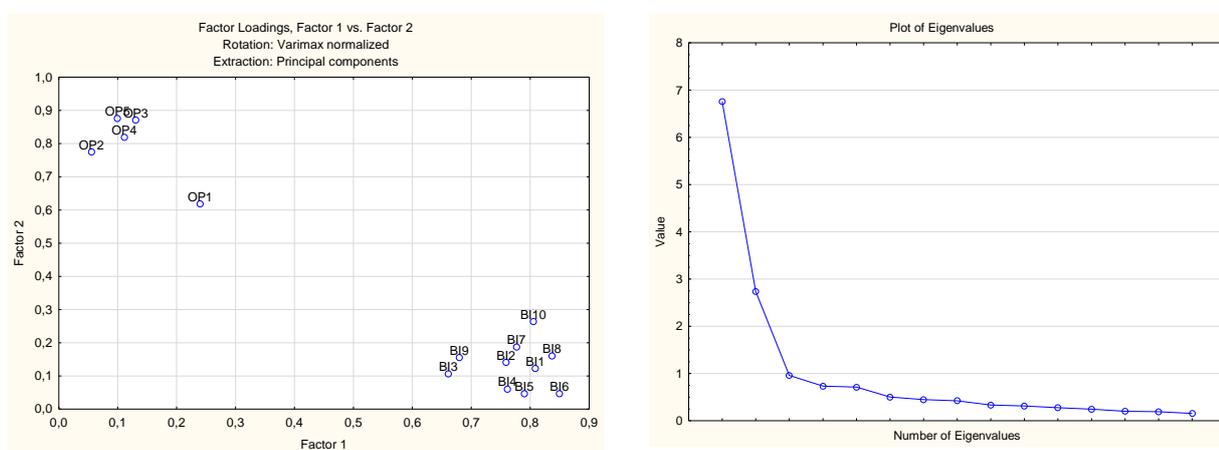| Indicator | Factor 1 | Factor 2 |
|---|---|---|
| BI1 | 0.809 | |
| BI2 | 0.759 | |
| BI3 | 0.661 | |
| BI4 | 0.762 | |
| BI5 | 0.790 | |
| BI6 | 0.850 | |
| BI7 | 0.777 | |
| BI8 | 0.837 | |
| BI9 | 0.680 | |
| BI10 | 0.805 | |
| OP1 | | 0.618 |
| OP2 | | 0.775 |
| OP3 | | 0.870 |
| OP4 | | 0.819 |
| OP5 | | 0.875 |

Source: authors' work



Fig. 1. Factor loadings and plot of eigenvalues of individual indicators of business intelligence maturity and organizational performance

Table 6 presents the descriptive statistics of summary indicators of BI maturity and OP within the observed companies in Croatia and Slovenia. Average level of BI maturity is 3.270 with the standard deviation of 0.945. Average OP grade for the observed companies is 3.551 with the standard deviation of 0.751. In order to test the internal consistency and the reliability of the research instrument, Cronbach's alpha coefficients for BI and OP have been calculated. Both BI and OP summary indicators have Cronbach's alpha coefficients higher than the cut-off value of 0.70 recommended by Nunnally and Bernstein [45]. Therefore, the internal consistency and the reliability of the research instrument have been confirmed.

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Table 6. Descriptive statistics of summary indicators of business intelligence maturity and organizational performance, n=177

| Indicator | N | Min | Max | Mean | St. Dev. | Cronbach's alpha |
|-----------|-----|-----|-----|-------|----------|------------------|
| BI | 177 | 1 | 5 | 3.270 | 0.945 | 0.929 |
| OP | 177 | 1 | 5 | 3.551 | 0.751 | 0.866 |

Source: authors' work

Table 7 shows the Pearson's correlation matrix for the observed companies summary BI maturity and summary OP variables. It is visible that there is a weak positive correlation between summary BI maturity variable and summary variable for OP. This correlation is statistically significant at the 5% significance level. Based on the presented Pearson's correlation matrix, figure 2 presents the scatter plot of summary indicators of BI maturity and OP.

Table 7. Pearson's correlation matrix, h=2 variables, n=177 companies

| Variable | Summary BI | Summary OP |
|----------|------------|------------|
| Summary BI | 1.000 | 0.301* |
| Summary OP | | 1.000 |

Source: authors' work; Note: * - statistically significant correlations at the 5% significance level
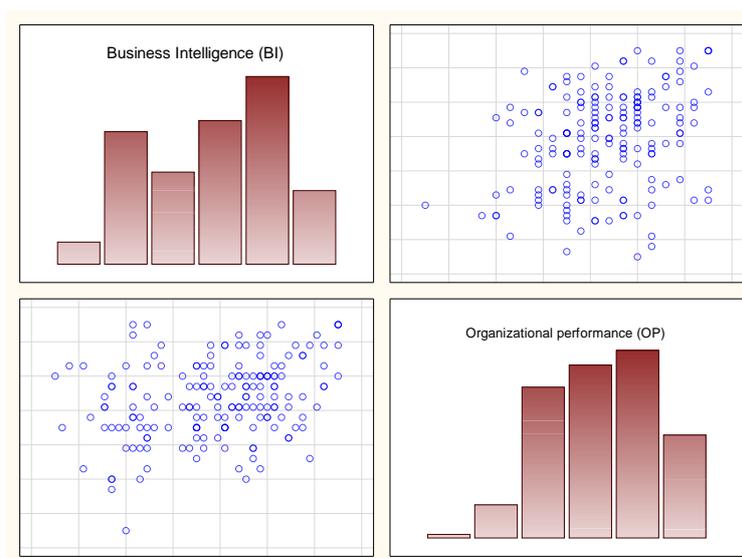


Fig. 2. Scatter plot of summary indicators of business intelligence maturity and organizational performance

### 4.1.2 *Organizational culture of sample companies*

The descriptive statistics of indicators of the organizational culture of the observed companies is presented by the table 8. Among the dominant characteristics group of indicators, the highest average of 28.82 with the standard deviation of 18.906 is in the case of the OC1c indicator which represents the strong focus on achieving goals, completing tasks and competitive employees. The lowest average of 23.46 with the standard deviation of 18.611 is present with the OC1a indicator, representing clan culture characteristics to be dominant. Within the organizational leadership group of indicators, the highest average of 33.36 with the standard deviation of 19.634 belongs to the OC2d indicator, representing the coordinated and organized leadership which provides smooth performance. The lowest average of 20.80 with the standard deviation of 13.876 belongs to the OC2b indicator, representing the innovative and

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entrepreneurial leadership prone to taking risks. In the management of employees group of indicators, the highest average of 32.34 with the standard deviation of 18.798 is visible with the OC3a indicator, representing the teamwork, consensus and cooperation, while the lowest one is present with the OC3b indicator (19.88 with the standard deviation of 14.230), representing the individual risk taking, innovation, freedom and uniqueness. In the fourth group of indicators, dedicated to organizational glue, the highest average of 30.34 with the standard deviation of 18.553 belongs to the OC4a indicator, representing the loyalty and mutual trust and as the core values on which the company is based on. On the contrary, the lowest average of 18.40 with the standard deviation of 12.570 is visible for the OC4b indicator, representing the commitment to innovation and development as well as the focus on setting new guidelines. The strategic emphasize group of indicators revealed the highest average of 31.19 with the standard deviation of 20.646 for the OC5d indicator, representing strong focus on sustainability and stability with the great importance of effectiveness, control and smooth operation of the company. In contrast, the lowest average of 20.40 with the standard deviation of 12.120 is present with the OC5b indicator which represents strong focus on acquiring new resources, setting new challenges, trying out new approaches and finding opportunities. In the last group of indicators, dedicated to criteria of success, the highest average of 36.68 belongs to the OCd6 indicator which represents efficiency based success and importance of reliable delivery, smooth production and low operating costs. The lowest average in this group of indicators belong to the OCb2 indicator (17.97 with the standard deviation of 12.022) which represents success based on the possession of unique and new products and/or services. In that case, a company is a leader in product and/or service innovation.

Table 8. Descriptive statistics of indicators of organizational culture

| Indicator | N | Min | Max | Mean | St. Dev. |
|---|---|---|---|---|---|
| OC1 – Dominant characteristics | | | | | |
| OC1a | 177 | 0 | 100 | 23.46 | 18.611 |
| OC1b | 177 | 0 | 100 | 23.53 | 16.825 |
| OC1c | 177 | 0 | 100 | 28.82 | 18.906 |
| OC1d | 177 | 0 | 100 | 24.14 | 20.814 |
| OC2 – Organizational leadership | | | | | |
| OC2a | 177 | 0 | 100 | 23.82 | 16.485 |
| OC2b | 177 | 0 | 100 | 20.80 | 13.876 |
| OC2c | 177 | 0 | 100 | 21.96 | 19.470 |
| OC2d | 177 | 0 | 100 | 33.36 | 19.634 |
| OC3 – Management of employees | | | | | |
| OC3a | 177 | 0 | 100 | 32.4e3 | 18.798 |
| OC3b | 177 | 0 | 100 | 19.88 | 14.230 |
| OC3c | 177 | 0 | 100 | 21.44 | 18.389 |
| OC3d | 177 | 0 | 100 | 26.25 | 20.598 |
| OC4 – Organizational glue | | | | | |
| OC4a | 177 | 0 | 100 | 30.34 | 18.553 |
| OC4b | 177 | 0 | 55 | 18.40 | 12.570 |
| OC4c | 177 | 0 | 100 | 24.97 | 17.188 |
| OC4d | 177 | 0 | 100 | 26.29 | 20.759 |

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| Indicator | N | Min | Max | Mean | St. Dev. |
|---|---|---|---|---|---|
| OC5 – Strategic emphases | | | | | |
| OC5a | 177 | 0 | 100 | 24.21 | 16.712 |
| OC5b | 177 | 0 | 50 | 20.40 | 12.120 |
| OC5c | 177 | 0 | 90 | 24.20 | 14.851 |
| OC5d | 177 | 0 | 100 | 31.19 | 20.646 |
| OC6 – Criteria of success | | | | | |
| OC6a | 177 | 0 | 100 | 19.73 | 14.194 |
| OC6b | 177 | 0 | 70 | 17.97 | 12.022 |
| OC6c | 177 | 0 | 80 | 25.67 | 15.231 |
| OC6d | 177 | 0 | 100 | 36.68 | 20.632 |

Source: authors' work

The descriptive statistics of summary indicators of organizational culture by types is presented by table 9. Overall, the highest average grade has been given to the hierarchy variable, being the average of 29.652 with the standard deviation of 15.843. The lowest average of 20.164 with the standard deviation of 8.701 belongs to the adhocracy variable. The largest range of points is present with the clan variable, while the smallest range of points belongs to adhocracy variable.

Table 9. Descriptive statistics of indicators of organizational culture

| Variable | N | Min | Max | Mean | St. Dev. |
|---|---|---|---|---|---|
| Clan | 177 | 0.000 | 96.667 | 25.665 | 12.454 |
| Adhocracy | 177 | 0.000 | 50.000 | 20.164 | 8.701 |
| Market | 177 | 0.000 | 65.000 | 24.510 | 11.575 |
| Hierarchy | 177 | 0.000 | 85.000 | 29.652 | 15.843 |

Source: authors' work

Table 10 presents the sample according to the dominant organizational culture. The overall sample consists of 33.3% of companies with hierarchy as s dominant organizational culture, followed by the 31.6% of the companies having clan as a dominant organizational culture. On the contrary, only 7.9% of the companies revealed to have adhocracy as their dominant organizational culture.

Table 10. Number of sample companies according to dominant culture, n=177

| Characteristic | Category | Number | Share (%) |
|---|---|---|---|
| Organizational culture | Clan | 56 | 31.6 |
| | Adhocracy | 14 | 7.9 |
| | Market | 48 | 27.1 |
| | Hierarchy | 59 | 33.3 |

Source: authors' work

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## 4.2 K-means cluster analysis

In order to organize collected data into meaningful structures, the k-means cluster analysis has been employed using the statistical software Statistica. First, the graph of the cost sequence has been made in order to determinate the best number of clusters. As shown by the figure 3, it has been suggested that the best number of clusters for this study is two. Graph of the cost sequence illustrates the error function for different cluster solutions which is the average distance of observations in samples which are being tested to the assigned cluster centroids [46].
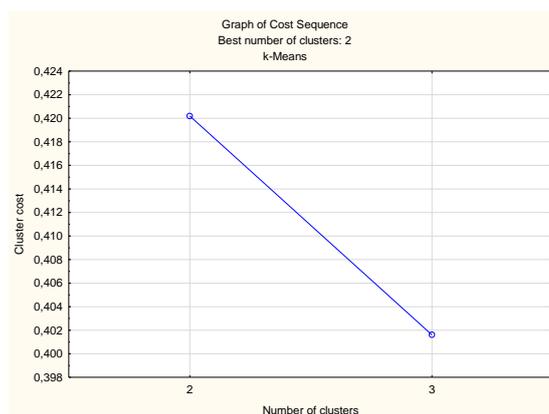


Fig. 3. Graph of the cost sequence

Next, the ANOVA analysis has been conducted for 15 indicators and two clusters on a sample of 177 observed companies. The results of the ANOVA analysis for the BI and OP individual indicators have been presented by the table 11. In the presented case, the null hypothesis which states that the means between observed indicators statistically differ has been rejected with the statistical significance at the 1% level for all observed indicator, except indicator OP2 representing customers' retention rate, where the significance level is at 5%.

Table 11. ANOVA table, k-means clustering, h=15 variables, k=2 clusters, n=177 sample companies

| Indicator | Between sum of squares | df | Within sum of squares | df | F-value | p-value |
|---|---|---|---|---|---|---|
| BI1 | 124.779 | 1 | 157.062 | 175 | 139.030 | 0.000** |
| BI2 | 68.905 | 1 | 146.733 | 175 | 82.180 | 0.000** |
| BI3 | 51.586 | 1 | 166.662 | 175 | 54.167 | 0.000** |
| BI4 | 93.136 | 1 | 177.858 | 175 | 91.639 | 0.000** |
| BI5 | 69.329 | 1 | 142.546 | 175 | 85.114 | 0.000** |
| BI6 | 104.696 | 1 | 167.180 | 175 | 109.593 | 0.000** |
| BI7 | 102.481 | 1 | 180.197 | 175 | 99.525 | 0.000** |
| BI8 | 95.879 | 1 | 116.629 | 175 | 143.865 | 0.000** |
| BI9 | 146.851 | 1 | 176.279 | 175 | 145.785 | 0.000** |
| BI10 | 146.460 | 1 | 134.490 | 175 | 190.576 | 0.000** |
| OP1 | 7.137 | 1 | 94.908 | 175 | 13.160 | 0.000** |
| OP2 | 3.567 | 1 | 122.004 | 175 | 5.117 | 0.025* |
| OP3 | 14.754 | 1 | 158.681 | 175 | 16.271 | 0.000** |

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| Indicator | Between sum of squares | df | Within sum of squares | df | F-value | p-value |
|-----------|------------------------|----|-----------------------|----|---------|---------|
| OP4 | 9.578 | 1 | 174.942 | 175 | 9.581 | 0.002** |
| OP5 | 8.998 | 1 | 168.743 | 175 | 9.331 | 0.003** |

Source: authors' work; Note: * - statistically significant at the 5% significance level; ** 1% level

Table 12 presents the cluster means for the individual indicators of BI and OP. It is visible from the table 12 that 51.98% of the observed companies has been assigned to the cluster 1, while 48.02% of them has been assigned to the cluster 2. Within the cluster 1, the highest mean of 4.370 of the individual indicator is present with the BI4 indicator, representing the level of technical architecture maturity of BI, while the lowest one of 3.489 is visible with the OP4 indicator, representing profitability of the company. Within the second cluster, the highest mean of 3.718 belongs to the OP1 indicator, representing the level of customer satisfaction with products and services of the company, while the lowest mean of 1.753 is present with the BI9 indicator, representing the level of the profitability assessment of BI.

Table 12. Cluster means, k-means clustering, h=15 variables, k=2 clusters, n=177 sample companies

| BI & OP individual indicators | Cluster 1 | Cluster 2 |
|-------------------------------|-----------|-----------|
| BI1 | 4.022 | 2.341 |
| BI2 | 3.978 | 2.729 |
| BI3 | 4.022 | 2.941 |
| BI4 | 4.370 | 2.918 |
| BI5 | 4.217 | 2.965 |
| BI6 | 4.022 | 2.482 |
| BI7 | 3.935 | 2.412 |
| BI8 | 3.826 | 2.353 |
| BI9 | 3.576 | 1.753 |
| BI10 | 3.891 | 2.071 |
| OP1 | 4.120 | 3.718 |
| OP2 | 3.978 | 3.694 |
| OP3 | 3.554 | 2.976 |
| OP4 | 3.489 | 3.024 |
| OP5 | 3.663 | 3.212 |
| Number of cases | 92 | 85 |
| Percentage(%) | 51.9774 | 48.0226 |

Source: authors' work.

Figure 4 presents the distribution of 10 BI individual indicators and 5 OP individual indicators across the two identified clusters. Those distributions give an insight in the amount of differences of the surveyed companies in each cluster according to the observed indicator. The taller the distribution, the differences among the surveyed companies are bigger and vice versa, the narrower the distribution is, the smaller are the differences among the observed companies.

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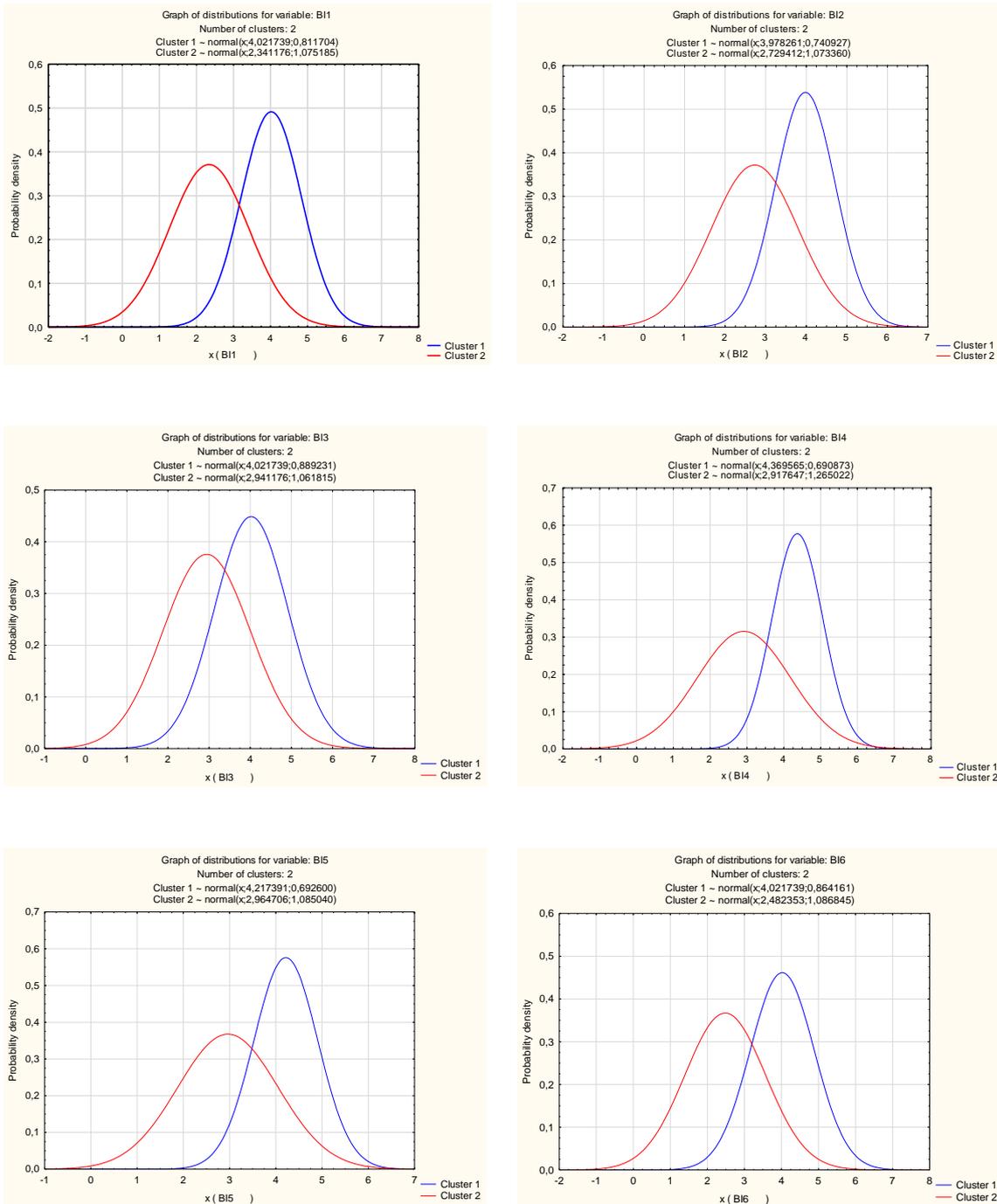
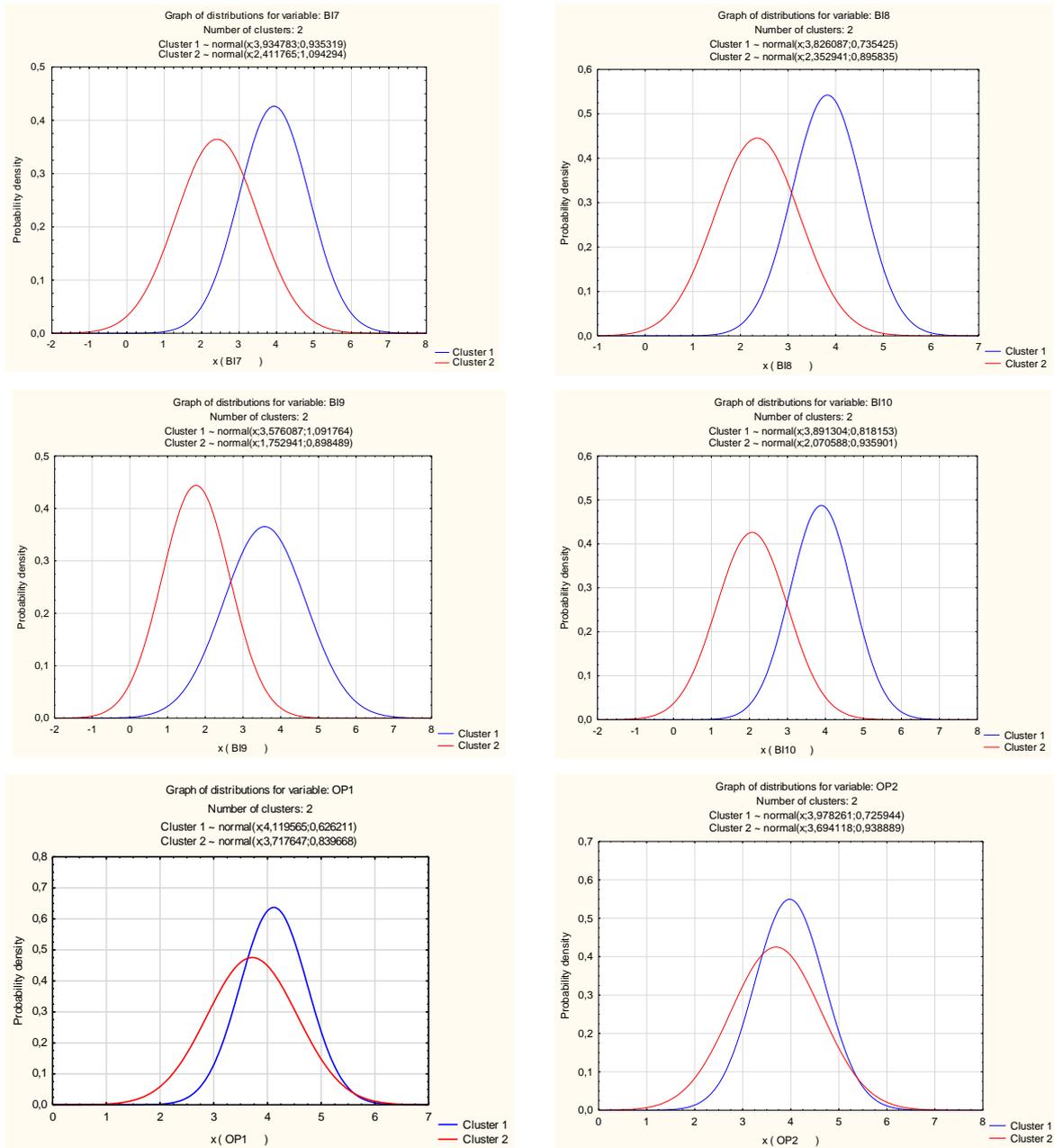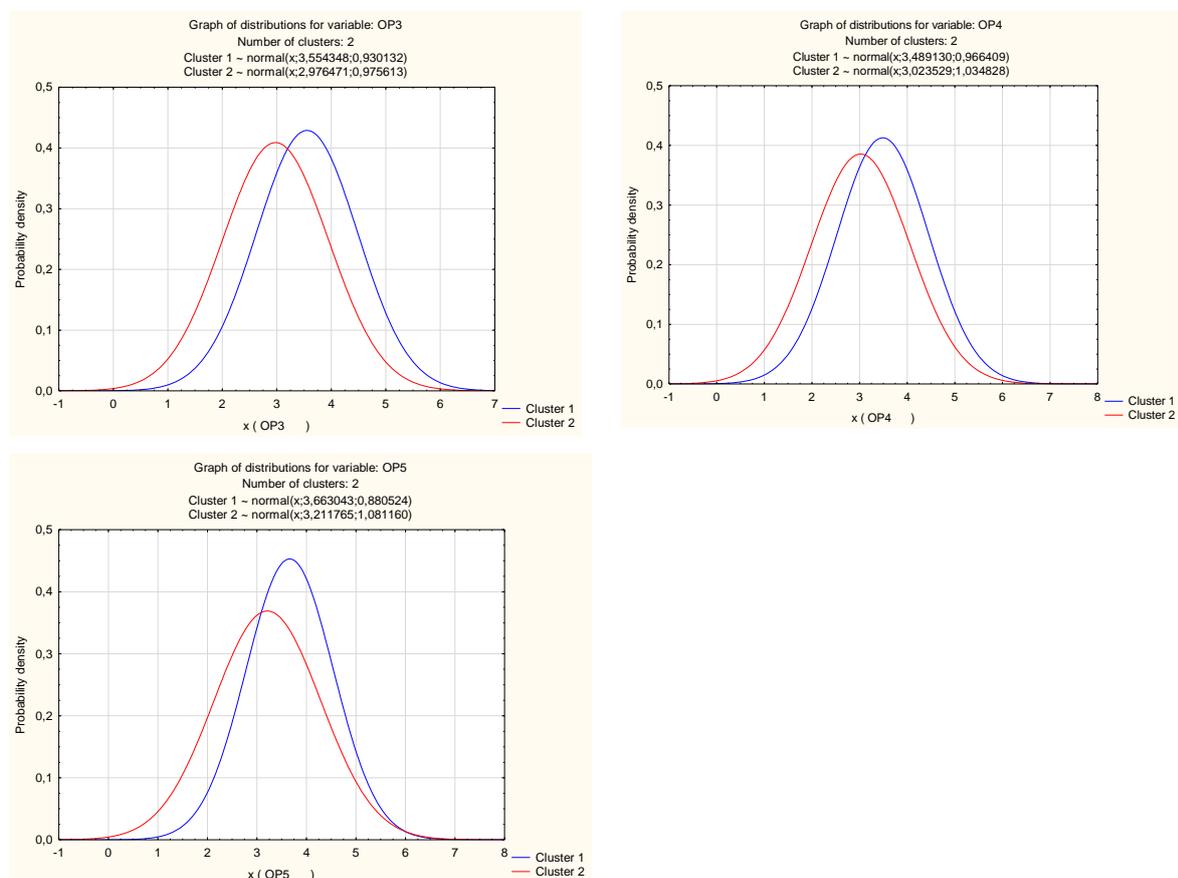

Fig. 4. Distributions of business intelligence and organizational performance indicators across clusters

Note: left curve refers to Cluster 1, and right curve to Cluster 2

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Fig. 4. Distributions of business intelligence and organizational performance indicators across clusters (continued)
Note: left curve refers to Cluster 1, and right curve to Cluster 2

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Fig. 4. Distributions of business intelligence and organizational performance indicators across clusters (continued)

Note: left curve refers to Cluster 1, and right curve to Cluster 2

## 5. Discussion

This section provides a short discussion of the cluster analysis presented in the results section of the paper.

### 5.1   Characteristics of cluster members according to business intelligence maturity and organizational performance

The k-means analysis of the 177 companies from Croatia and Slovenia identified two clusters. Figure 5 presents the graph of mean values of 10 BI individual indicators and 5 OP individual indicators across two identified clusters. Presented cluster means reveal the existence of differences between clusters according to the observed individual indicators of BI and OP.

Cluster 1 comprises 92 companies. According to the results of the analysis, companies assigned to cluster 1 have higher levels of BI maturity as well as the better OP. The level of technical architecture maturity of BI in those companies is very high which means high level of enterprise-wide data warehouse usage. However, the level of the profitability assessment of BI is low in comparison to other BI indicators. In terms of OP, the highest average among other OP indicators is visible with the level of customer satisfaction with products and services of the surveyed companies. This

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indicates that the customers of those companies perceive that they receive their money's worth for the products and services of the observed companies. The lowest average results are present with the profitability of the observed companies. However, all of the stated results are still above the average values present in the second cluster.

Cluster 2 consists of remaining 85 surveyed companies. These companies have lower scope of business intelligence systems usage which means that BI is usually used in isolated manner by individuals within the companies in second cluster. Unlike the trend in first cluster, companies from the second cluster have lower level of the usage of dedicated BI storage. On the other hand, similar to trends in cluster 1, companies from cluster 2 also have low average results in profitability assessment of BI which indicates that the companies in this cluster have low or no profitability assessment of BI. When it comes to the OP, the companies from the second cluster have level of customer satisfaction with products and services of the companies as well as the high customers' retention rate. The lowest results are present in case of the sales growth rate which means the sales growth rate is not high above the average of the industry for the observed companies.
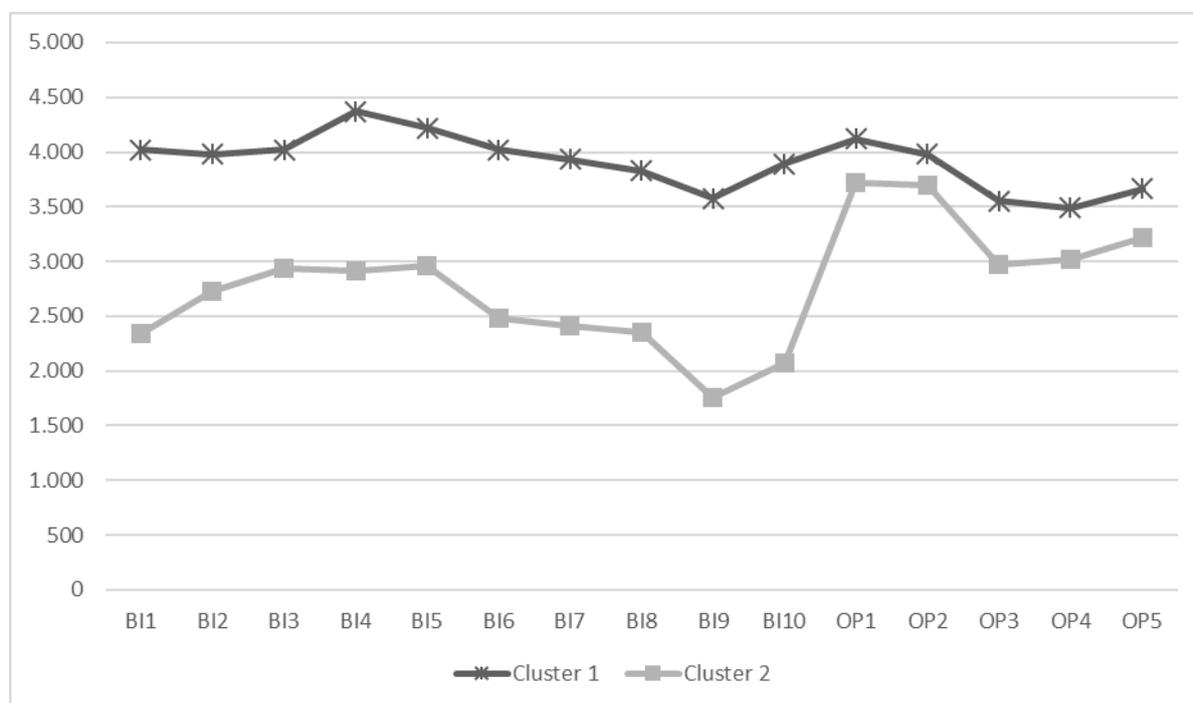


Fig. 5. Graph of the clusters means.

While organizations in both clusters follow very similar pattern in terms of organizational performance (OP1 to OP4), Cluster 1 obviously include mostly the top performers, while in Cluster 2 are mostly the lower performers. Figure 4 and Figure 5 show that the top performers have higher average levels of BI maturity in all its dimensions (BI1 to BI10). Therefore, it is clear that there exists a relationship between BI maturity and organizational performance. While BI mature and BI immature organizations differ significantly in technological aspects, such as the level of technical maturity (BI4) and the types of BI tools used (BI6), the main differences can be found in the organizational dimension, i.e. in the level of profitability assessment (BI9) and the level of BI strategy (BI10), and the scope of usage (BI1). In other words, organizations with higher level of organizational performance use strategic approach to BI implementation with a clearly identified link to the value generated by the use of BI and with this they are also able to provide higher acceptance level of BI. It is reasonable to believe based on these results, that in turn these differences in the approach to BI implementation are reflected in improved organizational performance.

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## 5.2 Differences across clusters according to company characteristics and dominant culture

In order to examine the differences across clusters according to the company characteristics and dominant organizational culture, a cross-tabulation analysis has been conducted. In terms of the country of origin, cluster 1 is comprised of roughly 61% of Slovenian companies and 39% of Croatian companies, while cluster 2 is comprised of roughly 62% of Slovenian companies and 38% of Croatian companies, indicating almost an equal distribution of the companies among clusters with the regards to the country of origin. When it comes to the country of origin and number of employees, there are no statistically significant differences between two identified clusters. However, there are statistically significant differences among the companies of two clusters in terms of the yearly turnover. The results of the cross-tabulation of clusters according to the country of origin and size is presented in table 13.

Table 13. Cross-tabulation of clusters according to country of origin and size

| Characteristic | Category | Cluster 1 | Cluster 2 | Chi-square (p-value) |
|---|---|---|---|---|
| Country | Slovenia | 56 | 53 | 0.041 |
| | Croatia | 36 | 32 | (0.839) |
| Number of employees | 0-50 employees | 8 | 10 | 1.302 |
| | 51-249 | 43 | 41 | (0.729) |
| | 250-1000 | 24 | 23 | |
| | 1000+ employees | 17 | 11 | |
| Turnover | 0-10 mill. EUR | 18 | 23 | 10.002* |
| | 10 mill. EUR – 50 mill. EUR | 36 | 29 | (0.019) |
| | 50 mill. EUR+ | 35 | 21 | |
| | N.A. | 3 | 12 | |

Source: authors' work; Note: * - statistically significant at the 5% significance level; N.A. – not available

Table 14 presents the results of the cross-tabulation of clusters according to the industry. There is an equal number of companies from secondary and tertiary sector present in the cluster 1 (both 36%), while the most companies assigned to second cluster (34%) is from the secondary sector and, in comparison to the first cluster, cluster 2 is comprised of a more companies from the quinary sector. However, there is no statistically significant difference between clusters regarding the industry type of the observed companies.

Table 14. Cross-tabulation of clusters according to industry

| Characteristic | Category | Cluster 1 | Cluster 2 | Chi-square (p-value) |
|---|---|---|---|---|
| Industry | Primary | 2 | 3 | 10.205 |
| | Secondary | 33 | 29 | (0.070) |
| | Tertiary | 33 | 20 | |
| | Quaternary | 17 | 13 | |
| | Quinary | 5 | 15 | |
| | N.A. | 2 | 5 | |

Source: authors' work; Note: N.A. – not available

The results of the cross-tabulation of clusters according to the dominant organizational culture is presented in table 15. The dominant organizational culture among the companies from the cluster 1 is the clan culture (38%). According to the Cameron and Quinn [32], the companies with dominant clan culture are family-like, internally focused and flexible,

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characterized with teamwork, employee involvement programs and corporate commitment to employees. Within the cluster 2, most of the companies (44%) have hierarchy as their dominant organizational culture. Those companies are also internally focused, but at the same time strongly focused on stability and control and characterized by formal procedures, rules and policies [32]. The cross-tabulation analysis revealed statistically significant differences between clusters at the 5% significance level in terms of dominant organizational culture type. These differences could explain the higher average results of the individual BI and OP indicators of the companies from the first cluster in comparison to those from the second one if characteristics of the dominant organizational cultures are taken into consideration. It is important to notice that the use of BI system is mostly voluntary and that it has been shown that socio-organizational factors are the key drivers of BI acceptance and use [47]. Therefore, in organizations with the dominant Clan culture, where the value of BI has been recognized (BI9), the use of BI will be encouraged and will result in high levels of BI usage (BI1). On the other side, in many hierarchical organizations, focused on control and governed by rules and policies, the need to implement and use of BI will not be questioned and therefore the value will not be understood (BI9) to the same extent as in more flexible organizations and its use will not be encouraged (opposed to enforced) throughout the organization (BI1).

Table 15. Cross-tabulation of clusters according to dominant culture

| Characteristic | Category | Cluster 1 | Cluster 2 | Chi-square (p-value) |
|---|---|---|---|---|
| Organizational culture | Clan | 35 | 21 | 8.526* |
| | Adhocracy | 9 | 5 | (0.036) |
| | Market | 26 | 22 | |
| | Hierarchy | 22 | 37 | |

Source: authors' work; Note: * - statistically significant correlations at the 5% significance level

## 6. Conclusion

The goal of this paper was to analyze the impact of the level of BI maturity to organizational performance of the company. In that analysis, the role of the organizational culture has been taken into consideration. The paper presented the results of the k-means cluster analysis performed on a sample of 177 companies from Croatia and Slovenia. Overall, two clusters have been identified throughout the analysis. The cross-tabulation analysis of the identified clusters revealed that the dominant organizational culture among the companies assigned to the first cluster is the flexible and friendly clan culture, while the dominant organizational culture among companies from the second cluster is the structured and formal hierarchy culture. Also, the analysis revealed statistically significant differences between clusters in terms of the dominant organizational culture and yearly turnover.

The results of cluster analysis clearly show that **organizations that can be labeled as top performers (Cluster 1) tend to have more mature BI, as opposed to lower performers (Cluster 2)**. While this study is not conclusive in terms of showing causal relationship between BI maturity and organizational performance, it demonstrates importance of all the BI maturity dimensions. Besides, significant differences between in terms of dominant organizational culture type confirm that **some organizational culture settings are more appropriate for achieving higher level of BI maturity**. Considering the nature of different organizational culture types, the most probable explanation of the results is that while the investments in BI technology are important, achieving overall high level of BI maturity go hand in hand and with some organizational culture characteristics which can in turn result in improved organizational performance.

Although this research extends the body of knowledge, there are also some limitations to be recognized. One of the limitations of this research is unequal ratio of responses gathered from Croatia and Slovenia and relatively small number of respondents on which this research is based, so the generalization of conclusions is limited and further validation and research is needed in order to strengthen the conclusions drawn from this paper.

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