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Development of digital products and services: Proposal of a framework to analyze versioning actions

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ABSTRACT

Recent expansion in availability of data and of technological resources, as well as the ease of generating, reproducing and adapting digital products and services (DPS), has greatly expanded our ability to quickly generate a wide range of digital offerings. This increased capacity and complexity in turn demands greater operational and managerial effectiveness of organizations regarding the management of DPS versions and of versioning practices. Although versioning has been the subject of study in many disciplines, there is yet little theory development that explicitly seeks to understand the impact and dynamics of versioning actions. Using grounded theory as a research method, we develop a broad framework for conceptualizing versioning actions with the aim of obtaining better understanding of different versioning strategies and of the impact of versioning actions on DPS quality, taken from the interference analysis of the dimensions of information quality related to the DPS. Our framework encompasses actions directed to the three principal components of the DPS architecture, namely the content, technological and process platform, as well as their subcomponents. The framework aims to help researchers and managers reflect on and select the most effective versioning actions, thus reducing the incidence of unexpected events arising from interdependence among the dimensions of information quality that may otherwise be missed during the planning and definition of the versioning actions.

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1. Introduction

The expansion of the use of information and communications technology resources across different locations, objects, and persons (pervasive computing) is a central feature of the new and still developing information society (Castells, 1996; Gorey & Dobat, 1996). These developments have allowed the collection and storage of data in an unprecedented scale – the so-called big data phenomenon – which constitutes an excellent environment for the development of new digital products and services (DPS) (Goes, 2014; Jagadish et al., 2014). The ease and low cost of reproducing and adapting digital artifacts, compared to the physical products of the industrial era, creates a more dynamic business environment in

terms of the creation, correction and improvement of DPS (Shapiro & Varian, 1998). In the words of Woodard, Ramasubbu, Tschang, and Sambamurthy (2013, p.537) “relentless innovation and competitive pressures dictate that firms continually adapt these [digital] artifacts to changing market and technological conditions”. These results in a higher frequency of events associated with the life cycle of DPS. More improvement events and the accumulation of new DPS versions to be registered requires greater operational and managerial effectiveness on the part of organizations that undertake versioning practices. In this study, versioning is defined as a set of actions that modify the DPS, including actions directed to its content (improvement, reduction, correction, and/or degradation) and/or to its technological platform (content representation/structure) and/or its process platform (DPS storage, recovery, processing, and presentation).

According to Smith (2010), versioning should be an integral part of academic programs and professional training. However, it is seldom addressed, even in software engineering training programs.

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Regarding scientific research, the subject is the object of studies in different areas, such as business administration (Bhargava & Choudhary, 2008; Gershoff, Kivetz, & Keinan, 2012), engineering (Andrikopoulos, Benbernou, & Papazoglou, 2012; Rezgui, Brown, Cooper, Brandon, & Betts, 1998), computing (Maliappis & Sideridis, 2004; Xue, Orgun, & Zhang, 2008), information science (Tennis, 2006), and geoinformatics (Bakalov, Hoel, Heng, Menon, & Tsotras, 2011). Despite the diversity of areas with interest in the subject, there is yet little theory development that explicitly seeks to understand the impact and dynamics of versioning actions. Equally diversified are the organizational units and professional subdisciplines that practice versioning in companies, with a more intensive and visible use by marketing, operations, and research and development professionals. Regarding the studies on the versioning subject, the bibliographic review described in the second section identifies studies from different areas according to the analysis of the publishing sources. These sources show versioning taxonomies that are piecemeal and ad hoc. The diversity and specificity of the literature on versioning hinder its understanding and use by professionals who need to manage the entire DPS life cycle. According to Van Aken and Romme (2009), fragmentation and specificity impede the application of scientific knowledge by the practitioner. For example, a holistic perception of versioning actions is required from the manager responsible for the DPS, whose actions are comprehensive, covering the conception, definition of sales strategy, operation and evolution of the DPS and who dialogs with professionals from different areas, such as R&D, marketing, and operations.

Although experts in DPS content development, technological platforms for DPS operationalization, and DPS sales and marketing within organizations are different people working in different areas, their actions are interdependent regarding interference with DPS quality. As a result, actions on the different components and subcomponents related to the content or technological platform, for both processing and representation of DPS, must be planned, executed, controlled and adjusted as a whole by the DPS manager. For example, consider the case of a marketing and development professional who must upgrade the DPS content, for which it is necessary to improve the quality of the images in the content, as in a digital book. To achieve this quality, the individuals responsible for the representational technological platform of the DPS may change the images' content structures from the bitmap (BMP) format to the Tagged Image File Format (TIFF). The increase in the size of the image files in the TIFF format creates difficulties for the technological platform of the DPS process because of the longer time needed to transmit and display the contents to the user, which results is perceived as low DPS availability by the user. In other words, there is a gain in the preciseness dimension but a loss in the DPS availability dimension.

The jobs of DPS managers involve activities of conception, definition of sales strategy, and the development, operation and evolution of the DPS, which require cooperation with professionals from different areas, such as R&D, IT, marketing and operations. It is important for DPS managers to have a holistic perception of the diversity of the versioning actions that occur in organizations in order to manage properly the quality levels of their DPS. Considering the fragmentation and specificity of the literature on versioning described in the next section, one can see that the extant literature does not currently provide such a holistic view of the versioning actions from an organizational perspective, as required by the DPS manager. This study addresses this difference between the current (fragmented literature on versioning actions) and the desired (holistic view) situations, defined by Simon (1996) as a "problem space". To explore this gap, we undertook a field study

that attempted to more fully understand and describe versioning actions and their interdependencies within the organizational context. For this purpose, information was gathered regarding versioning actions in five DPS-oriented organizations, which are described in Appendix A. Relevant incidents (text units) were identified in the field data and were coded and classified to obtain meanings and to identify patterns according to the fundamentals of the grounded theory research strategy (Langley, 1999).

To achieve the objective of the study, the following specific goals were defined:

- Identify and analyze the DPS versioning actions performed by the different areas of the organizations, aiming to extract codes that allow for understanding and defining of the dynamics of those actions;
- Identify and analyze the variety and essence of the DPS components and subcomponents that can be changed to create a new DPS version; and
- Discuss the complexity of the versioning actions by describing the effects of the interdependencies of the components and explaining said interdependencies based on the systemic effects among the dimensions of information quality related to the DPS.

2. Theoretical review and conceptualization

To discuss the results of the field survey and to propose and present the new knowledge obtained, it is necessary to conceptualize the components and subcomponents that comprise the DPS, and this subject is the first addressed in this section. Next, a bibliographic review on versioning is presented, evidencing the fragmentation and specificity of the subject, as indicated in the description of the "current situation" used to define the "problem space". The third subsection addresses the conceptualization of the dimensions of information quality used to analyze the versioning actions found in the field survey and described in the "Analysis and Discussion of Results" section. Finally, the term "digital product and service" (DPS) is defined.

An understanding of the concepts of the dimensions of information quality and of the DPS components and subcomponents is necessary for the results of this study to be implemented and to help facilitate managerial decisions regarding versioning actions. This mastery is explained by the analysis of the parts that constitute the main results of this study, called "Framework of versioning actions for DPS". The framework covers the diversity of versioning actions in DPS components and subcomponents, and it identifies such actions as possible causes of changes in DPS quality. The effects of these actions are identified from the analysis of the effects of interference on a set of dimensions of the information quality of the DPS.

2.1. Components of DPS architecture

According to Meyer and Zack (1996), one of the central components of the informational product architecture is the repository, which is divided into content and structure. Similarly, we adopt the term DPS repository, which we too divide into content and structure, which are exemplified and defined as follows. Considering a book as an example of a digital product, the information contained in it represents the content; taking the software available on the Internet as a digital service, the ordered set of arithmetic and logic instructions that constitute the algorithm of the computer program represents its content. According to Meyer and Zack (1996), the content may be placed in different logical or physical structures, for example, codified in letters format on a

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