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Effect of product lifecycle management on new product development performances: Evidence from the food industry

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ABSTRACT

Food industry is becoming more and more crucial for all kind of economies worldwide. Though, despite the higher attention this sector is gaining, there is still uncertainty on how to properly manage food New Product Development (NPD) process. In particular, it is not clear whether IT solutions and methods successfully applicable to traditional manufacturing industries – in particular Product Lifecycle Management (PLM) solution- would have the same positive impact in the food industry. In this context, the present study starts from the belief that even in the food industry the NPD process can benefit from the implementation of a PLM solution. We introduce and test three propositions: (i) the implementation of a PLM solution is positively related to firm's process management capability, thus improves NPD performances; (2) the implementation of a PLM solution is positively related to firm's coordination capability, thus improves NPD performances; and (3) the usefulness of PLM functionalities differs for each NPD stage. The study is based on a multiple case study approach, with data gathered from several multinational food companies. Our results confirm the propositions were correct and specifically the implementation of PLM solutions in food companies positively affect process management and coordination capabilities, resulting in the improvement of overall NPD performance. Moreover, this paper discusses which food NPD stages are affected by PLM solutions and how.

1. Introduction

Nowadays the food sector is considered one of the most important sectors of the current economy and it has drawn the attention of different authorities and organizations [1]. Despite the importance of this sector being recognized globally, companies operating in the food industry still face many challenges in managing their products and competing in the market [2]. In fact, over the last years, an accelerated number of tasks have influenced food companies, pushing them to focus on innovation to maintain, or to gain competitive advantage [3]. In this context, there are different challenges affecting these companies and most of them are related to driving change and creating new demands on product development. Successful companies have to understand and to accept these challenges, and find ways to address them through processes and solutions focused on *new product innovation* and *development* [3,4].

New product success requires excellence in three categories: (i) reducing product development cycle time, (ii) increasing product development innovation and (iii) reusing company knowledge assets [3]. To achieve success in these three areas, companies must look to the factors that drive innovation: people, knowledge, and systems. The latter (systems) enables employees to efficiently leverage the company's expertise and knowledge, as well as to effectively generate big ideas and profitable products. Product Lifecycle Management (PLM) solution could be seen as a key driver of innovation and success [2,5–8]. Though, while successful applications of PLM solutions can be found since the late 1990s in the so-called *discrete* manufacturing industries – where automotive sector shows the greater number of adopters [9]- very little is known about the impacts of PLM solutions implementations in New Product Development (NPD) within *process* manufacturing kind of businesses, where food industry belongs to.

The present study starts from the assumption that, as it happens in NPD in discrete manufacturing industries, also the food NPD process can benefit from the implementation of a PLM solution. This idea originates from the peculiarities that characterize the food NPD process, as outlined in the following. In the food industry, safety is extremely

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relevant [10] especially because of the products vulnerability; e.g. dealing with natural products that are often perishable. Thus, they could become harmful if not managed in a timely and safe manner [11]. It seems then logical to consider as necessary to dispose of a huge number of real-time data about food properties during NPD (composition, state, temperature, etc.) that must be managed and combined with other information. The use of the PLM solution allows to maintain full traceability of accurate and complete product data through the entire product structure, from finished products down to ingredients and packaging materials. Moreover, providing a single, reliable source of technical product description, consents to reduce the risk of quality problems due to product content errors, and to support faster new product introduction. In addition, managing food safety risks across the product development process requires documented policies and procedures that describe how to deal with the product throughout its life cycle [12]. Recipes and formulas must be certified for compliance with regulations. Furthermore, the latter vary from country to country. Indeed, currently, there are myriad of laws, regulations, standards, processes, tools and technologies intended to ensure food safety. Government agencies continue to impose complex and ever-changing regulations on the industry. An example is the Hazard Analysis and Critical Control Points (HACCP) protocol [13], which follows a systematic approach to identify, evaluate and control steps in the process that are critical to food safety. As suggested by Granros [14], a fully automated HACCP protocol ensures that proper controls are developed and integrated into appropriate downstream processes and systems [14]. In this scenario, food companies have to meet all these requests by producing profitable products that are also nutritional balanced, flavorful, safe and appealing [10]. The proper use of the PLM solution supports companies to identify what regulations, policies and obligations are applicable to them. Furthermore, it allows to proactively ensure compliance throughout the product life cycle and fully integrate product quality and food safety into the process of developing and managing products.

Moreover, while retailers and food service operators are demanding improved productivity and lower prices from the industry, consumers have renewed concerns about food safety and are expecting new health and wellness products [15] calling for clearer and more accurate labels [10]. Thus, even in this case, the correct use of the PLM solution allows to ensure product integrity, with a real-time understanding of the impact on compliance, nutrition, and other product characteristics. This solution helps also to improve the communication with the final customer, fostering companies to develop and revise product packaging and labels more effectively, improving cross-functional tasks among technical, marketing, and design teams.

Since in the literature, almost no studies investigate the effect of PLM solutions on NPD performances in the food industry, this paper wants to cover that gap. The main idea in which this work is grounded is that even in the competitive and highly regulated food and beverage industry, an integrated PLM solution can improve the NPD performances, affecting both firms' *process management capability* and *coordination capability* (these two dimensions will be presented in the next section). Despite the growing importance assumed by PLM solutions in the scientific literature, not only few studies investigate the moderating effect of a PLM solution adoption for NPD performances [16], but also none of them is on food industry. Building on the pioneer work of Tai [16], with this study we are investigating how PLM solutions can improve NPD performances in the food industry, as well as at which stages of the food NPD process are affected by such solutions and how (which performance are influenced), since we expect different phases of NPD might require different data input and activities to be performed.

Not only literature lacks of studies able to explain the impact of PLM solutions on food NPD performance, but also food NPD process has not been clearly described yet. This is why with this research we want to first explore and schematize a generic food NPD process, that we call New Food Development (NFD) process. By doing that we are focusing on big enterprises, since large firms usually have a more formalized and structured NPD process, as well as a PLM solution can often represent an expensive investment usually only large firms can afford.

After an introduction of the conceptual background behind this study, and of the relative propositions (Section 2), we describe the research structure and explain the methodology used to conduct the study (Section 3). In Section 4, the findings of the research are presented and later discussed in Section 5. Finally, Section 6 concludes the paper, summarizing main contribution – both in term of knowledge and practice- of this research and outlining future and ongoing research directions.

2. Conceptual background and research model

2.1. IT solutions and NPD performance

The term 'life cycle' generally indicates the whole set of phases from 'its cradle to its grave'. Product life cycle can be defined by three main phases: Beginning of life (BOL) including design and manufacturing, Middle-of-life (MOL) including distribution, use and support and, and End-of-life (EOL) where products are retired in order to be recycled or disposed [17]. This paper focuses on the BOL phase, as it is recognized as the most adding value phase [18].

Creating an integrated product information environment is an important determinant of a company's capacity to manage the life cycle of their products [19]. Literature proposes various Information Technology (IT) solutions that can support NPD [20–22]. Laurindo and de Carvalho [23] studied the link of enhanced performance of the NPD process while increasing their use of IT applications. The results of the analysis showed a competitive advantage, understood as a reduction in development cycle time and development cost, and the increase of customer satisfaction, perceived as the executive perception of improvement in final product quality. Moreover, according to MacCormack, Verganti, and Iansiti [24], the effective use of IT in NPD to provide agility and responsiveness has become a source of competitive advantage. The positive impact of IT on NPD can be achieved in different ways, with tools such as databases, project management applications, design tools (like CAD/CAE/CAM) and interconnection between the different players in the development process [23]. Thus, the role of IT in NPD can vary from simple administrative support to an important strategic position [25].

2.2. PLM

The acronym PLM has been broadly adopted and defined by different communities with slightly different interpretations. One definition that sums up all the previous is the one of Terzi et al. [19], defining the PLM solution as a product-centric – life cycle oriented business model, supported by IT, in which product data are shared among actors, processes, and organizations in the different phases of the product life cycle for achieving desired performances and sustainability for the product and related services. As a technology solution, PLM is an integrator of tools and technologies that streamlines the flow of information through the various stages of the product life cycle and seeks to provide the right information at the right time and in the right context [19]. Such solution has come to signify what some call the 21st-century paradigm for product development [26] as it addresses the entire life cycle of a product and its intimately cross-functional nature [27].

PLM is made of several ICT tools, platforms and systems. A special impact of PLM is on BOL phase with a huge variety of tools and systems supporting the various design and development activities [18]. PLM solutions include integrated information systems that comprise different industrial software such as Computer-Aided technologies (CAx) integration, product data management, computer-integrated manufacturing, and configuration management systems [16]. Product