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Industrial challenges in managing product development knowledge

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ABSTRACT

To systematically create and share product development knowledge creates challenges for engineering companies. This paper presents an extensive study regarding the process of identifying such challenges in managing product development knowledge from the perspective of designers and engineers. This research is part of the LeanPPD, a project funded by the EU-PF7 (www.leanppd.eu), to address the need of European manufacturing companies for a new model, which extends beyond lean manufacturing and incorporates lean thinking into the product design and development process. A rigorous research methodology has been employed, which included the use of questionnaires and focused interviews with key informants from industry, involving forty-two product development engineers from nine different companies. The most significant concerns raised during the study concerned knowledge life cycle activities, product development environment and management. Thirty-eight challenges were identified, classified and discussed in order to provide the knowledge management community with practical evidence, and also to inform future research directions in managing product development knowledge.

1. Introduction

Developing new products is vital for long term success in manufacturing organisations [11,29,16]. Previous research indicates that most of the product life cycle cost is committed in the early design stages [48,5,12]. It was also during research into product development that Takeuchi and Nonaka [52] realised the importance of knowledge transfer and learning organisations, from which later developed the model of knowledge conversion [40–42]. This has since been recognised across different disciplines, such as manufacturing [36], management [10] and information technology [31]. Hence, the capacity to develop successful products depends to a significant extent on managing product development knowledge. This perspective is commonly agreed upon within the emerging lean product development community [29,26,30,50].

Currently however, companies operate in an environment that demands ever increasing knowledge management capabilities. Successful companies in the automotive industry for example, compete to globally create and share knowledge [22] between a distributed network of suppliers [13,24,23] and moreover amongst different product platforms and modular toolkit systems [54]. Hence, recognising knowledge management throughout all aspects of product development is highly complex and challenging. This paper contributes to the understanding of apparent challenges in product development by providing industrial evidence from key informants, and concludes with further insights regarding those critical challenges which require further research in terms of future knowledge management. In view of that, the study employs a novel research method aiming to interpret first hand empirical data into real industrial challenges in conjunction with a classification method to represent its results.

The remainder of this paper comprises a review of related work in the area of knowledge management which discusses challenge-related themes in product development, followed by the research methodology employed in this study and a section illustrating the results of empirical data analysis and classification. Three further sections discuss the challenges of managing product development knowledge, focusing on the most significant identified concerns, ending with a section presenting the conclusions from the research.

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2. Related literature

The related literature has two facets; firstly, relating to knowledge management in product development or in organisational levels which include product development functions; and secondly, in the context of reporting challenges to managing product development knowledge. Publications were targeted that discussed related themes regarding either the demand for explanation or justification of encountered conditions, or which questioned subject related aspects of knowledge management.

Such challenge-related themes are discussed in different ways. Alavi and Leidner [2] for example, identify research issues in the knowledge management process, whereas Heisig [18] identifies critical success factors as named in knowledge management frameworks found in science, practice, associations and standardization bodies. It is difficult therefore, to find a single piece of research that addresses a wide range of challenges. In reality, these types of research did not focus on identifying challenges of managing product development knowledge in the first place. However, a discussion of challenge-related themes could be identified as a result of the adapted research methods. The literature review revealed the following three types of work based on the research method:

- Work based on secondary data resulting from reviewing and reflecting published sources.
- Work based on empirical data resulting from industrial survey research.
- Work based on empirical data resulting from direct observation in the company to perform a case study.

The work type based on secondary data discusses challenge-related themes in different subject areas. These are organisational knowledge management [2,4,18], learning in project teams in new product development [14], knowledge management in manufacturing [6] and engineering design [38], and knowledge-based engineering [53].

The second work type is based on empirical data resulting from industrial survey research. This includes research in the subject area of knowledge management systems [1], information management in engineering SMEs [20,19] and product innovation [25]. Survey research discussing challenge-related themes in the particular subject area of new product development include supplier knowledge exchange [11], knowledge management [33], inter-firm knowledge transfer [27], knowledge creation [47] and lessons learnt [17,28].

The third type of work discussing challenge-related themes is based on direct observation within the industrial environment. These include subject areas of lean product development implementation [29] as well as knowledge sharing [7] and collaboration [44] in new product development.

Given the above, twenty articles have been reviewed according to the discussed challenge-related themes and presented in Table 1. A total of fifty-nine challenge-related themes have been identified and categorised into eight groups. The numbers in brackets, as illustrated in Table 1, correspond to the number of similar themes within the discussed group. For example, knowledge-access was raised as a demand for justification in two articles, namely by Kalogerakis et al. [25] and Schulze and Hoegl [47], hence the number 2 is shown in brackets. The following paragraphs presents the identified challenge-related themes based on similar group discussion as listed in Table 1.

Most of the reviewed articles discuss challenge-related themes with regard to knowledge processes such as -transfer, -storage, -mapping, -access, -identification and -creation. Kalogerakis et al. [25] for example, recognise the lack of a formal process for decision taking and stated that engineers have limited access to knowledge sources that support product innovation. Moreover, Schulze and Hoegl [47] identify the combination of explicit knowledge as particularly challenging during knowledge transfer in product development. The demands of exploring supporting knowledge management techniques includes knowledge mapping [6], knowledge representation [38,29] and knowledge identification [44,6].

Another group of discussion themes refers to the management of information covering challenge-related themes of information; these being -flow, -excess, -redundancy, -transfer and -prioritisation. It is evident that information management is subject to a large quantity of legacy information [38] embedding redundant [33] or flawed [19] information into its challenge. In addition, the translation of information into new products [11], as well as definition and prioritisation of information [7] is seen as challenging when exchanging knowledge in product development.

With regards to communication, challenge-related themes include cross-functional as well as team related barriers. The latter include temporary team membership [14] as well as team distance [47]. The application side of knowledge triggers various possibilities, though a challenge remains to address its integrity and re-use side [53] in particular as an automatic mechanism that support the acquisition of new knowledge [6].

Challenge-related themes discussed regarding the aspect of management demand enhancement of current practices, such as involvement of key management in mentoring or storytelling roles during post project reviews, as identified by Goffin and Koners [17]. Other management challenge-related themes include misconceptions with regard to extent of knowledge capturing [4] or definition of knowledge management systems [1], quantification of advantages [53] as well as the outsourcing of technical knowledge [29].

Discussed challenge-related themes with regard to the corporate organisation highlight the magnitude of project complexity [14] and organisational structures [18] that consequently trigger challenges of integration [6] or embeddedness [14]. Knudsen [27] also highlights the organisational environment, in particular the difficulty of expressing customer need in inter-firm relationships.

Human related challenge-themes include discussion about associated factors, such as effect of routine tasks on product innovation [27], fluid team boundaries [14] as well as trust in technical competence among product development team members [33]. Lu et al. [32] point out the challenge to fuse subjective assessment and objective data to realise a comprehensive evaluation of proposed design solutions, since a human-centred product development involves complex situations and members with different opinions on certain criteria. Challenge-related themes with regard to technology include demand for extended IT capabilities [2] as well as alignment of technology and knowledge management with corporate strategy [4].

The review of the related literature presented the identified challenge-related themes in managing product development knowledge and their inter-relationship based on similar areas of discussion. This is summarised in Table 1, which also provides the platform to relate such themes to the industrial challenges, as presented later in this paper. The review has revealed a need for further empirical research to enhance the current state-of-the-art in the area, as well as to focus primarily on identifying an extended range of industrial challenges. In addition, the collection of first hand empirical data purely from key industrial informants would enhance the current understanding of challenges encountered in managing product development knowledge.

Given the above, this paper focuses on the identification of challenges in managing product development knowledge from the perspective of key informants, namely product designers and