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# Transition towards Circular Economy: An intraorganizational perspective identifying knowledge wastes

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**Abstract.** Circular Economy (CE) has been embraced among multiple academics and practitioners alike for some time now. However, in Operations Management it is still in its infancy. Consequently, the dimension of organizational aspects has remained unclear. This study picks up this depict and provides manufacturers with valuable insights regarding in-house product development when transitioning toward CE, which is important as this is where the production starts. To sharpen the understanding of CE from a theoretical point of view, the study applies Lean thinking as an Organizational learning system where a special focus towards Organizational knowledge is put forward.

**Keywords:** Lean thinking, Circular Economy, Sustainability, Organizational learning, Organizational knowledge, Action research

## 1 Introduction

Academics and practitioners have embraced Operations Management (OM) concepts to increase the likelihood of improved sustainable operations [1]. Despite the plethora of publications accentuating the many benefits within sustainable strategies, especially those embedded in Circular Economy (CE), the body of knowledge is inadequate. For instance, there is still limited research focusing on the transformative capacity of a firm to change the linear economic modes of production [2]. This is rather interesting as the transition towards CE is evident in the face of present challenges such as environmental impacts and resource scarcity while its implementation seems to be determined by internal operations. These aspects are of great importance for manufacturing firms as

production is a transformative process itself. After all, the processes of input of material transformed into outputs is achieved by the use of resources, intangible and tangible, organized in a production system [3]. Thus, it will not be enough to just add new priorities and principles to firms and their production systems, as a successful transition towards a sustainable and CE strategy often involves a complete restructuring [4]. According to [5], it is therefore beneficial to encourage and facilitate for organizational learning as it is more effective that employees realize that changes in norms and values of the wider society are aligned with the direction of the new paradigm the organization is embracing. However, to enhance the possibilities for organizational learning to sustain and prosper, the processes and notion of knowledge creation and sharing is imperative. Recent research in OM accentuate that firms should be aware of the opportunities that lie in a knowledge-based approach during the assessment and encouragement of continuous learning, as this seems to generate the awareness, learning and actions necessary to thrive sustainability in firms' operations [2, p. 821]. While circularity and sustainable development are inevitable principles for any industry to tap into, lean thinking has been heightened as the means to achieve such a transition because of its strong focus on people [6]. After all, organizational structures, activities and operations are intertwined processes that have great impact on product and service outcomes, and on the people performing these tasks. Accordingly, to succeed with sustainability and circularity, there is a need for manufacturers to take ownership of their environmental performance in their products [3] and continue engaging in developing the people dimension of their organizations.

Despite the promising element embedded in CE, it is on an embryonic stage with regards to several aspects. For instance, issues targeting firms' readiness level, the scarce amount of ready-to-use applications, and behavioural and policy-oriented issues have been accentuated [7]. Thus, it is essential to comment on both opportunities and challenges about how to ease its application. Also, within the field of OM, CE is in its infancy, consequently (intra)organizational aspects have remained unclear [4]. This study picks up the latter depict and aims to sharpen the understanding of challenges in transition toward CE within the context of lean thinking as an organizational learning system and the perspective of organizational knowledge. More specifically, the study delineates knowledge related obstacles encountered during an ongoing CE project, which is developed in collaboration with a medical engineering firm and their product development function (PDF).

The rest of the composition of the study is as follows: An introduction to relevant theories is provided in chapter 2, while chapter 3 describes the research methodology deployed. In chapter 4, we present the findings, which also represent the frame of reference for the discussion and the concluding remarks in chapter 5.

## **2 Theoretical background**

### **2.1 Lean thinking**

There is still a general misunderstanding of what lean thinking is and how it can contribute with value creation beyond waste elimination on the shop floor [8]. According

to [9], the main objective of lean is to eliminate waste by concurrently reducing or minimizing, supplier, customer and internal variability, as a means of an integrated socio-technical system. Similarly, this research departs from a lean thinking paradigm and thus does not consider lean as merely a production system just emphasizing waste elimination. Instead, lean thinking is viewed as a holistic approach in OM that allows problems to surface, and then solve these problems by encouraging learning cycles resulting in knowledge creation while preserving a culture of continuous improvements [10]. In so doing, lean is perceived and applied as an organizational learning system focusing on long-term goals and sustainable competitiveness. While the latter characteristics underscore the need for dynamic capabilities and proactiveness, the aspect of organizational learning heightens lean as a people-centric philosophy.

This does not mean that one should exclude the important and effective principle of waste elimination, on the contrary. If manufacturers are to be able to stay competitive, the capability to detect and execute waste elimination is crucial, especially as the societal awareness and concerns surrounding environmentally damaging practices and sustainability has intensified. It might even have become a necessity to extend waste elimination along the production phase to be able to consider the entire lifecycle and thus the whole value chain of the manufacturer [11]. Waste is therefore part of the sustainability thinking paradigm. More so, lean thinking is argued to support the proper choice of processes (and technology) that use renewable or better-performing resources with the purpose of eliminating waste and continuously improve to reach the ultimate ambition of an overall zero waste environment [6, p. 16], which particularly coalesces with CE [3]. Compared to lean thinking however, the social dimension in CE is often overlooked, which is rather surprising as the transition is equal to a ‘hyper’ change that requires not only an organizational transformation but necessities’ a cognitive shift throughout the organization.

Hence, rather than simply associating lean thinking as a tool to eliminate waste, it has developed into a philosophy to gain competitiveness by continued learning. Theories on organizational learning are quite explicit in that learning leads to improved operational performance and more importantly improved capabilities [12]. Thus, it is intriguing to think about how a well-calibrated system such as lean thinking, developed through synthesized learning can reap advantages of individual best practices and tools organizational wide [10]. Hence, this mirrors our holistic approach to lean thinking as an organizational learning system.

## **2.2 Organizational learning and Organizational Knowledge**

According to [13], organizational learning is at its core a status of continuous change since changes follow when organizations acquire experiences. These experiences affect both cognitive and behavioural learning patterns or outcomes. For instance, learning patterns, which can be equal to operational learning, are often a step-by-step task (e.g., operating a piece of machinery) that can be captured in routines which later plays it out in know-how. While the cognitive element of experience is related to what [14] refers to as conceptual learning, as it has to do with the thinking behind why things are as they are. This form of learning sometimes challenges prevailing conditions or procedures

and thus leads to new frameworks in the form of mental models. The new frameworks in turn can lead to new opportunities for discontinuous steps of improvement by re-framing a problem in radically different ways [14, p. 55]. As such, learning can be understood as a process that emerges when an organisation gets to know something new and acquire the knowledge to transform it into actions, without necessarily acting upon it [15]. This is similar, to what [16] are heightening in their theories of action, when they stress that actions represent a measure of what is actually learned. Others define organizational learning as the process of improving action through better knowledge and understanding [17, p. 803].

Organizational knowledge as a concept is challenging to clarify as it embodies two kinds of awareness: a focal identifiable (explicit) object and a subsidiary (where tacit knowledge is embedded), unidentifiable one which are mutually exclusive and represents the structure of all acts of knowledge [18, p. 58]. While, explicit knowledge can be identified and thus articulated, tacit knowledge is highly personal and difficult to communicate by verbal articulation. Moreover, the source of tacit knowledge creation is a result of experiences performed by the individual(s) [19]. However, knowledge obtained can be embedded in a variety of repositories, including individuals, routines and transactive memory systems. Consequently, changes in one of these repositories means changes in organizational knowledge which again co-shapes and pre-structures practices, and thus stimulates organizational learning [13].

Within the context of lean, it is therefore not enough to acknowledge that organizations and their employees must learn, equally important is how organizations do when they learn what they need to know [8]. While in CE, organizations must aim to guide and inform the integration of different types of knowledge and perspectives as well as the consideration of multiple means and actors that must be addressed for transformative actions [1-2]. Thus, to meet the required transitions with regards to sustainability, waste elimination and value creation, firms must nurture the enhancement of organizational knowledge.

### **3 Methodology**

This study is part of an extensive research project focusing on cyclic thinking and circular products where the research team have been actively involved in the planning process, which helps to ensure that relevant aspects are being accentuated when developing the research design. That said, (all) involved participants have collaboratively developed the project which contributes to bypass a linear problem solving approach, and thus enters a cyclic methodology, including elements concerned with deliberate reflections [20]. Accordingly, the researchers have not only been involved as participating experts but as learners themselves, which in methodological terms is referred to as action research (AR) [21]. Coughlan and Coughlan [20] heightens the potential of using AR in OM when investigating complex and emerging organizational aspects. More importantly, AR emphasizes societal changes and local constructivism [22], which is a critical element when transitioning toward CE. Further important aspects

warranting AR is the ability to create and disseminate knowledge while at the same time learning from the context and the phenomenon under investigation.

During an ongoing CE project at a medical engineering firm (henceforth Alpha), data were collected in an iterative manner between theory and the following learning actions; a Gemba walk, 12 semi-structured interviews, Extended Value Stream Mapping, a workshop and by the means of Obeya. The obtained knowledge derived from the gathered data went through several rounds of reflections, both individually and in collaboration with participants, which elicited an awareness among the participants of how their way of working and thinking impacted on what they registered as why things are as they are (cyclic thinking). These insights were later brought into the analysis during an open coding process. Based on the foregoing actions, a number of issues came to the fore. In the following section, we delineate typical organizational knowledge related obstacles encountered during the production process of one of Alpha's high-tech medical mannequins (SmartX). Hence, SmartX is meant to be used as a frame of reference for Alpha's remaining product portfolio, which aims to be produced according to CE principles and thus suitable for this purpose.

#### **4 Findings – Knowledge obstacles as wastes**

Continuous sustainability of any firm depends on how well it manages its waste generation, especially as waste minimisation is requisite to preventing materials depletion [23]. At Alpha, such waste is caused by various activities especially at design, sourcing, and the manufacturing stages of the product lifecycle. Specifically, the interview findings reveal that there are some instances of typical wastes generated by the sourcing function as a result of untimely exchange of information with the PDF and the constant upgrades of SmartX leading to ineffective materials' purchase (over/under procurement), inefficient inventory management and wastage of storage. Waiting another typical waste in lean, was mentioned in connection with time spent searching for available resources, which was common in product development (PD), where much of the time was spent on searching for engineers to perform critical mechanical tasks. This is a major challenge as it indicates lack of multi-skilled / flexible human resources at Alpha that can respond quickly and be re-tasked to other teams as demand changes.

Other types of wastes experienced by all participants at Alpha include misused human resources and ineffective internal communication, where the former is known as the eight waste in lean but also fall under CE. This type of waste contributes to the loss of general improvements opportunities like skills, time, upgrades and learning and knowledge sharing [24]. Hence, it occurs when employee skills, talent, and capabilities are underutilized, not adequately used, or simply not utilized at all [25]. A severe issue related to this is the aspect of lack of resources, which was aired on several occasions, particularly when highlighting obstacles related to capacity constraints and unavailability of technology. Despite these notions, especially regarding capacity constraints, is the challenge with loss of tacit knowledge. Most noteworthy because engineers and/or

designers are leaving for greener pastures. This could potentially impact on the firm's growth and economic competitiveness as the technical elements (cf. know-how) is crucial during PD and hence, often shared or obtained through human interactions. The cognitive elements (cf. mental models) are crucial with regards to the transition CE requires. Accordingly, tacit knowledge is embedded in both individuals and in organizations [19]. Hence, within the context of CE adoption, this might be a challenge as that would mean all the CE non-codified, disembodied know-how that is acquired via the informal absorption of learned behaviour and procedures [26], can be lost with the CE experts leaving or quitting their current jobs. The concerns heightened regarding tacit knowledge was not only restricted to individuals leaving Alpha, but also targeted existing competence gaps leading to consequences that could hamper the knowledge base of the entire organization. The latter notion magnifies the potential obstacles that can emerge between the manufacturing function and the PD with regards to e.g., knowledge mismatch and thus impact the entire life cycle of the SmartX. For instance, the lack of material know-how can result in unnecessary design features or increase environmental damages, while weak technical know-how can result in massive rework. A severe hampering aspect for CE strategies.

Closely related to this is the lack of knowledge reuse, which was accentuated by all the functions. With no reuse of knowledge, the teams are unable to coordinate different resources from several aspects, hindering them in analysing and solving problems better, as well as creating new solutions [10, 24]. Lack of reusing knowledge of previous project implies waste of design time and needless surge of design changes for the designers at Alpha. For example, the designers may not be able to draw lessons from the successful solutions before when designing similar versions of mannequins, thereby leading to an increase in the human capital investment as well as making similar mistakes (rework). However, this is not unusual, as knowledge reuse rate is not high in most engineering design teams. This is mostly due to the existence of knowledge heterogeneity in PD that increases the difficulties of knowledge reuse [10]. At Alpha, designers are limited in their ability to maximize knowledge reuse by the fact that there are so many difficulties to search for, access, and integrate reusable design knowledge across multiple sources. Accordingly, there seem to exist an inherent obstacle with regards to knowledge utilization. Otherwise, reusing knowledge can accelerate the speed of knowledge transfer and share within and across functions at Alpha, as well as improve their agility.

Figure 1 summarizes the most typical types of knowledge obstacles as wastes encountered by the PDF. Knowledge wastes at sourcing and the manufacturing stages along the product lifecycle of SmartX are also included.



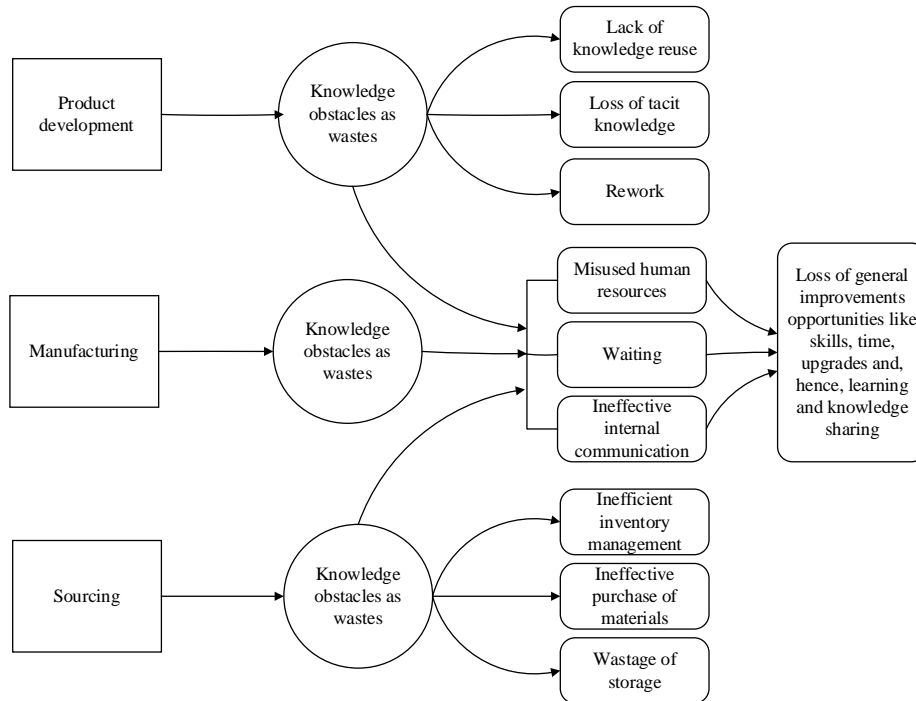


Figure 1: Knowledge obstacles as wastes

## 5 Discussion and closing remarks

It is not a novel insight in OM that PD including design, plays a crucial role throughout the product life cycle, and that it affects both manufacturing and operational phases. Reflected upon from a lean perspective, the delineated organizational knowledge obstacles in this study, illustrate the important aspect of a product-centric approach also when embarking on CE. An important insight obtained is that the perspectives of lean as an organizational learning system can assist firms to foster the capabilities needed to localize knowledge, reuse it, and hence transform it into usable knowledge in PD. This is because learning (cycles) is the basic tenant of lean, but also because of its strength in knowledge creation and not least the embodied culture of continuous improvements. Yet these intrafirm aspects seem to be neglected features of PD in general [10] and in our case for CE in particular. Of course, what type of organizational knowledge that should be of value and therefore learned and reused, as well as what type of organizational knowledge is lost or not identified within the realm of PD depends on its context, and therefore likely to attain different priority when posed to different functions for the same product. Thus, the more relevant or adequate knowledge the PDF has access to and the more efficient they can utilize and share it with interrelated functions (i.e.,

manufacturing) along the entire life cycle the leaner the product and its process and better the chances to achieve circularity.

Hence, organizational knowledge obstacles can be perceived as a double sword challenge. Firstly, its traits represent a severe waste in CE. Secondly, they seem to hinder organizations to learn what they need to know [27] and thus, also the cognitive changes required when transitioning to CE. In other words, obstacles related to organizational knowledge sketch some deeper problems for manufactures in how to alter existing and future products to better fit both the capabilities of the manufacturing system [cf. 3, 8, 28] and the belief systems of employees, as well as those of CE. Hence, detecting organizational knowledge obstacles in PD on the pursuit of designing and manufacture sustainable products requires firms and their members to learn how to learn. The leverage seems to lie in obtaining high levels of organizational knowledge, to challenge established thinking and to re-examine the established PD paradigm. When embraced in such manner, opportunities to stimulate learning about how to act our way into new ways of thinking [29] also referred to as double-loop learning [16], emerges. Accordingly, by combining lean thinking (when executed as an organizational learning system) with CE principles as a means to develop new business strategies seem to be a promising approach to tap into when a firm needs to think in a cyclic manner to produce tomorrow's circular products. Afterall, learning is the change in knowledge and the change in knowing, which involves changes in cognition and changes in behaviours.

Although our findings are interesting, they should be interpreted in the context of the limits inherent in AR. Because the process of knowledge creation and the absorptive capabilities needed for organizations to embed them takes time, exploring organizational knowledge challenges with regards to CE as an active learner might therefore require a longitudinal design. However, since the current study is part of an ongoing CE project, the potential to add to the knowledge obtained so far, is already initiated and where some of it reported through other academic channels. Thus, the continuation of AR learning and its dissemination is somehow secured.

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