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The Potential for Purchasing function to Enhance Circular Economy Business Models for ETO production

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Abstract. Inclusion of ‘circular principles’ in the activities of the purchasing process from the initial stages to the end of product life can help all actors in the value chain to deliver sustainability goals through an active, cost-effective and accountable approach. Yet, research on this linkage has been virtually nonexistent. This study extends perspectives and theories on purchasing and circular economy business models (CEBMs) for engineer-to-order (ETO) production. Based on a case study, a framework that identifies critical purchasing activities relevant for enhancing the implementation of CEBMs is developed. The framework advocates that engaging in the proposed activities can compel the purchasing function to increase its strategic focus by being proactive and relentless in embracing circularity in its agenda. In addition to accentuating the relevance of purchasing function in ETO production, the framework shows how harnessing it can benefit circular strategies.

Keywords: Circular Economy Business Models, Strategic Purchasing, ETO production.

1 Introduction

The potential for the purchasing function to unleash strategic benefits is well documented. Nonetheless, a gap still exists between the potential strategic role of purchasing and the operational role it continues to exhibit. As such, purchasing must abandon the status quo by focusing on issues beyond cost cash savings and start building long-term capabilities for making broader contribution to the organization’s value creation [1]. Since value creation processes of a firm are embodied by its business model (BM), creating strategic value will require purchasing to play an active role in enhancing the implementation of organizations’ BMs. Currently, there is a wide consensus that adopting circular economy (CE) is critical for realizing sustainability ambitions and for the promotion of economic growth [2]. However, achieving these ambitions will only be possible if businesses start to embrace CE strategically and operationally along with the

enactment of appropriate and consistent regulations [3]. Thus, businesses must implement circular economy business models (CEBMs) [4], which can be defined as “the rationale of how an organization creates, delivers, and captures value with and within closed material loops” [5].

Despite being critical for economic growth and a sustainable future, the adoption rates of CEBMs have been fairly low [2]. Among other things, the required changes in product design, production, and logistics systems pose a challenge in the implementation of CEBMs [5]. Conceivably, ways for enhancing the adoption of CEBMs warrant attention. The present paper explores the potential role of the purchasing function in enhancing the CEBMs for ETO production. The ETO context is selected for two reasons. First, CEBMs for ETO production has so far received limited attention despite its importance [7]. Second, purchasing plays a vital role in accomplishing ETO projects [8]. Therefore, insights provided by the present study are relevant to purchasing practitioners working in an ETO environment as well as scholars who investigate ETO related matters.

2 Strategic purchasing in the ETO production environment

Strategic purchasing can be defined as “the process of planning, implementing, evaluating, and controlling strategies and operating purchasing decisions for directing all activities of the purchasing function toward opportunities consistent with the firm's capabilities to achieve its long-term goals” [9 pp. 201]. Stated differently, strategic purchasing is exemplified by its focus, involvement, and visibility in the creation of firms' competitive advantage [10]. Thus, to be strategic, a purchasing function must be aware of the firm's strategic plans, proactive in its operations, willing to take risks, and relentless in pursuing strategic objectives. More so, purchasing must participate in the strategic processes of the firm [11]. This will allow alignment of the purchasing strategy with the firm's business strategy, which according to [12], is important for contributing to the competitive advantage.

Broadly, ETO refers to a production strategy whereby a product is designed, engineered, and produced according to the specifications provided by a specific customer [13]. This way, ETO products tend to be highly customized and produced in low volumes (often one-of-a-kind). Since the design of ETO products starts when a customer places an order, it is challenging to accurately forecast demand, identify all the required materials and produce the products in advance [14]. Like other products, the value of ETO products can be distinguished into customer's perceived value versus supplier's perceived value [15]. As ETO products are customized according to the customer's specifications, their business viability is only possible when the customer's perceived value surpasses the ETO vendor's perceived value [16]. Taken together, the features of ETO production have implications on the purchasing strategy of the firm. For instance, the sequence that engineers decide how the product should be assembled may not necessarily be the optimal sequence for purchasing the required inputs. Following [12] and [17], this indicates that for a purchasing function to deliver strategic benefits in an ETO environment, it must participate in the strategic processes of the firm and calibrate its

activities accordingly. In some cases, it may also need to be proactive in initiating strategic initiatives.

3 Potential CEBMs for ETO production

In the emerging field of CEBMs, Kvadsheim et al. [7] examine ETO products and propose their relevant CEBMs, which are briefly described in this section: 1) *Circular supplies* that involve replacing traditional production inputs with renewable, bio-based or recovered materials that can influence the conceptualization of ETO product design and manufacturing process; 2) *Product life extension* aims to extend the life of products (e.g. through reuse, remanufacturing). This is desirable from a CE perspective, as it implies ETO products and materials embedded in them would remain in the system for a long time, thereby reducing extraction of new resources; 3) *Product as a service* offers product access and retain ownership to internalize benefits of circular resource productivity. With this model, ETO firms have an advantage in selling services and recapturing residual value at end-of-life and 4) *Resource recovery* involves production of secondary raw materials from waste streams. This model is a good fit for most ETO firms, especially where waste material from products can be reclaimed through take-back management and reprocessed cost effectively.

Building on the work of [18] and [19] in distinguishing CEBMs from linear models, [20] categorize CEBMs according to the mechanisms by which resources flow through a system. *Slowing loops* is about designing long-life products and extending the life of products to slow down the flow of resources. *Closing loops* is about recycling to close the loop between post-use and production, and *narrowing loops* aims at using fewer resources per product (e.g. through efficient manufacturing processes and lightweight product design). What is more, while slowing and closing resource loops clearly characterize CE, the narrowing loops strategy also fits in the current linear economy [21]. From these aforementioned CEBMs, it can be concluded that *product life extension* and *product-as-a-service* models seek to retain product value by slowing resource loops. Furthermore, that the *resource recovery* model contributes to closing resource loops by retaining the material value, and the *circular supplies* model seeks to narrow resource loops by retaining material value as well. Combining these key strategies with their respective CEBMs allows developing a framework for guiding the role of the purchasing function in enhancing the CEBM implementation.

4 Research methodology

The present study deploys case study method. According to [22], case study method is useful in studying issues related to purchasing and supply management particularly when investigating contextual issues such as understanding purchasing in particular settings. Since the present study focuses on the potential role of purchasing in one particular context— ETO production, case study method is deemed appropriate. Specifically, a single case study is preferable considering the exploratory nature of the study.

The selected company, hereafter pseudomized as Promaker, is an ETO company that manufactures and supplies custom-made propulsion, positioning and maneuvering systems to domestic and international shipyards and ship owners. The production of the propulsion systems is done on-site and organized as projects that involve engineering design, procurement and production functions. All these functions are kept in-house to ensure quality of the end product. In order to meet or exceed customers' perceived value, Promaker ensures clear understanding of customer requirements, which forms the basis for determining components and subsystems needed to create the end product. Over the past few years, Promaker mostly applied single sourcing strategy and maintained close relations with its suppliers. However, in order to reduce costs and increase quality, the company is in the process of introducing a multiple sourcing strategy.

Data collection was conducted as follows. Firstly, data were collected through semi-structured interviews with individual managers of key functional areas (i.e. product development/engineering, purchasing, production, logistics, and aftersales) to enhance the understanding of processes and issues pertaining to their operations and their viewpoints on the implications of adopting CEBMs. Interviewing all these informants ensured an adequate understanding of Promaker's current BM. Secondly, the information provided by the key informants was triangulated with direct, non-participant observation and document review. In terms of analysis, the study deploys identification and delineation approaches [23], which allowed us to develop a framework that envisions ways through which the purchasing function can enhance the implementation of CEBMs in ETO production. Finally, we performed a quasi-validation of the framework through an expert interview. Similar to [24], the selected expert has deep knowledge and extensive experience in leading various functions in ETO companies and is currently a CEO of an ETO company different from Promaker.

5 Analysis and discussion

The identification and delineation of the purchasing activities that are relevant for enhancing CEBMs in the context of ETO production were achieved through a synthesis and categorization of the collected data. To begin with, CEBMs for ETO production were identified and categorized according to key strategies for moving towards CE, that is, slowing loops, closing loops and narrowing loops. Subsequently, activities involved in a purchasing process were distinguished into three main categories: pre-selection, selection and contracting, and post-award activities. Finally, based on the understanding of the ETO production developed through the case study, relevant purchasing activities were identified for the ETO CEBMs. The activities were then refined through an expert interview. Figure 1 presents the resulting framework that identifies purchasing activities relevant for enhancing the implementation of CEBMs for ETO products.

As shown in Figure 1, the purchasing function can contribute to the enhancement of such CEBMs right from the pre-selection phase of the purchasing process. This phase consists of activities such as needs identification and analysis, material specifications, discussion with sales people, and supply market analysis. Purchasing function can

<i>CE strategies</i>		<i>ETO CEBMs</i>	<i>Purchasing activities</i>		
			<i>Pre-selection activities</i>	<i>Selection and contracting activities</i>	<i>Post award activities</i>
Slowing loops	<ul style="list-style-type: none"> — Product life extension — Product as a service 	<ul style="list-style-type: none"> • Emphasize circularity in the discussions with internal clients and suppliers • Market research to explore possibilities for obtaining product as a service and used/repared products/components • Explore possibilities for designing products in a way that increases durability/maintainability • Discussion on needs analysis and ideas for improved products with other stakeholders (e.g. customers, experts) 	<ul style="list-style-type: none"> • Assess potential to improve products based on circularity and technical specifications (technical dialogue with suppliers) • Acquire product as a service • Consider used/repared products/components • Consider product longevity • Consider product maintenance services and product warranties • Consider upgrading services • Consider refurbishment/remanufacturing of components • Consider direct reuse of products/components • Consider supplier take-back agreements • The contract regime must be flexible enough to allow CEBM 	<ul style="list-style-type: none"> • Coordination for effective product maintenance • Close collaboration with suppliers, customers and third-party operators 	
		Closing loops	Resource recovery	<ul style="list-style-type: none"> • Emphasize circularity in the discussions with internal clients and suppliers • Explore possibilities for industrial symbiosis • Explore potentials for exploiting the residual value of resources (upcycling and/or downcycling) • Explore the performance characteristics of recovered materials 	<ul style="list-style-type: none"> • Consider geographically proximate partners (i.e. with comparably low logistics costs) • Coordinate verification of the partner suitability • Consider valorization of the materials contained in waste streams (i.e. ensure that their unit cost is lower relative to market price of finished materials) • Consider recovered materials with high certainty of performing as required • The contract regime must be flexible enough to allow CEBM
Narrowing loops	Circular supplies			<ul style="list-style-type: none"> • Emphasize circularity in the discussions with internal clients and suppliers • Explore potentials for exploiting the residual value of resources (upcycling and/or downcycling) • Explore the performance characteristics of recovered materials 	<ul style="list-style-type: none"> • Emphasize long lasting components • Consider replacing traditional production inputs with renewable or recovered materials • Consider integrating locally derived secondary materials into the supply chains • Emphasize recovered materials to be good substitutes for the traditional materials they replace, as well as sufficiently available and affordable • Consider purchasing finished fully machined parts • Improve resource efficiency (i.e. reducing scrap when machining/cutting parts) • The contract regime must be flexible enough to allow CEBM

Figure 1. Framework to guide the purchasing function in enhancing the implementation of CEBMs in ETO production

enhance ETO CEBMs during this phase by considering and embedding relevant CE principles, depending on the specific CEBM a firm chooses to implement. In addition to potential bidders, a dialogue between purchasers and other stakeholders (e.g. customers, experts) can provide valuable information that would help specify purchasers' needs. For example, in the case of product as a service BM, undertaking an extensive market research in order to get information on customers' willingness to pay for product use without owning the product themselves. Such information may be meaningful in order to keep the final contract within a certain budget frame. Likewise, CE principles can be considered and embedded during the selection and contracting phase. This phase consists of activities such as analysis of supplier proposals, negotiation and selection of suppliers. During this phase, not only CE principles should be included in the evaluation process, but it is an opportunity for the purchasing function to discuss with potential suppliers on their role in supporting the implementation of CEBM fit for their firm. Among the activities suggested in this phase, flexible contracting emerged as an important element for all CEBMs. This coincides with [25] who argues that contracting is a strategically critical capability in forming and shaping relationships across supply chains. Particularly, we argue that flexible contracting must take center stage in the implementation process to ensure that upstream activities are aligned with the selected CEBMs. After signing the contract with the preferred supplier, relevant post-award activities must engage to support the agreed terms related to the selected CEBMs. These can include activities such as nurturing a strategic alliance as well as coordination for effective product maintenance and effective product flow. For instance, effective take-back arrangements and upgrading services will require continued relationship with suppliers.

Although the proposed framework focuses on ETO production, most of the proposed activities can also be relevant for other production strategies such as Make-to-order, Assemble-to-order, and Make-to-stock. While an activity such as collaborating with internal and external clients during the needs analysis phase is specifically relevant for ETO production, other activities such as exploration of possibilities for industrial symbiosis, flexible contract regimes, and close collaboration with suppliers can be useful in the implementation of CEBMs even in other contexts than ETO production. However, important to mention is that large volumes and wide range of products involved in other production strategies may hamper the implementation of some of the proposed activities in the developed framework. In such cases, creating and maintaining strategic relationships with a large number of suppliers in order to enhance CEBMs may become challenging.

6 Closing remarks

The underlying premise of this paper is that the purchasing function can play a key role in enhancing CEBMs. Since the suitability of CEBMs is context dependent, the paper focuses its analysis on the ETO context and proposes relevant purchasing activities for enhancing ETO-CEBMs. Like any other new practice in an organization, enhancing the implementation of CEBMs will require major changes in the purchasing function.

Overall, the implementation of the proposed activities can compel the purchasing function to increase its strategic focus by being proactive and relentless in embracing circular principles in its agenda. In addition to looking for opportunities to introduce circular principles with the current product lines, the purchasing function must seek possibilities to innovate with suppliers on new circular products. This will require building a strong business case through quantification of the gains to be achieved. Notably, the purchasing business case must be aligned with the firm's vision and business strategy. Following [26] line of reasoning, we argue that innovating with existing and potential suppliers for supporting CEBMs will require that the purchasing function: (1) explores unmet needs and anticipates future needs by working closely with other functions and clients (2) explores external opportunities for enhancing CE beyond first-tier suppliers (3) involves suppliers in CE projects.

Although the present study provides useful insights, it is important to outline some limitations as they provide opportunities for further research. Firstly, the study has developed a framework based on a single case study, hence future studies may further explore the subject based on multiple ETO cases. Secondly, given the increasing recognition to embrace CEBMs across different industries, future studies may consider investigating the potential role of the purchasing function in enhancing CEBMs in settings other than ETO production.

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