Int. J. Production Economics 131 (2011) 453–462

Contents lists available at ScienceDirect

Int. J. Production Economics

journal homepage: www.elsevier.com/locate/ijpe

Decentralizing decision making in modularization strategies: Overcoming barriers from dysfunctional accounting systems

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ARTICLE INFO

Article history:
Received 22 July 2009
Accepted 21 December 2010
Available online 1 January 2011

Keywords:
Modularization
Accounting
Cost allocation
Decision rule
Decentralization

ABSTRACT

Research on product modularity is dominated by an operations management (OM) perspective, through which numerous models to predict optimal modularization strategies have been developed. However, we argue that implementation of these predictions is hampered by prevailing project accounting systems which distorts the economic effects of modularization at the level of the individual product. This has the implication that decisions on modularization can only be made by top management if decision authority and relevant information are to be aligned. To overcome this problem, we suggest a solution that aligns the descriptions of the economic consequences of modularization at the project and portfolio level which makes it possible to decentralize decision making while making sure that local goals are congruent with the global ones in order to avoid suboptimal behaviour.

1. Introduction

Rapid product development is key to sustainable competitive advantage, both in terms of satisfying the seemingly ever increasing customer demand for variety and to keep competitors off the market. Product development is, however, a rather resource demanding activity, and speeding up this process will therefore typically incur more costs. In addition, even though empirical results are somewhat ambiguous (cf. Anderson, 1995), it is generally assumed that increased product variety has a negative impact on company costs (e.g. Miller and Vollman, 1985; Banker et al., 1995; Kaplan and Cooper, 1998). With increased product portfolio heterogeneity the company will typically have to source, manufacture, and sell in smaller batches and the support functions of the company will typically have to be expanded to accommodate the increased internal demand for activities such as planning, change over, quality testing, etc.

Fisher et al. (1999) suggest two general approaches to handle increased costs caused by increased variety. One approach is process oriented and the other product oriented. Whereas the process approach focuses on introducing flexible manufacturing equipment, the product approach is concerned with designing products that make it possible to offer variety at low costs. Product modularity, i.e. using the same components (modules) in different products and thereby allowing for variety at low costs (Ramdas, 2003), is one example of the latter approach. The concept of modularity varies across literature (Fixson and Clark, 2002; Fixson, 2005; Salvador, 2007), however, we use it equivalently to component sharing (Ramdas et al., 2003) and component commonality (Labro, 2004). Product modularity is not a new phenomenon (see Starr, 1965, 2010). However, it seems to attract growing attention. Recent years have seen a rising number of publications on this (e.g. Kim and Chhajed, 2000; Baldwin and Clark, 2000; Nobelius and Sundgren, 2002; Salvador et al., 2002; Doran, 2003; Zhou and Grubbström (2004); Antonio et al., 2007; Doran et al., 2007; Brun and Zorzini, 2009; Brun et al., 2009; Jans et al., 2008; Gomes and Joglekar, 2008) and it is claimed that companies across industries increase their use of modularity (e.g. Sanchez, 1999; Kim and Chhajed, 2001). Indeed, according to Heikkilä et al. (2002) modularity has become one of the most discussed issues in product development, technology, and business management.

As argued by Labro (2004), modularity or commonality has primarily been researched from an operations management (OM) perspective, whereas there are only few contributions from management accounting researchers. This is somewhat surprising considering the apparent relevance for this domain, given the fact that surveying the relevant literature, it is evident that product modularity is supported by an economic rationale. OM research has, for example, shown that modularizing companies may enjoy increased economies of scale (Krishnan and Gupta, 2001), reduced demand for support activities (Thonemann and Brandeau, 2000) and reduced investment in tools (Fisher et al., 1999). Other more soft approaches have identified reduced assembly time due to

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doi:10.1016/j.ijpe.2010.12.020

learning curve effects (Nobelius and Sundgren, 2002), and increased market share (Nobeoka and Cusumano, 1997; Sanderson and Uzumeri, 1995). The arguments in this paper are developed from a management accounting perspective, but based on insights from OM research.

Ramdas et al. (2003) present three organizational structures for approaching modularity: the coordinated projects approach, the project-by-project approach and an intermediate partially coordinated approach, i.e. a mix of central and local decisions. They develop a model that predicts the coordinated projects approach to offer the most cost-efficient path. Ramdas et al. (2003) suggest that model implementation may be challenged by designers who perceive the use of such a model as a distraction from more important development work. In this paper we add another challenge. We argue that the implementation or continued support of the optimal strategies predicted by the OM models will encounter difficulties in practise—not because they are formal or because they must necessarily rely on a set of assumptions, but because companies' accounting systems will act as barriers to implementation.

We base our discussion on Ramdas et al. (2003), but we believe that our claim is generally valid across OM models—irrespective of the correctness of the model because if the accounting systems used in practise do not provide information that supports the OM model prediction, implementation will be impeded. This is the case in many companies where the accounting system is set up to account for the individual projects' performance. Unit costs of the common components probably differ from the cost of the unique component being substituted—to the benefit of some projects and detriment of others—and development cost of the common component is split between participating projects in a heuristic manner. Consequently, the economic consequences of modularization are not described adequately in the individual projects' accounts and decisions to modularize or not should be based on the aggregate consequences across all participating projects only. This has the implication that decisions must be made by top management if decision authority and decision information are to be aligned. In this situation all projects should be coordinated centrally, corresponding to Ramdas et al.'s coordinated project approach. This is probably infeasible, since "[*a*]*ttention is the chief bottleneck in organizational activity, and the bottleneck becomes narrower and narrower as we move to the top of the organizations*" (Simon, 1976:294). The objective is therefore to change the project accounting system so that it does not act as an obstacle to decentralization and in such a way that it encourages project managers to make local decisions in congruence with global goals. We develop the boundaries of such a system and within this a rule-based profit and cost allocation approach that makes this possible.

The remainder of the paper is organized as follows: Section 2 presents a review of OM literature on economic decision making for modularity. In Section 3 we develop a changed project accounting system that makes decentralization of modularization decisions possible and illustrate the idea by an empirical example in Section 4. In Section 5 we discuss some practical challenges and Section 6 concludes the paper.

2. OM models and modularity

OM researchers have enriched the field with a number of formal models that aim to provide optimal solutions to a wide set of problems related to decision making in product modularity. The models are seemingly becoming more and more comprehensive: from the initial narrow focus on inventory costs, over more elaborate, full-cost models to recent developments of models which include both cost and revenue effects.

Some of the earliest contributions focus on the effect from modularization on holding costs. The classical argument is that safety stock levels may be reduced for a given service level (Collier, 1982) due to risk pooling (Eynan and Rosenblatt, 1996; Thonemann and Brandeau, 2000). In a similar vein, companies may enjoy reduced holding costs on work in progress inventories due to delayed differentiation (Lee and Tang, 1997; Swaminathan and Tayur, 1999). Balakrishnan and Geunes (2000) provide a new perspective on the substitution options that a production planner may benefit from if products are based on modularity. For example, low demand components may be economically substituted with higher demand components of equal or higher functionality. This is relevant in industrial situations where seasonal fluctuations characterize demand. Hillier (2002) suggests that the more costly common modules should be used as safety stock and shows that such a strategy outperforms integral products with no commonality or, at the other extreme, products with "pure commonality".

Another classical cost consideration in modularization is the trade-off between development costs and unit costs: increasing investments in the product development stage may result in decreased unit costs in the manufacturing stage. In determining this balance, both platform development costs, product-unique development costs, unit costs and over-design costs (a part of the unit costs) should be included (Krishnan and Gupta, 2001); only the specific situation will determine the optimal strategy. Krishnan et al. (1999) develop a model to optimize decision making in what they call the aggregate-planning phase, i.e. the strategic decisions taken before a platform and set of products to be developed are determined. They investigate the trade-off between increased platform development costs and decreased development costs at the individual product level.

Another stream of research addresses the problem from a "total-cost" perspective with a view to developing more comprehensive models. Thonemann and Brandeau (2000) have developed a model to determine the optimal level of commonality considering both direct and indirect costs and development costs. A model created by Ramdas et al. (2003) addresses the problem from a tactical perspective. This model is tested on three different scopes of product modularity: aggregate planning, project-by-project and an intermediate scope, where some architectural decisions are made at a central planning office and some are made locally by project management. They find that aggregate planning is the most profitable scope, but also acknowledge that the hybrid, intermediate scope, is the one most likely to be found in industrial settings.

In many situations both income and cost effects must, however, be included to analyze the profitability potential of modularity. As Fisher et al. (1999) argue, minimizing costs will not necessarily lead to optimized profitability. If products are based on platforms or common modules, companies risk that products cannibalize each other. Robertson and Ulrich (1998) point out that companies need to pursue a balance between commonality and distinctiveness and suggest that we should differentiate between internal and external commonality according to whether the commonality is visible to the customer or not. As Heikkilä et al. (2002:24) put it, "*an Audi owner knowing that a considerable part of the components in his car are the same as those used by Skoda might not be totally happy with the situation*". This accentuates the relevance of yet another trade-off, namely the one between cost and revenue interactions. This is modelled by Kim and Chhajed (2000), Desai et al. (2001) and Ramdas and Sawhney (2001), and more recently by Heese and Swaminathan (2006) arguing that it is essential to take into account interactions between commonality, production cost, quality emphasis per customer segments, and the company's effort to reduce production costs in order to optimize the cost and revenue effects of modularization.