Available online at www.sciencedirect.com

ScienceDirect

Procedia CIRP 51 (2016) 63 – 71

www.elsevier.com/locate/procedia

3rd International Conference on Ramp-up Management (ICRM)

An Integrated Decision Support System Considering Interdependencies Between Time-to-Market and Market Diffusion under Competition

Felix Giedziella[a,*] and Grit Walther[a]

[a]*Chair of Operations Management, RWTH Aachen University, Kackertstr. 7, 52072 Aachen, Germany*

* Corresponding author. Tel.: +49 241 80 23832; fax: +49 241 80 6 23830. *E-mail address:* felix.giedziella@om.rwth-aachen.de

Abstract

Industry faces fundamental challenges as new competitors from emerging countries enter markets. Thus, competition increases and time-to-market as intermediate span between R&D and series production gets more important. Additionally, customers ask for more individualized products. However, the resulting increase in product variety leads to rising complexity and costs and thereby, limited resources have to be allocated to a multitude of parallel product development projects.

To tackle these challenges and stay successful, companies aim at decreasing time-to-market with constant or even lower resource input. While complexity management and resource allocation have extensively been discussed for R&D and series production, approaches for the intermediate time-to-market phase are still scarce.

Against this background, the aim of this contribution is to analyze the interrelations between time-to-market and resource allocation in a competitive environment with a decision support system. To reach this aim, we present a system-dynamics simulation model analyzing the market diffusion of a product in a competitive environment. with the proposed model, we are able to derive information on interdependencies between resource input and time-to-market depending on competitors' behavior.

We apply the model to the gas turbine industry. In order to do so, we create a dataset merging recent data from literature with information gathered in expert interviews. Thus, we are able to quantify the parameters of the model. Results are presented highlighting the interdependencies between resources and time-to-market for the competitive environment of the gas turbine market.

Peer-review under responsibility of the scientific committee of the 3rd International Conference on Ramp-up Management (ICRM)

Keywords: Complexity management; time-to-market; new product development; market diffusion

1. Introduction

Production industry nowadays faces continuous change and various challenges. On the one hand, competition increases as companies from emerging countries like China, Brazil or India challenge industry leaders from Europe, Japan or the United States. [1, 2] In this competitive environment, established industry leaders often focus on innovation in order to preserve a unique selling proposition. [3, 4] Furthermore, first mover advantages and market entry timing are becoming increasingly relevant for company's success. [5]

On the other hand, consumer needs are increasing as consumers request highly individualized products at low costs (e.g. in textile [6] or food industry [7]). As a result, product variety has increased in the past and this trend is expected to continue. [8, 9] However, grown product variety leads to increasing costs as complexity rises in all phases of the product's life cycle. [10] Again, companies rely on innovation in order to tackle this complexity and to meet high cost pressure despite of the high product variability. [1, 3, 4] However, resources provided by industry are increasingly limited and have to be allocated among all product varieties and all life cycle phases (i.e. for product development, ramp-up, production and after sales). [11]

The afore mentioned challenges and characteristics lead to several implications. First, companies offer more products in less time, which is resulting out of a situation with permanent multi product development. [8] Second, despite this increase

Peer-review under responsibility of the scientific committee of the 3rd International Conference on Ramp-up Management (ICRM)
doi:10.1016/j.procir.2016.05.044

in the number of products, companies have to focus on an early market entry and thus reduce the time-to-market in order to stay successful in a competitive environment. [12] Therefore, companies have to shorten the early stages of the product's life cycle, i.e. the time span between project start and market introduction covering the phases of product development and production ramp-up. [13] This is possible by applying higher effort in product development and ramp-up [12, 14, 15], e.g. by parallelization of processes. [16] However, for multiple products this strategy is contradicted by limited resources. Thus, a goal conflict arises between early market entry with shortened time-to-market and limited resources. Additionally, resource allocation in product development and ramp-up is a crucial and demanding task due to high uncertainties in these early life cycle stages. [12, 13]

While quite some literature can be found on complexity and resource allocation for product development as well as for series production (e.g. [8, 17, 18]; reviews: e.g. [14, 16]), literature is still scarce for the intermediate phase (time-to-market) between project start and market introduction covering the phases of product development and production ramp-up.

Against this background, the aim of this contribution is to develop a decision support system (DSS) to analyze the interdependencies between time-to-market and resource allocation in a competitive market environment in order to consider current challenges and to derive managerial implications regarding interdependencies between resource input, time-to-market and market diffusion. To achieve this aim, we constitute several requirements for the decision support system.

First, project progress within time-to-market, especially during product development and production ramp-up, has to be depicted depending on the resources provided in the corresponding life cycle phases. Second, the market introduction and product diffusion has to be modeled and competition between a number of competitors as well as differing market entry times have to be regarded when modeling the market diffusion. Third, decisions should be based on an economic evaluation based on cash flows within time-to-market and market diffusion.

The paper is divided into five subsections: In section 2, an overview on related literature regarding project management during time-to-market and market diffusion of products is given. The decision support system considering interdependencies between time-to-market and market diffusion under competition is presented in section 3. A case study from the gas turbine industry is introduced in section 4, and the model is validated and results are derived in section 5. Section 6 concludes this paper with a short summary and an outlook on future research.

2. Literature Review

In this section we discuss main research streams regarding the afore mentioned model requirements. First, research focusing on measuring and describing project progress during time-to-market is presented. Second, research on market introduction and diffusion of innovative products is introduced with a specific focus on competition.

There is a high number of papers discussing interrelations of project progress in early life cycle stages, especially during product development. The *Phase-Review Process* is aiming at a standardization of cooperation between suppliers during product development. [19] Thereby, product development is subdivided into discrete sequential phases, each ending with a management review, at which a decision is taken on weather to proceed with the project or to terminate it. [19] This process allows for a structured handling of partially contrary tasks. [19] Nevertheless, the model is not applicable for our approach, since it requires sequential phases and does not allow for parallelization. Also, some phases of time-to-market are neglected (e.g. ramp-up), and no answers can be derived on the amount of resources needed during product development.

The *Stage-Gate Process* has been widely applied and extended in research and industry since its introduction by Cooper (1990). [20] Product development (or other tasks) are subdivided into discrete stages [20], which can be performed sequentially or parallelized. [20] The Stage Gate process shows a high applicability for modeling project progress during time-to-market. [21] Although the ramp-up phase is not considered in the original Stage Gate process, it can easily be added as an individual stage. As the approach consists of discrete stages, it can be modeled in a quantitative way. Most recent modifications of the Stage Gate process integrate customer and user interaction at the stages of the product development process [22], allowing for higher flexibility and agility. [22] However, resources are neither considered in the original Stage Gate process nor in its extensions.

Ulrich et. al. (1995) developed a process model that subdivides product development into the following five phases: concept development, system-level design, detail design, testing and refinement, and production ramp-up. [23] Detailed information is given on the tasks including qualitative indications on needed resources. In addition, the model aims to integrate different stakeholders and follows an interdisciplinary approach to problem solving. [23] While this model covers all relevant life cycle stages (including ramp-up) and provides qualitative insights into resource decisions, it does not quantify the amount of resources needed.

The *Value Proposition Cycle* by Hughes and Chafin (1996) aims to overcome the sequential progress of traditional project management by enabling continuous learning, consensus and identification of important information within project teams. [24] The model consists of four iterative loops in order to capture market value, to develop business value, to derive winning solutions and to apply project and process planning. [24] While the model regards resource input in a qualitative way, quantitative decision support is not considered.

Concluding, none of the discussed project management approaches fulfills our model requirements to derive quantitative decision support on resource demand in the time-to-market phase covering both, product development and production ramp-up, as shown in table 1. Two approaches take qualitative resource input into account, but are not able to