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## Method for the Evaluation and Adaptation of New Product Development Project Complexity

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### Abstract

This paper presents a method that enables project managers to evaluate the complexity of an intended new product development project and adapt it to ensure fit with the organization's capacities and the project setting. Central hypothesis is that complexity drivers of the project are causing resource consumption and thus costs. Therefore, a systematic evaluation of complexity drivers and their subsequent demand placed on the resources of the organization for each activity of the project needs to be conducted. For this purpose a novel approach based on a resource-oriented process cost calculation method has been developed. The approach includes a consideration of uncertainties regarding the complexity impact and definition of a capacity to tolerate complexity. Consequently, by analyzing the project's complexity for its cost and resource impact as well as comparing it with the organization's capacities, planners are able to identify critical complexity drivers upfront that would disrupt project execution and develop countermeasures.

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### 1. Motivation

Companies operate now in an environment that has substantially changed during recent decades. Besides increasing globalization and the following international competition as well as more volatile international markets, a shift from a seller's to a buyer's market is often observed [1]. Customer demands are increasingly heterogeneous, differentiated and sophisticated. To meet these demands and stay competitive, companies regularly react with the introduction of new products, a higher product variety and shorter product life cycles [2]. The development of new products is thus essential for the success of an organization and driver of corporate growth [3]. Therefore, research relating to product architectures and complexity has been conducted. More recently, the corresponding development organizations as well as the organizational complexity of product development projects have been of interest [4,5].

An increasing amount of work in corporations is carried out via projects [6,7]. As a result, some scholars observe a

“projectification” of the firm and the business environment [6]. Others claim that “we live in a projectified world” [7].

In spite of the importance of new product development projects, cost overruns, missed deadlines and specifications are problems that can be observed frequently [8].

While multiple reasons for poor project performance can be identified, one underlying reason, mentioned by researchers as well as practitioners, is the increasing complexity of projects [10,11].

### 2. Introduction and fundamentals

The goal of this paper is to present a method to evaluate the complexity of an intended new product development project upfront as well as adapt it to ensure fit with the organization's capacities and thus achieve a better project performance. To understand the impact of complexity and the demands placed on the resources of the organization one must systematically examine the link between the two domains.

## 2.1. Complexity

Complexity is frequently named as a reason for poor project performance [10,11]. However, there is no generally accepted definition of the term “complexity” itself [12]. From a system theory viewpoint, complexity is often defined as a system feature, which is determined by the number and the variety of its elements and their relationships to one other as well as their dynamic changes [13]. Since projects can be characterized as systems [14], this understanding of complexity is adopted for this work.

### 2.1.1. Project complexity

Similarly, to the term complexity, there is currently no agreed upon definition of the term project complexity even though research has been conducted over years [14].

GERALDI [15] found out when inquiring about project complexity with practitioners that it is “something [...] that made a project unique, more complicated and more difficult to execute, manage and control [...]”. VIDAL ET AL. [14] proposed a definition, which is similar to the findings of GERALDI, highlighting that complexity is a feature that can be used to characterize a project and that it is affecting project management. They postulate [14]: “[...] project complexity is the property of a project which makes it difficult to understand, foresee and keep under control its overall behaviour, even when given reasonably complete information about the project system. Its drivers are factors related to project size, project variety, project interdependence and project context”. The present work will follow this definition and understanding.

### 2.1.2. Measurement and evaluation of complexity

One can differ fundamentally between two possibilities to measure or evaluate complexity. The first and *direct* option is to use a measured value, which determines a complexity degree. The second and *indirect* option is via economic effects of complexity [16].

An overview of direct approaches focussing on measuring project complexity can be found for instance in VIDAL ET AL. [17]. While there are challenges in measuring complexity directly, one can use complexity drivers to make statements about the level of complexity in organizations [18].

Complexity drivers can be understood as a phenomenon that is causal for the (increasing) complexity of a system [19]. Other authors, using synonymous terms instead of complexity driver, have a similar understanding. [10,18,20]. For example, MARLE and JABER [10] use “factors” to answer what “makes a project more complex” and to assess how these factors “contribute” to project complexity.

Based on RENNEKAMP [18], complexity drivers are defined in the context of this work as “plurality of external and internal factors, which increase the complexity of a project and can be used for indirect evaluation of the project complexity level”.

## 2.2. Operationalizing Ashby’s law of requisite variety

A product development project can be characterized as an open system, as such, its complexity should be considered in dependence of its environment [19]. Following the “law of

requisite variety” postulated by ASHBY [21], who stated that “only variety can destroy variety”, this translates into the requirement that the internal complexity of a system has to match the external complexity [19]. If one transfers ASHBY’S Law into practice, this means for example, that the more complex the product program and markets are, the more complex the organization and in consequence its coordinating processes have to be [16]. The assignment of e.g. an engineer to a product development project means building up internal complexity. Building up internal complexity results in additional costs, but on the other hand enables to better react to external complexity, which is complexity stemming from the project environment. Examples are complexity drivers relating to customers, markets or technologies [19].

While the measurement of varieties (or complexities, when understanding variety as a measure of complexity) is hardly possible in practice, the idea and term are essential, because it is about harmonization of comparative factors [22].

In summary, one can conclude that it is necessary to evaluate the complexity of a project in the context of the surrounding project setting (and external complexity) and adapt it reciprocally. But project managers and planners have to further consider the capacities of the organization to tolerate complexity. These capacities are operationalized in the present context by the limited resources and/or budgets of an existing company.

## 3. Related research

There are a number of comprehensive project complexity frameworks, which enable their users to identify factors that drive the complexity of a project. But these approaches often conduct only a qualitative assessment of complexity in a project and don’t build a bridge between complexity and its implications for the organization in terms of costs and resource demand [10,20,23].

On the other hand, numerous attempts to quantify project complexity through mathematical models have been attempted in research. With these models, one is able to directly measure complexity, but systematically tracing back these evaluations to resource demand is not part of their work [5,17,24]. REBENTISCH ET AL. [5] focusing on organizational complexity in product development projects, state that if their calculated complexity score surpasses a “complexity capacity” an organizational redesign should be performed. But it is noted that this “complexity capacity” still needs to be developed.

Approaches which aim to link complexity to performance figures in companies, took a process perspective to operationalize the term complexity via complexity drivers [16,18,25]. However, these approaches focus on specific facets of complexity in companies. Thus, identifying the relevant complexity drivers is not part of their work [25] or they focus on a limited number of complexity drivers in companies [18], or specific processes in companies [16].

As a result, there is a need to develop a method to systematically evaluate the complexity of product development projects via complexity drivers and their quantitative impact on the resources of the organization in a given project setting – under consideration of the capacities of the organization to

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