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Analysing the organizational factors of project complexity using structural equation modelling

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Abstract

The advancements in the field of project management have driven researchers to take heed of numerous issues related with evaluating and managing complexity in projects, which demonstrates the evident significance of the subject. Among several key factors, organizational factors make up a large portion of project complexity as previous research confirms. While several project complexity measures do exist, every measure has its limit and evaluates project complexity from its own criteria. Furthermore, existing literature lacks modelling of these organizational factors to explore the interrelationships among them. This study aims to identify and model these factors to assist project managers in handling organizational factors of project complexity in a more regulated fashion. The model is developed using structural equation modelling technique. Findings include the noticeable effect of project size on project complexity as well as other factors. Positive effects of project variety and the interdependencies on project complexity are also observed.

Keywords: Project complexity; Complexity factors modelling; Organizational complexity; Structural equation modelling

1. Introduction

The growing interest in the subject of project management is evident from recent research activities that define project management from numerous dimensions, particularly complexity. Attempts have always been made to increase human ability to address complexity issues by proposing models and other formulations and to emphasize the role of project actors regarding the issues of time, cost and scope (Vidal and Marle, 2008). Atkinson (1999); however, goes beyond this conventional "iron triangle" and develops another framework to consider success criteria – the Square Route – after highlighting the fact that projects continue to be described as failing, even when the factors and the criteria for success are known. This implies, and seems in practice, that project management is keen to adopt new models to achieve success.

Project complexity takes various forms and can be seen from social, technological, environmental and organizational viewpoints. In this regard, we use Baccarini's well-established dichotomy considering that project complexity is composed of technological complexity and organizational complexity (Baccarini, 1996) and opine that a detailed analysis of both technological and organizational complexities is imperative to comprehend the concept of project complexity. The role of organizational complexity factors and their significance are dominant as the literature suggests (Bosch-Rekveldt et al., 2012; Vidal and Marle, 2008). Previous research on project complexity is, however, more concerned with the numerical measurement of complexity in projects and measuring complexity from specific criteria, for e.g., the complexity of the

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sequencing and scheduling problem, graph-based complexity measures and project complexity index based on AHP, which are not directed towards finding out and measuring the underlying factors of organizational complexity. While theoretical frameworks to identify organizational complexity factors do exist, a thorough and multidimensional account of organizational complexity must take into account the behaviour and interrelatedness of these factors, which have not been sufficiently examined.

The most appropriate approach to capturing this behaviour of factors is structural equation modelling (SEM). We propose a conceptual model that is meant to facilitate the project managers' understanding of project complexity and its contributing organizational factors employing SEM. The model takes into account the theoretical frameworks on project complexity (for e.g. by Bosch-Rekveldt et al., 2011; Vidal and Marle, 2008), complemented by an extensive literature review. The results are measurement and structural models — a framework that represents the multidimensional interactions of variables. The proposed model is then validated using 150 valid questionnaires from project management professionals working in four different geographical locations.

Besides explaining the concept of project complexity, organizational complexity and justifying the choice of SEM, the paper discusses a research framework and the results of analysis. Perspectives for future research are finally specified.

2. Complexity in projects

2.1. Defining project complexity

Simon (1996) underlines that how complex or simple a structure is depends critically upon the way in which we describe it. Perhaps due to this subjectivity, the issue of defining *complexity* seems unsettled, as far as the literature is concerned (Vidal et al., 2011a; Whitty and Maylor, 2009). Deciding on whether or not a project is complex has itself become a complex matter. It has been asserted that project complexity means that many different actions and states of the world parameters interact, so the effect of actions is difficult to assess (Kauffman, 1993; Simon, 1969). Maylor et al. (2008) and Whitty and Maylor (2009) debate on the exact definition of a complex project, and the differences between "complicated" and "complex" projects and state that a project would only be complex when uncertainties play a role, if not, the project at most would be complicated. Vidal et al. (2011a) define project complexity as, "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" (719), underscoring the importance to assess complexity, lending support to decisions made on keeping project behaviour under control. In this situation, the study of this property of projects (and the underlying factors that make projects difficult to understand) will certainly be vital to prevent a project from being a tougher task to perform and harder to foresee its related elements. This becomes a fundamental criterion to select factors for modelling as suggested by the literature.

2.2. Organizational complexity

Since complexity takes various forms namely social, technological, environmental and organizational, it is important to state clearly the type of complexity being analysed (Baccarini, 1996). Worth mentioning here is the work of Bosch-Rekveldt et al. (2011) who proposed the TOE framework, consisting of fifty factors in three families, Technical, Organizational and Environmental. Bosch-Rekveldt et al. (2012) conducted an online survey using this TOE framework and came up with an agreed stance of respondents on the vexatious nature of organizational complexity in engineering projects. They concluded that organizational complexity worried project managers more than technical or environmental complexities. Vidal and Marle (2008) argued that approximately 70% of project complexity factors are organizational. This seems quite related with Baccarini's view on organizational complexity which, he says, is influenced by differentiation and operational interdependencies (Baccarini, 1996). We follow these assertions by considering in our model the organizational factors only, knowing that this covers a major area of complexity in projects. Moreover, in today's world, attempts of organizations to be competitive tend to augment differentiation (both horizontal and vertical) and interdependency thereby increases organizational complexity, which makes the topic relatively worth analysing.

2.3. Assessment of the complexity and the research gap

A number of models based on the problem of measuring (or conceptualizing) complexity and uncertainty in projects do exist. Vidal et al. (2011a), Vidal et al. (2011b), Edmonds (1999), Latva-Koivisto (2001) and Nassar and Hegab (2006) performed a thorough survey of these existing formulations. One may directly refer to them for more information on existing complexity measures, nevertheless, we discuss some of them in this section.

- Kaimann (1974) defined the Coefficient of Network Complexity (CNC) that applies to both PERT and precedence networks and can also be applied to any model of a project as a graph. The CNC is related with classification of the degree of complexity of a critical path network. It may also serve as an indicator of the attention spent in planning the project.
- Temperley (1981) proposed a cyclomatic number that gives the number of independent cycles in a graph. The cyclomatic number (S), with number of arcs (A) and number of nodes (N), is computed as follows:

$$S = A - N + 1.$$

- Akileswaran et al. (1983) focused on the computational complexity of some project management issues, such as the sequencing and scheduling problems.
- Nassar and Hegab (2006) argued that CNCs are imperfect. CNCs show that the system is more complex than it actually