



# Complexity, uncertainty and mental models: From a paradigm of regulation to a paradigm of emergence in project management

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## Abstract

In project management research, it is acknowledged that two perspectives on project performance must be considered: *project efficiency* (delivering efficient outputs) and *project success* (delivering beneficial outcomes). The first perspective is embedded in a deterministic paradigm of project management, while the second appears more naturally connected to the emerging non-deterministic paradigm. Complexity and uncertainty are key constructs frequently associated with the non-deterministic paradigm. This conceptual paper suggests that these two concepts could very well explain and define particularities of both paradigms, and seeks to articulate both perspectives in a contingent model.

First, the constructs of complexity and uncertainty are clarified. Second, the role of project managers' mental models in managerial decision-making is considered. In the third part of this article, we propose a theoretical model suggesting that project managers should consider contingent variables to differentiate managerial conditions of regulation from managerial conditions of emergence.

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## 1. Executive summary

It is generally understood that the world is becoming more and more complex. Project managers are experiencing this in their daily activities, being faced with a growing number of complex situations. The project management literature – particularly in the non-deterministic paradigm – has focused on this issue of complexity. However, two perspectives – project management and the management of projects – co-exist in the project management research community, as do two paradigms: deterministic and non-deterministic. This lack of unified theory – as well as the difficulty of agreeing on a definition of complexity – does not help project managers understand how to maximize performance in complex projects.

The research presented here attempts to propose richer lenses for looking at project management. We suggest that a better understanding of the construct of complexity, its associated construct of uncertainty, and the way human beings predict these through mental models are possible groundings for a contingent and comprehensive approach.

In this conceptual work, we first investigate the literature on complexity, highlighting three levels that can be found in different research works. We then investigate the literature on uncertainty, which also converges towards three levels of uncertainty. Finally, we add the notion of mental models as a means for project managers to understand the situations in which they find themselves, and gather all the findings in a conceptual model of project management.

Our study adds to the literature on complexity and uncertainty in project management by gathering many existing research works from different sciences. Tables summarizing these literatures shed light on the possibility of identifying three different levels of complexity and of uncertainty, which form the pillars of a contingent project management model.

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Overall, our conceptual paper suggests that it is possible to bridge the existing gap between the two project management paradigms. One reason for the difficulty of managing complex project situations lies in the limitations of classic project management methods. Complex and uncertain projects require newer methodologies based on understanding: the modelling approaches. By understanding the levels of complexity and of uncertainty in a situation, project managers can adapt their decision-making approach in order to maximize performance.

## 2. Introduction

Ten years ago, researchers in project management started to acknowledge the lack of a unified theory of the management of projects, whether defined in its narrow ('project management': PM) or broad ('management of projects': MoP) sense (Smyth and Morris, 2007). This concern is still raised by the project management research community, especially in the area of project performance, where the streams of research on success and failure do not converge (Padalkar and Gopinath, 2016b). The growing complexity of projects led to the emergence of a non-deterministic paradigm (Padalkar and Gopinath, 2016b), which raised the question of how to generate performance in complex projects; one major issue was agreeing on a definition of complexity itself.

The co-existence of the PM and MoP perspectives is a source of confusion for project managers, who are faced with a wide variety of project management conditions, and who cannot really know which project management approach is better adapted to the complexity of their project. Is there a way to reconcile these two perspectives? How can project managers understand which management principles they should adopt, depending on the managerial decision-making conditions under which they are working?

The PM perspective is supported by the execution-based model of the Project Management Institute (PMI), while the MoP perspective – founded on Peter Morris's research – is more comprehensive and open to a new definition of project success (Pinto and Winch, 2016). In his definition of the nature of project management, Turner makes a real distinction between the 'operational' project perspective (which is focused on the result of the project implementation: the output) and the 'strategic' project perspective (focused on the outcome resulting from the project implementation phase). This distinction is also found in the project management literature on success and failure, which differentiates between 'project efficiency' (project implementation performance), and 'project success' (project benefits performance) (Cooke-Davies, 2002; Serrador and Turner, 2015a; Turner and Zolin, 2012).

Beyond the two perspectives of PM and MoP, two paradigms have emerged from surveys on decades of project management research. The first is the deterministic paradigm, which is well established (Pinto and Winch, 2016) and is strongly dominated by operations research. It contributed significantly to the increase in project management performance with phase-project-planning methodologies in the 1960s (Morris, 2010). The second is the non-deterministic paradigm,

which emerged in the mid-2000s (Padalkar and Gopinath, 2016b), putting a particular emphasis on complexity in projects (Crawford et al., 2006; Geraldi et al., 2011a; Whitty and Maylor, 2009). Non-deterministic research employs not only complexity but also uncertainty (following Turner's broader definition of project management) as its main lenses, but both concepts remain ambiguous, preventing this paradigm from moving forward (Padalkar and Gopinath, 2016a). For instance the PMI's view on complexity is far removed from that of complexity theory (Bakhshi et al., 2016).

Although the first paradigm is well established and the second is attracting much research interest, there is no clear way for project managers to understand how to position themselves in relation to these two paradigms. Complexity can sometimes be associated with both the deterministic paradigm (the PMI's view) and the non-deterministic paradigm (the complexity-theory view), and sometimes it is linked only to the non-deterministic paradigm. Complexity in projects is regularly associated with uncertainty, but these two constructs are not clearly differentiated in order to understand their specific role in project management theory.

The first contribution of this conceptual paper is to synthesize various research literatures (systems theory, decision theory and planning theory) in two tables, which reveal the contingency nature of complexity and uncertainty. We reveal not only that both constructs can be categorized in three levels, but also that each of these three levels suggests a specific managerial way of addressing situations: algorithmic, stochastic or non-deterministic. General systems theory revealed that managers interact with projects through decision models (mental models) to make their managerial decisions. The second contribution reveals that the prediction capacity of these decision models defines the level of uncertainty that project managers have to address, and impacts the level of complexity of the project as a whole. The third contribution is a contingent framework of project management, which positions management paradigms of regulation and of emergence according to the level of complexity and uncertainty that project managers must face. As a consequence, this comprehensive framework provides new lenses for project managers in order to select the appropriate management approach.

In Sections 3 and 4 of this paper, the constructs of complexity and uncertainty will be explored, and the link between the two will be developed. In these two sections, three main approaches are revealed: algorithmic, stochastic and non-deterministic, which can be linked with the constructs of both complexity and uncertainty, and which are ingrained in decision theory.

Section 5 sheds light on the fact that mental models are key in managerial decision theory. Mental models – and, more specifically, decision models – are characterized by their role in managerial capacity to predict. Predictability is also a key concept characterizing complexity and uncertainty.

In Section 6, we propose a theoretical framework for project management that helps to distinguish the decision and action conditions of risk versus uncertainty. From a contingency perspective, this conceptual framework reveals systemic

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