



# Are complexity and uncertainty distinct concepts in project management? A taxonomical examination from literature

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## Abstract

Project management research is characterized by dominance of determinism, decision-theoretic approaches, and weak theories. The growth of research interest in non-deterministic paradigms through the lenses of complexity and uncertainty is recent, and could provide stronger theoretic explanations. However, analysis of select project management literature reveals that the constructs of complexity and uncertainty are yet to be grounded in terms of definitions and constituent variables. We argue that definitional clarity is necessary for the non-deterministic research to move forward. In this paper, we propose taxonomy of constituent terms of complexity and uncertainty based on semantic analysis of select literature and show that the two constructs are broadly confounded in their constituent terms. While our finding may appear to align with complexity theoretic concept of strong interrelationship between complexity and uncertainty, we argue that such confounding represents intermingling of varying ontological and epistemological preferences within the community of project management scholars rather than a broad adherence to the complexity theory. The paper contributes to project management literature by facilitating further research toward stronger construct definitions and theory-building efforts. The paper also contributes to research methods by offering a novel methodology to elicit taxonomy of terms and to illuminate the confounding and separating terms across multiple constructs.

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## 1. Introduction

The field of project management research is characterized by the dominance of deterministic paradigm and decision-theoretic approaches. A review of literature reveals two themes anchored in determinism. Much of the early project management research lasting until late 1980s employs conceptual or analytical methods, and focuses on scheduling optimization, resting on the premise that project activities and their interrelationships are fixed and measurable (Kolisch, 1996; Herroelen et al., 1998; Kolisch and Padman, 2001; Herroelen and Leus, 2004, 2005; Hartmann and Briskorn, 2010). Subsequently, empirical studies seeking success or failure factors have gained prominence in 1990s (Kloppenborg

and Opfer, 2002; Tesch et al., 2003; Turner and Müller, 2005; Jugdev and Müller, 2005; Rozenes et al., 2006; Huemann et al., 2007; Ika, 2009; Müller and Jugdev, 2012). The search for success or failure factors has also led to expansion of the research domain to broader organizational contexts, behavioral and interdisciplinary themes, organizational and external actors, strategic benefits, risk, etc. (Belout and Gauvreau, 2004; Turner and Müller, 2005; Huemann et al., 2007; Aloini et al., 2007; Littau et al., 2010; Padalkar and Gopinath, 2015). On the backdrop of determinism, a small non-deterministic stream is evident from 1960s. This includes critique of PERT and of beta distribution (Grubbs, 1962; MacCrimmon and Ryavec, 1964; Schonberger, 1981); modeling of uncertainty in project phenomena by relaxing the assumptions about fixed attributes (Martin, 1965; Burt, 1977; Cook and Jennings, 1979; Williams, 1992; Bowman, 1995; Cho and Yum, 1997; Elmaghraby et al., 1999; Chapman and Ward, 2000); use of system dynamics to model the nonlinear effects of feedback loops

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in projects (Williams et al., 1995; Rodrigues and Williams, 1998; Williams, 1999; Eden et al., 2000); and modeling the project phenomena under fuzzy or probabilistic assumptions (Chanas and Zieliński, 2001; Browning and Eppinger, 2002; Van de Vonder et al., 2005; Jensen et al., 2006; Chen, 2007). The dominant research orientation has continued to be instrumentalist, while seeking decision-theoretic models/methods, or success/failure factors as prescriptions for project performance.

The non-deterministic stream holds significance in view of the weak theoretic nature of project management (Shenhar and Dvir, 1996; Shenhar, 2001; Söderlund, 2004; Cicmil et al., 2006; Smyth and Morris, 2007; Whitty and Maylor, 2009; Morris, 2010; Jacobsson and Söderholm, 2011). It represents a paradigmatic change and has the potential to supply alternate narratives and explanations through different methodological approaches. The widening of research agenda and contexts in late 1990s appears to have aided the growth of non-deterministic research in the post-2000 period. From a brief scan of literature, we observe attempts to model project phenomena under complexity-related assumptions (Austin et al., 2002; Howick and Eden, 2001; Xia and Lee, 2004, 2005; Cho and Eppinger, 2005; Danilovic and Browning, 2007) and theoretic discussions, definitions, or constituent terms of complexity (Baccarini, 1996; Williams, 1999; Shenhar, 2001; Pich et al., 2002; Sommer and Loch, 2004; Benbya and McKelvey, 2006; Cooke-Davies et al., 2007; Geraldi and Adlbrecht, 2007; Maylor et al., 2008; Vidal and Marle, 2008; Brady and Davies, 2010; Lenfle, 2011; Geraldi et al., 2011; Ramasesh and Browning, 2014), or of uncertainty (Tatikonda and Rosenthal, 2000; Turner and Müller, 2003; Ward and Chapman, 2003; Cho and Eppinger, 2005; Atkinson et al., 2006; Perminova et al., 2008). Thus, it appears that researchers employ complexity and uncertainty as the principal lenses for non-deterministic enquiry. The importance of non-deterministic stream calls for a deeper study of how project management literature treats the two lenses of complexity and uncertainty.

This paper is organized as follows. Section 2 reviews relevant project management literature dealing with complexity and uncertainty. Section 3 presents the research methodology and data selection for building taxonomy for the two constructs from project management literature. Section 4 discusses the results of the taxonomical analysis.

## 2. Complexity and uncertainty in project management literature

A research lens is a theoretic orientation or a schema that allows the researcher to “focus on certain variables and relationships while ignoring others” (Ancona et al., 2001). The lens provides the context for choosing the research methodologies that are consistent within the schema. These choices require that the lenses and the constructs associated with them are unambiguously defined. A review of project management literature reveals a couple of key insights about the state of definitions. First, there is sufficient evidence about lack of consensus on the definition of complexity in project context (Sommer and Loch, 2004, p. 1335; Maylor et al., 2008, p. S17; Cooke-Davies et al., 2007, p. 51; McLain, 2009, p. 61; Bosch-Rekveltdt et al., 2011, p. 730; Geraldi et al., 2011,

p. 968; Vidal et al., 2011, p. 718; Brady and Davies, 2014, p. 22); or uncertainty (Williams, 1999, p. 271; Perminova et al., 2008, p. 74; McLain, 2009, p. 61). A review of recent papers confirms that definitions of complexity continue to be ambiguous (Ramasesh and Browning, 2014, p. 193; Browning, 2014, p. 232; Qureshi and Kang, 2015, p. 166; Saunders et al., 2015, p. 468).

Second, the two constructs appear to be associated with a large number of terms and may be terminologically confounded with some of these terms. For instance, Baccarini (1996) views complexity as “consisting of many varied interrelated parts” (p. 202), while Williams (1999, p. 271) treats “number of elements” and “interdependence of elements” as constituents of “structural uncertainty” which is proposed as an element of complexity. Ward & Chapman (2003, p. 99) regard “number of influencing factors and their interdependencies” as constituents of complexity, which in turn contribute to project uncertainty. Shenhar (2001, p. 397–399) regards the two constructs as orthogonal to each other, while Tatikonda & Rosenthal (2000, p. 78–79) view complexity as consisting of “interdependence among the product and process technologies, novelty of goals, and difficulty of goals” and thus contributing to project uncertainty. Sommer & Loch (2004, p. 1335–1336) treat complexity and “unforeseeable uncertainty” as separate constructs, while noting that the use of the term “complexity” is not consistent in the PM literature. Complexity as an element of uncertainty is reiterated by Atkinson et al. (2006, p. 688–689), while Geraldi & Adlbrecht (2007, p. 33) and Geraldi et al. (2011, p. 976) support uncertainty as an element of complexity. Vidal et al. (2011) claim that complexity can be viewed as a “property of the system that makes it difficult to understand” (p. 719). Pich et al. (2002) define complexity as information inadequacy when “too many variables interact” (p. 1009). Perminova et al. (2008, p. 76) equate complexity to “systematic uncertainty.” Brady et al. (2012) argue that the two constructs are distinct. De Meyer et al. (2002, p. 61–63) regard uncertainty as a continuum from simple variations (foreseeable uncertainty) to chaos (unforeseeable or “epistemic” uncertainty). However, other authors associate epistemic uncertainty with unknown variables or unknown relationships, as part of complexity. For example, Brady & Davies (2010, p. 155) refer to “unexpected interactions” – semantically adjacent to unknown interrelationships – as part of complexity. Thus, three broad strands of argument are visible from literature: (i) uncertainty as a component of complexity, (ii) complexity as a component of uncertainty, and (iii) independence of the two constructs.

It is clear that there is an absence of inter-subjective agreement among project management researchers on the constructs’ constituent terms and also about how the constructs relate to each other. The question of such absence of agreement motivates this paper. Grounding of construct definitions is critical for theory-building effort, as definitional weaknesses could lead to divergence in research without obtaining strong theories. While clear construct definitions by themselves may not be sufficient for theory-building, they are necessary to obtain a robust ontological and epistemological frame to aid further research progress. Noting that project management research offers a rich set of terms, words, or phrases to describe the two constructs, building taxonomies would be a pre-requisite to proposing strong definitions.

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