Chapter 19
Complexity Theory and System Dynamics for Project Risk Management

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ABSTRACT

As a consequence of the consensus that projects are growing in complexity from ever ambitious goals there is a perpetual search for methods aimed at pinpointing and describing the source of complexity with the objective of subsequently reducing uncertainty, managing risk and improving project performance. An area of study that has engaged enquiring minds for over fifty years but has not yet been accepted into mainstream project management is the study and application of systems thinking and system dynamics. The purpose of this chapter is to promulgate the view that the mapping of projects as systems should be re-examined as a means of articulating and responding to complexity. The chapter examines general systems theory, systems thinking and systems dynamics with examples of causal loop diagrams as an aid to describe and respond to risk exposure. It includes simple causal loop diagrams as a means of illustrating how risks may be identified and addressed. The emphasis is on seeing the 'big picture' to avoid gaps and omissions in the management of risk and uncertainty.

INTRODUCTION

A subject that increasingly holds the interest of the project community is the subject of project complexity. This is demonstrated by the proliferation of academic papers, journals, training courses and university degrees focussed specifically on project complexity management. The consensus being that complex projects present a far greater challenge to project managers who are seeking to secure a project's objectives. The increasingly ambitious nature of projects in terms of their burgeoning scale, value, technical novelty, compressed timeframes and growing socio-economic impact present unparalleled challenges and all against the backdrop of a legacy of failed projects, where objectives have not been delivered. Progressively, at the commencement of large projects, project directors are debating with their senior

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team the characteristics of their project. Particularly its degree of complexity and the need for the adoption of a strategic approach to address the perceived high level of inherent uncertainty. However research has shown that conventional project management methods such as detailed planning, tight controls and formalized communication are not adequate to manage complexity and the associated uncertainty. This chapter aims to describe practical steps to address complexity and the management of uncertainty through the discipline of risk and uncertainty management, recognised by the PMI and Prince2 project management methodologies as one of the indispensable project knowledge areas. The author suggests a lens through which to examine project complexity, to gain greater clarity and insights, is the interdisciplinary research area of complexity theory, (put simply the study of complex systems) and its sub-disciplines of systems thinking and systems dynamics.

Nature and Performance of Complex Projects

There is broad consensus in the literature that due to their defining characteristics a set of construction projects may be classified as complex and that the degree of complexity is increasing (Baccarini, 1996; Braglia & Frosolini, 2014; Flanagan & Jewell, 2005; Gidado, 1996; Hillson & Simon, 2007, Loosemore et al., 2003; Vidal & Marle, 2008, Walker, 2002; Wideman, 1990, Williams, 1999). This complexity is commonly borne out of a combination of:

- Scale,
- Goals,
- Duration,
- Cost,
- Technology,
- Social impact, and
- Risk exposure.

The discernible growth in complexity is in part attributable to the emergence of very large scale developments which are described as megaprojects. The characteristics that may classify a project as a megaproject are an investment over $1 billion, high uncertainty, possible intangible benefits and attractive long-term outcomes (Eweje, Turner, & Müller, 2012; Flyvbjerg et al., 2003a; Miller & Lessard, 2000). While an increasing number of megaprojects are being undertaken around the world, the record of their performance is poor (Flyvbjerg et al., 2003a). These very ambitious projects have commonly been associated with cost overspend, delays and or shortcomings in scope and quality (Flyvbjerg et al., 2003b). Analysis of 258 projects found that nine out of ten transportation projects exceeded their budget and for rail projects the average cost escalation was 45 percent (Flyvbjerg et al., 2004). The importance of complexity to project performance is explored in Chapman's proposed framework of complexity (Chapman, 2016).

Project Complexity Stems from Uncertainty

To be able to address complexity it is necessary to discern its source. Authors such as Turner, and Cochrane (1993) refer to two primary characteristics of complexity, namely: