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A consistency-checking consensus-building method to assess complexity of energy megaprojects

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Abstract

Project complexity has been recognised as one of the main causes of failures in many energy megaprojects worldwide. This research aims to develop a Project Complexity Assessment (PCA) method, which consists of three components: a taxonomy of Project Complexity Indicators (PCIs), an integrated Delphi and Analytic Hierarchy Process (AHP) process to establish weights of the PCIs, and numerical rating criteria for all PCIs. An innovative aspect of the research is the effective consistency checking and consensus building method during the Delphi-AHP process. The developed PCA method is demonstrated in an energy megaproject case study.

Keywords: Energy megaprojects, complexity assessment, Delphi, Analytical Hierarchy Process, Group Decision Making, consistency checking, consensus building.

1. Introduction

Energy may possibly be the most essential resource the world will be in need for in the future. The global need for energy has surged dramatically in the first decade of the twenty-first century, more than any other analogous period in human history, resulting in very large and complex energy infrastructure projects being undertaken. These

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so called megaprojects are commonly defined as projects with a capital investment of at least one billion U.S. dollars; they are characterised as complex, costly, with long time frames and high levels of uncertainty (Flyvbjerg et al. 2003; Merrow 2011). Typical energy megaprojects include oil and natural gas extraction fields and refineries, large hydroelectric, nuclear or other types of power stations, and renewable energy projects such as wind and solar farms.

Unfortunately, these megaprojects are experiencing alarming rates of failure in meeting their business goals, their capital budgets and their delivery schedules. The energy sector alone reported high rates of project failure. A specific report on the energy sector by the Independent Project Analysis (IPA) involving 318 projects across the world, clearly demonstrated a downfall in the performance of energy megaprojects (Merrow, 2012). It highlighted 78% of projects were disappointing; there was an average of 33% real cost overruns; and 64% of these projects experienced serious production shortfalls in the first 2 years of operation. Problematic aspects of failures are identified where the inability to adequately determine and manage project complexity was considered as the largest risk to successful delivery of energy megaprojects.

With the increasing recognition of project complexity as a critical component of project delivery, particularly in the context of energy megaprojects, an immediate need for research in this area has been recognised. However, the project complexity discipline has not been effectively understood and is often perceived as a difficult subject to communicate about. Therefore, new and robust methods and tools for assessing and managing project complexity need to be developed. This research reports a new Project Complexity Assessment (PCA) tool that enables quantitative measurement of the level of complexity for any energy megaproject. The tool has been developed using a new GDM method. The paper’s main focus is to tackle the common defects of existing GDM methods applied to project complexity evaluation that are: lack of comprehensive determination of project complexity indicators; lack of robust consistency and consensus processes to elicit the weighting of PCIs; and lack of effective definition of quantitative rating criteria. The practical application of the produced PCA tool is demonstrated with an energy megaproject case study.

This paper is organised as follows: section 2 reviews current approaches and methods on project complexity evaluation; section 3 introduces the GDM method adopted in this study; section 4 presents a newly developed taxonomy of project complexity indicators; section 5 demonstrates the process of consistency-checking consensus-building within an integrated Delphi-AHP method to elicit the weights of indicators; section 6 presents the development of numerical rating criteria for all PCIs; section 7 demonstrates the practical application of the proposed PCA tool through a case study; and finally section 8 discusses the results and presents conclusions.

2. Research background

Complexity is recognised as one of the main idiosyncratic attributes of megaprojects and, at the same time, a cause of failure in energy megaprojects. Sovacool and Cooper (2013) mentioned complexity as the most unknown and pathless attribute of megaprojects that needed to be addressed. This issue has led to many works on project complexity being carried out in recent years. But the efforts to date seem to have generated more confusion than precision, as complexity and project complexity have been interpreted in many different ways. This research considers a more specific realisation of project complexity, introduced by Williams (1999), as it explains that project complexity increases as a result of swift changes in the environment, enlarged product complexity and increased project-time pressure. Recent research (Bosch-Rekveldt et al. 2011) demonstrated project complexity is characterised by a number of indicators, but their categorisation has not been consistent or agreed.

In addition, criticism has been directed towards current research for its inability to be implemented in practice. Little et al. (1998) have expressed the significance of objective and quantitative evaluation of complexity; also it has been suggested that any practice driven complexity assessment method should entail explicit objective measures (Remington & Pollack, 2007). Yet, until recently, studies on project complexity have been mostly devoted to the conceptual aspects of project complexity (Maylor et al. 2008; Kardes et al. 2013). Recent research has been designed to measure levels of project complexity (Vidal et al. 2011; He et al. 2014). The GDM methods was selected as the main methodology of these works; however their accuracy, practice applicability and completeness are challenged by the following three issues: (1) The indicators contributing to project complexity are not fully identified and have not been organised in a standard categorisation, or taxonomy; (2) The proposed methods mainly