22. Project risk management in complex socio-technical systems: A resilience perspective

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Complexity is an inherent property of socio-technical activities and represents a continuously growing concept in modern project environments (Marle and Vidal, 2016). Complexity is often used to describe those phenomena that cannot be totally understood and kept under control, oppositely to complicatedness (Ulrich and Probst (1988); Dekker et al. (2012)). A joint combination of the two traditional scientific approaches for complexity management (i.e. descriptive and perceived complexity) has been early acknowledged as necessary to cope with nowadays project management issues (Schlindwein and Ison 2005). Since all approaches for describing complex projects are models of reality, they necessarily deal with the limited perception of the analyst, i.e. his/her improper understanding of reality. Therefore, the approaches to deal with project risks are inherently biased, leav-ing room for the emergence of unforeseeable effects (Baccarini, 1996).

In the last decade, similar observations have been largely explored in the context of risk and safety management for socio-technical systems, leading to the theory of "Resilience Engineering" (RE) (Flin, 2006; Hollnagel, 2011). Acknowledging the limitations of traditional risk approaches, an effective project management should combine traditional risk management with resilience management, where resilience is intended as the ability to recover from endogenous or exogenous shocks or disturbances (Patriarca et al., 2018).

Based on the assumptions of RE, this research aims to explore the potential benefits of adopting the Functional Resonance Analysis Method (FRAM) (Hollnagel, 2012) for modelling socio-technical properties of projects. The research aims to explain how a RE-based approach may favour an effective resilience management, and consequently support the project manager in coping with socio-technical risks.

Design/methodology/approach

The paper refers to the FRAM, which has been largely used to model complex socio-technical systems, mainly for risk management and accident analyses in the context of safety management, see (e.g.) (Furniss et al., 2016; Melanson and Nadeau, 2016; Patriarca et al., 2017). The FRAM relies on four basic principles, which are here discussed with reference to current project risk management characteristics (Hollnagel, 2012):

- Principle of Equivalence. Project failures and successes have the same origin: they emerge from everyday performance variability, i.e. on how operators in the project behave in their day-to-day work. Functional variability allows both things go right and things go wrong, depending on complex interactions among tight-coupled agents and processes.
- Principle of approximate adjustments. People as individuals, as groups, or as organizations, adjust their performance to match the operating scenario. Nevertheless, in any project activity, these adjustments become unavoidable, due to intractability and under-specification of work conditions. The adjustments remain approximate due to the limitedness of resources, or even due to the local rationality of the worker in the project.
- Principle of emergence. Not every event during project lifetime can be linked to one (or multiple) linear static causes. Many events are emergent, rather than resultant from a specific combination of static conditions. Dynamic combinations of time and space conditions during the project might make emerge an event, not leaving detectable traces by *ex post* analysis. This principle represents also a paradigm shift to the label of human error, since failures usually cannot be explained only by referring to individual malfunctions, but are rather a symptom of complexity-driven project criticality.

- Principle of Functional resonance. The functional resonance represents the detectable signal emerging from the unintended interaction of everyday variability for multiple signals. This variability is not random, it rather depends on recognizable behaviours of the agents involved in the project, which act dynamically, based on their local rationality and on the available resources.

Starting from the FRAM, projects should be described according to a functional perspective, where a function refers to the activities that are required to produce a certain outcome. The FRAM thus implies a thorough analysis of project activities, as a preliminary step to manage complexity, and detect potential resonant couplings. For this purpose, the FRAM suggests modelling functions (i.e. what an individual, group, technological agent does) following six fundamental aspects, i.e. Input (I), Output (O), Time (T), Control (C), Precondition (P), Resource (R), put at the corner of a hexagon, the peculiar FRAM basic element (Hollnagel, 2012). Then the FRAM prescribes modelling each interaction between upstream and downstream functions in order to study how each interaction might be variable, thus leading to functional resonance (Figure 22.1 presents a simple FRAM model).

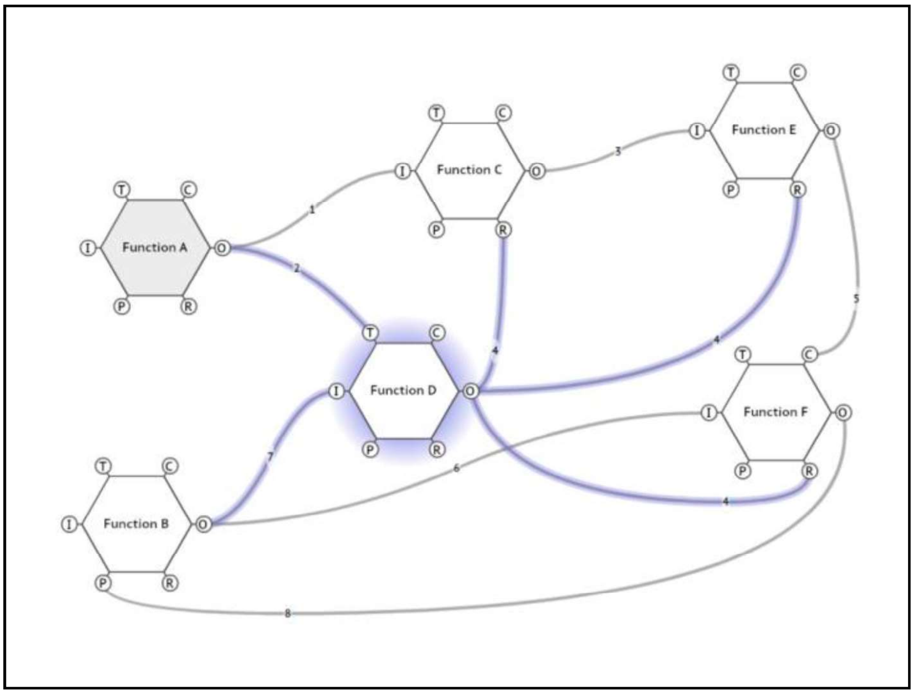

Fig. 22.1. A simple FRAM model made up of 6 functions.

Findings

Effective project risk management cannot be based exclusively on hindsight, nor rely on error tabulation and the calculation of failure probabilities. Projects are complex, and such data are not necessarily available or reliable. A functional representation and understanding of complexity has the potential to support more realistic perspectives to manage project risks, and project resilience.

Following RE, a FRAM approach does not consider performance variability, of any kind, as a threat to be mandatorily avoided. Rather than focusing on developing constraining means (in particular for human performance variability) such as barriers, interlocks, rules, procedures and the use of automation, a FRAM model prioritizes areas for in-depth analysis of variability, leading either to reduce, or to amplify it, at least if acknowledged as non-critical and even necessary for project success. In RE, performance variability is considered both normal and necessary: it is the source of both positive and negative outcomes. Project success cannot be obtained exclusively by constraining performance variability, since that would also affect the ability to achieve desired outcomes. The solution is instead to dampen the variability that may lead to negative outcomes and at the same time to reinforce the variability that may lead to positive outcomes.

Originality/value

Following the logic of RE, this research proposes the possibility to explore a methodological alternative to traditional risk management techniques for project risk management through the support of a recently introduced method, i.e. the FRAM. This latter is intended as a method to partly mitigate several main impacts of project complexity, i.e. ambiguity, uncertainty and propagation (Marle and Vidal, 2016). About ambiguity, the FRAM acknowledges the impossibility to deal with exhaustiveness in identifying criticalities, and proposes a new perspective to identify a series of emerging events, which not necessarily would remain visible in case of failure-oriented analysis. About uncertainty, the FRAM complexity-based modelling techniques have been proved to be supportable by quantitative or semi-quantitative analysis, (e.g.) Monte Carlo simulation (Patriarca et al, 2017a). About propagation, the inherent non-linear foundation of FRAM, and its constituent functional resonance principles provides a foundation to cope with the limitation of linear causality reasoning.

Practical implications

It is worthy to notice that the applicability of FRAM has been recently enhanced by two software, both openly downloadable, i.e. the FRAM Model Visualizer (Hill and Hollnagel, 2016), usable to depict interactions graphically, and the myFRAM (Patriarca et al., 2017b), a VBA-based tool to formally support large-scale analyses and generate systematic data about the FRAM model.

Research limitations/implications

Managing project risks is a never ending challenge; and it has been proved to be a crucial area for project managers, as it represents a key factor for project success. Following the benefits of previous FRAM applications in a variety of scenarios for risk and safety management, this research promotes future applicability of the FRAM, and in general of RE-driven reasoning, for an eclectic effective project risk management.

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