

Systems Thinking for Project Management? Risky Not To

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Introduction

Projects fail regularly and spectacularly. For example, Denver's US \$5 billion airport was 200% overspent [1], the UK's Scottish Parliament was anticipated to be 10 times the original budget [2], and more recently the Perth Children's hospital experienced significant delays i.e. 4 years overrun [3]. Many of these cost overruns are experienced by reputable organizations with ostensibly considerable expertise in contemporary project management techniques. The failures are also despite the variety of guides available to project management practitioners, notably the PMBOK® Guide [4], and APM Body of Knowledge [5]. There is also a wealth of academic research on projects and their management which now spans many decades [6]. It seems reasonable therefore to assume that current project management practices are insufficient leaving projects exposed to undesirable outcomes such as overruns and that new ways of considering project management are required [7]. One such possibility gaining interest is the systems thinking approach.

Using systems thinking to consider projects and project risk is not new. For example, Peter Checkland [8], developed Soft Systems Methodology (SSM) as a result of finding system engineering approaches lacking. To develop SSM he drew on a range of influential system thinkers such as Bertalanffy [9] and Ashby [10]. Using the development of Concorde as an example, Checkland noted it was important to think about not just the technical systems (of which there are many) but also the financial systems, social systems, political systems and environmental systems and, moreover, their impacts on one another. The significance of taking a 'wider' perspective is echoed by Morris where he comments "project managers, and particularly those who teach and consult to them, generally only take a middle management, tools and techniques view of the subject. Few address the larger, more strategic, issues that crucially affect the success of projects" ([11], p 217). More recently Pinto and Winch state "PMBok focuses so closely on the actual delivery of the project that it comes perilously close to ignoring the larger context within which the project is idealized, validated and shaped by multiple stakeholder forces" ([7], p 238). Context – the wider world within which the project sits - matters.

Thus, it could be argued that to actively consider context when embarking on project management is important. One particular and significant aspect of project management is risk management. Having a good understanding of the risks (and opportunities) associated with the project can enable robust estimation, accurate work packages, scheduling etc. Consequently, as with project management it is important to take a context sensitive approach to risk management as it increases the chance of project success [12–15]. This means paying attention to three elements namely; a) capturing a *wide array of risks*

(within and surrounding the project), b) capturing the *impact of these risks* on one another – their systemic impacts, and c) recognising that *risks change over time* i.e. they are dynamic as researchers have found these to be salient in explaining cost/time overruns in complex projects [16,17]. Furthermore, these elements do not operate in isolation, they impact one another i.e. taking a more comprehensive view will increase the number of impacts experienced, further complicating the management of projects.

This chapter, focusing on a context or systems thinking approach to risk management thus commences with a brief exploration of the traditional method of project management before considering recent developments. The chapter then explores a particular method before concluding with some thoughts for future development.

Demands for Moving Forward in Project Management

Project Management research and practice has predominantly been prescriptive – assuming that project management is rationalist, that there is a single reality independent of interpretation, and that breaking the project down into discrete ‘chunks of work’ is the most appropriate means for management [15].

This seems contrary with reality as, for example, projects are designed and constructed by people who may have different understandings of the project as well as different aspirations for it. Focusing on understanding the context better, Boonstra et al. note that “project failure can often be attributed to social, cultural, and political factors and processes” ([18], p 1). They note that projects need to meet multiple requirements, some of which may well be incompatible with one another. This resonates with other researchers who note that projects are vulnerable to intangible or ‘soft, human risks such as organizational politics or challenges to ‘established norms’ ([19], p.799).

A survey conducted by White and Fortune [20] found that many project managers were surprised at the occurrence of unexpected side effects in their projects, the majority of which could be traced back to a lack of awareness of the project’s environment – its context. The authors posit that this “may imply that many of the tools and techniques the respondents used were poor at modelling ‘real world’ problems or that insufficient account of project boundaries and environments” (p. 5). Attending to context, recognizing multiple realities and human factor considerations, demands more expansive consideration, and thus taking a systems perspective, which concentrates on recognizing and assessing the impact of interconnectivity, multiple perspectives and multiple criteria, may be of benefit.

Contributing to this need to attend to the wider context and differing realities is a growing recognition of the importance of effectively managing stakeholders [21]. Stakeholders proliferate the context and can have considerable impact. Given that complex projects abound with stakeholders – for example, clients, end users, contractors, legislative bodies, environmental groups and local communities, understanding who these stakeholders are, and what impact they can have provides valuable insights. Projects such as the decommissioning of the Brent Spar clearly illustrate the profound effect stakeholders can have on projects and thus the need to explore risk from a stakeholder perspective [1].

One key aspect of stakeholder engagement is in the alignment of objectives – “sponsors and stakeholders often have competing characteristics and goals” ([22], p 908) and Boonstra and colleagues comment on the need to “meet multiple objectives and requirements, a number of which may be contradictory or

incompatible with the available capabilities and resources” ([18], p 20). Different goals/objectives not only can result in tensions between parties (a risk in itself) but also different perceived risks.

Alongside, and to some extent triggered by the demand for attending to project context, is recognising and managing the *systemic* nature of risks. According to Kwan and Leung ([23], p.635), treating risks as being independent of one another is “a common practice of current risk management approaches”. One reason for this is that projects may grow ‘amoebic’ like [24] and that projects behave in ways that are non-intuitive [25–27]. Post-hoc analyses reveal that non intuitive behavior can be explained by the interdependence of events that escalate the cost overrun due to feedback loops and portfolios of risk [13–15,26]. Fang and Marle note “some phenomena like chain reactions and loops are not properly taken into account” ([28], p 635).

A good illustration of systemic risks is the construction of the vehicle carrying trains travelling through the Channel Tunnel between France and the UK [29]. As a result of unforeseen exogenous risk events (e.g. Zeebrugge Ferry disaster) safety requirements were increased. This, in combination with the client imposed additional information requirements (data travelling the length of the train), resulted in the number of cables connecting the train being significantly increased. A consequence of this additional cabling was the carriages were overweight (there are strict limits due to track performance). As a result a weight reduction program was instigated which caused equipment and wiring to be changed. This affected both the design and manufacturing processes (impacting the entire project).

Examples such as these highlight the importance of attending to a *comprehensive* risk capture, a comprehensive and regular *capture and review* of the *impacts* between risk (recognizing that risks don’t act in isolation and change in salience over time) and acknowledging the *breadth of stakeholder* engagement. Each of these has implications for the other. Getting them right improves the chance of a successful project and getting them wrong has the potential for a vicious cycle of project overruns. Taking a systems approach to project management therefore may provide valuable insights and take cognizance of researchers suggesting that those in the project management field consider a more integrative and systemic approach [15,30,31].

Modelling Systemic Risk

If a systemic approach to project management is to be implemented, project management teams are faced with a number of challenges namely; how to gain/elicit a comprehensive picture of the whole (risks *and their* relationships) and how to manage such voluminous data in a manner that is practically useful. Given the interest in the more systemic approach to risk management some techniques and models have been developed, each with associated benefits and limitations.

Starting with ‘bow-ties’ and fishbone/Ishikawa diagrams, these techniques, developed for analysing major incidents and risks, move beyond a discrete view of risks. Both these techniques look at the causes and consequences/controls of major incidents however this is where the systemic exploration stops. There is no recognition of how incidents could impact one another. Bayesian Belief Nets (BBN), a probabilistic directed acyclic graphical model, allow for this inter-connectivity of risks however they struggle with situations where dynamic behaviour i.e. feedback, occurs. In addition, the probabilities on risks (when considered as discrete) are parsimonious.

Cynevin [32] encourages decision makers to look at problems and assess whether they are simple, complicated, complex or chaotic and thus “helps leaders determine the prevailing operative context so that they can make the appropriate choices” ([32], p 72). The Cynevin framework explicitly recognizes the need to take a holistic (systemic) approach when considering projects along with an appreciation that projects are dynamic. However, whilst providing a useful dialectical device the framework does not provide the means for capturing the conversation, modelling it and being able to effectively work towards successful project management.

Another systemic modelling approach that has seen considerable traction is the use of continuous simulation [28] in the form of System Dynamics (SD) modelling. Using system dynamics it is possible to model the feedback behavior, and explore the counterintuitive consequences of actions. For example, when seeking to understand cost overruns, system dynamics is able to model a project as anticipated and compare this with what was experienced. System dynamics has been used to understand project risks both prospectively [33,34] and forensically [12,35]. However these models are time consuming to construct and often opaque to those not familiar with the form of modelling.

Finally, and elaborated further below, is cause mapping. Causal maps are networks revealing chains of argument and attend to Fang and Marle’s demand that “risk interactions should be modelled with a network structure instead of a classical list or tree structure for representing the real complexity of the project” ([28], p 636). The maps comprise options, context, assertions, facts, and triggers along with their associated consequences and may capture 1000+ statements. Causal maps can be built through individual interviews, group workshops or using documentary materials. The maps are analysable [36] and allow for the *system as a whole* to be explored. Edkins and colleagues have explored the use of cognitive mapping methodologies in projects [37] as have Ackermann and Alexander [38].

Causal Mapping – building a systemic understanding of project risks

Although causal mapping has many forms, a specific form developed by Eden [39] and colleagues has effectively been used to aid decision makers in the project and risk management arena. The maps are built by capturing not only risk events/triggers but also their consequences through laddering or scaffolding [40] the chains of argument. Thus maps make it possible to reveal how one event impacts on another event potentially generating feedback dynamics and so depict the resultant escalatory effects - the ‘perfect storm’ - which send project costs spiralling. Consequently, maps enable project managers to attend to a comprehensive set of risks and their associated inter-connections.

Mapping in the project management arena has been effectively used both forensically and prospectively. For example Ackermann et al [29] discusses the use of mapping when modelling delay and disruption on a litigation case centred on the Channel Tunnel rail link. Williams et al [41] also reflect on the role of mapping in post mortem analysis to explain the destructive dynamics and Ackermann and Eden [42] reflect on how mapping supported workshops facilitated the development of a model that captured the project’s various disruptions and delays in a manner that encouraged openness and thus ensured a more robust understanding of the project could be determined.

Mapping supported workshops can also be used prospectively to support the risk management process [43]. During the workshop, the model is created interactively, capturing and editing contributions and associated links as they are generated by workshop participants. By using both the causal mapping technique and the *Group Explorer*¹ Group Support System (GSS) [44] the design provides participants from different parts of the organization with an opportunity to identify *any* risks they see as being of concern, allowing for both breadth and depth (comprehensiveness). Mapping allows each risk to be considered in relation to those that might trigger or exacerbate it (relationships) as well as the risks that might unfold as a result of it occurring i.e. the consequences. The risk map allows stakeholders to see the ‘whole’ as well as the ‘parts’ and is amenable to analysis, thus assisting in managing the complexity rather than reducing it. Analysis enables the detection of emergent properties such as feedback loops, ‘busy’/central risks and triggers, and exogenous variables [36] which help project managers put in place effective and efficient mitigation and management actions (See figure 1 for an illustration).

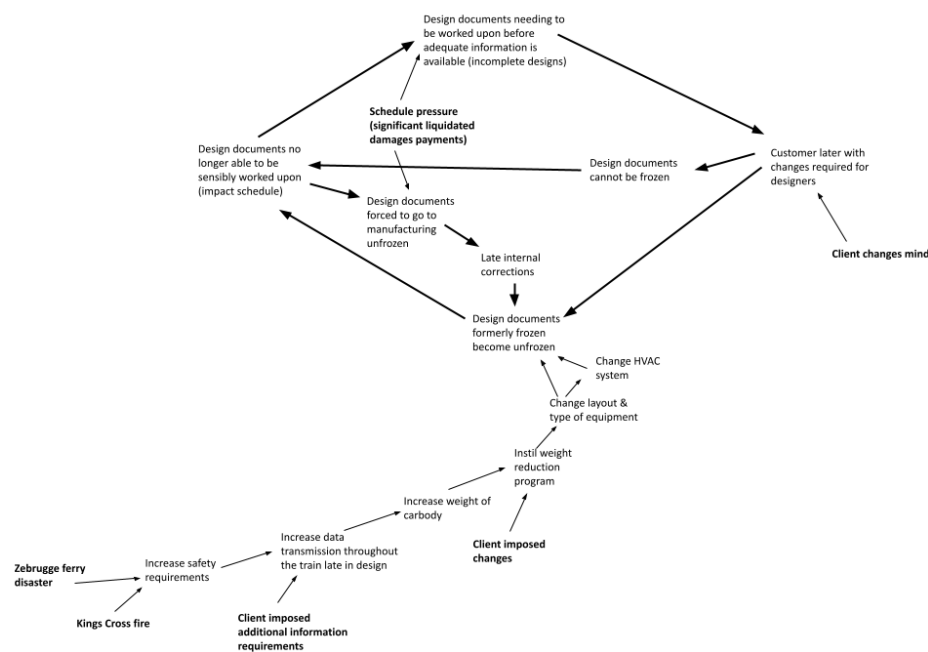


Figure 1: Illustration of causal mapping. The map (developed from a litigation case) shows triggers (bold italic statements) and consequential chains of argument. It also reveals nested feedback cycles (bold arrows).

The modelling and associated debate helps move participants from a divergent position to a more convergent and comprehensive understanding of both the project in question and projects in general. It may provide a dialectical device encouraging discussion and debate among project stakeholders, and consequently enabling them to gain a more nuanced understanding of the project as “project risk management frameworks should inform project teams about likely cross-impacts of planned actions” ([16], p.221).

¹ This software has now been superseded by Strategyfinder and can be found at strategyfinder.com

Not only does the technique allow for the modelling of risks resulting in an analysable network but it also is able to provide a foundation for more quantitative modelling efforts. For example the causal maps developed for litigation efforts (for a specific organisation) were used to develop a risk filter [45]. Additionally it can be used to provide the basis for a simulation model allowing for counterintuitive behaviors to be detected [46] and enabling the determination of quantum on a litigation case [16].

Developing a mass transit system – using mapping and systems thinking prospectively

A mass transit project was designed to connect the terminals of a major airport to one another and to the established rail system. The project straddled two jurisdictions (between two US states), each with their own budget, constituency pressures and objectives, and their own perspectives with respect to the project's goals. The design was predicated on an existing project carried out in South East Asia which had been considered successful and thus it was anticipated that learning from the Asian project could be translated to the new infrastructure. The project team supported by senior management, whilst feeling reasonably confident in their ability to successfully undertake the project, believed that there would be benefit from a comprehensive exploration of the risks.

Risk assessment causal mapping workshops were undertaken adopting the design noted above. The workshops revealed that staff were making the assumption that a mass transit system catering to South East Asian populations would translate directly to American populations (e.g. acceptability of service and facilities) but on closer examination, this assumption did not hold in the context of the current project. In addition, legislative concerns, in particular health and safety, of building a rail line on a raised platform in the middle of a busy expressway emerged, as highly salient due to the likely impact on communities.

Using this 'bottom up' approach, as opposed to the typical 'top down' method, allowed the client organization to gain a detailed view of risks. Moreover, through provision of anonymity and simultaneity of capture, the GSS enabled a wider range of insights, knowledge and experiences from participants to be surfaced. Participants thus reflected upon the project in question, rather than just simply adopting a checklist approach, and consequently, ensured a more rigorous exploration of the project risks. This approach reflects the important role experience plays in the identification and management of risks in complex projects ([Akintoye and Chinyio, 2005](#)).

Involving stakeholders in risk management enables both wider capture of risk through their various perspectives as well as stakeholder ownership and appreciation of the project's complexity and objectives. As discussed this can be achieved through risk workshops supported by a GSS such as *Group Explorer*. These workshops offer an environment for enhanced communication enabling shared understanding and reducing germination of potential conflicts. This is particularly potent given Krane et al. 's ([47], p.54) view that 'what is important (and hence given priority) to one actor may be quite insignificant to another'. The potential for workshops to enhance communication is illustrated in their application in a power generation project recently reported in the operational research literature [43].

Reflections

Mapping provides an alternative means of managing risks – in essence a systems thinking approach [48] and one that facilitates the consideration of three interrelated characteristics noted at the beginning of the chapter (see Table 1). The first, is the need to *think widely* to gain a more comprehensive view of risks than is typically offered by existing risk management infrastructure. This means going beyond the typical financial and technical ‘hard’ risks considerations to explore ‘soft’ risks that might emanate from the political, environmental and social perspectives. It also means involving others (stakeholders) in the process of risk management to gain more expansive perspectives recognizing that our individual views of projects are only ever partial. The second characteristic is the need to *think systemically*, exploring and understanding the triggers and consequences of risks so that patterns of risk systemicity, for example, feedback loops, can be identified and managed. Lastly, is the need to *think regularly* about risks, refreshing our understanding of the risks in a way that recognises risks change in salience over time (new risks emerge and existing risks fade away) and that the relationships between risks can also change, thus taking on more of a dynamic and learning approach.

Characteristic	Management Action
Think <i>widely</i>	Complement top down risk identification with bottom up Go beyond the finance/technical to consider social, political, environmental Incorporate the perspectives of other stakeholders in risk management Consider all stages of the project life cycle
Think <i>systemically</i>	Identify and capture the relationships between risks to reveal risk structures Adopt a systemic approach to risk mitigation strategies e.g. select actions capable of achieving a range of benefits and avoiding negative outcomes
Think <i>regularly</i>	Conduct regular refreshes of risk models, recognising that risks and their relationships change in salience over time. Incorporate new stakeholder views

Table 1: Characteristics of a systems thinking approach to project risk management.

There is a further feature of a systems thinking approach to project risk management that warrants attention. In table 1 each of the three characteristics of the approach is presented and described independently of the others. Viewing the characteristics from a systems perspective however reveals that they influence one another and that this influence brings further value to the risk management effort. For

example, as illustrated in Figure 2, increasing comprehensiveness in the identification of risks is likely to reveal new relationships between risks, thus contributing to improved understanding of risk systemicity. Engagement of stakeholders in order to improve comprehensiveness of risk capture is also likely to improve understanding of risk systemicity as new stakeholder perspectives bring to light risk relationships that were previously unidentified. Exploring the potential consequences or triggers of previously identified risks (i.e. risk systemicity) might reveal further risks. Finally, by exploring the systemic picture, it may become apparent that a wider array of stakeholders need to be involved to either ensure ownership and buy in, and/or to bring richness to underdeveloped areas of the risk map. Marle and Vidal when reviewing a rail project noted the importance of “greater coordination during the risk management process. It also underlines the need for cooperation and transversal communication within the project team” ([28] p 201). Thus, systems thinking is embedded in the consideration of individual risks as well as the process of risk management itself.

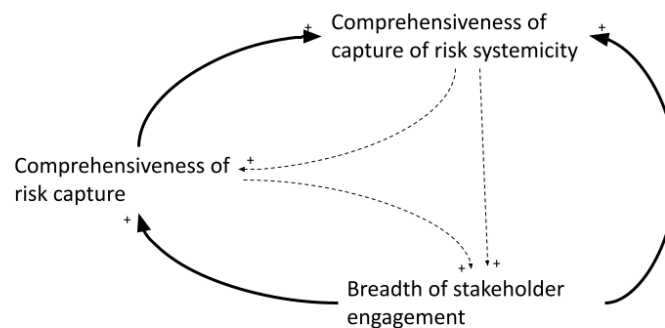


Figure 2: Virtuous feedback loops in a systems approach to project risk management. (Dotted links represent more tentative influences)

In addition, as touched on by the discussion regarding a systemic view of different stakeholder goals/objectives, considering strategy alongside project management ensures system coherence. Strategy explicitly considers stakeholders, goals, capabilities and issues – all elements that exist in project management. For example, when undertaking strategic management, scenarios are generated to test the nascent strategy mirroring the purpose of risk workshops.

Extrapolating into the future, there are a number of ways systems thinking ideas can enhance project management capabilities. The first centres on the project lifecycle where the growing interest in Private Public Infrastructure contracts may benefit from thinking systemically when considering risks, human resources and quality over a 25+ year time frame [49]. A second trend that is appearing addresses the value of training project managers in system thinking concepts and techniques [50–52] furbishing them with the means to manage complex problems. Harnessing the capabilities of emerging technologies provides a third strand. For example, the advent of 3 dimensional modelling may allow for risk systemicity to be captured, considered and analysed in completely new ways and thus yielding further insights. Finally leveraging systemic thinking to enable multi-disciplinary capabilities to be integrated may help in managing complex projects such as the decommissioning of oil and gas platforms where the range of stakeholders, values, and options demands a nuanced and sophisticated approach.

To conclude “proactive risk management can be achieved by monitoring the status of the risk network and adjusting the risk mitigation plan as the project progresses” [28] p 643) and as such notes the need to attend to taking a dynamic and systemic view to projects. Care is needed when determining management action as understanding the systemic effect is fundamental [53]. Project management “has to manage simultaneously risks of different natures, interrelated by cause and effect potential relationships and potentially occurring during or after the project” ([28] p 192) and causal mapping provides a powerful mechanism for doing so.

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