

Concept Paper

Understanding Collaboration in Integrated Forms of Project Delivery by Taking a Risk-Uncertainty Based Perspective

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Abstract: Background: Cross-discipline team collaboration between the project ownership team, design team and project delivery team is central to effective management of risk, uncertainty and ambiguity. A recently-developed framework that was developed to provide a visualisation tool to enable various project procurement and delivery forms has been adapted to answer the research question How can uncertainty best be managed in complex projects? Methods: The research involved reviewing transcribed recorded interviews with 50 subject matter experts that was originally analysed using axial coding with Nvivo 10 software to develop the framework that the paper refers to. It extends analysis to focus on risk and uncertainty previously reported upon in that study. Results and Conclusions: The adaptation presents a hypothetical partnering and alliancing project collaboration map taken from a risk and uncertainty management perspective and it also refines its focus on coping and sensemaking mechanisms to help manage risk-uncertainty in a practical and ‘how to do’ manner. This contributes to theory by extending the relationship based procurement (RBP) framework from taking a purely procurement theory focus to being applied in a risk-uncertainty project management theory domain. It also provides a practice contribution by explaining how the RBP mutation to a collaboration and risk-uncertainty management framework may be applied.

Keywords: project procurement; risk and uncertainty

1. Introduction

Much of the traditional project management (PM) literature has its focus on coping with risk and uncertainty in order to successfully deliver a project to plan (see, for example, [1–4]). Parties engaged in risk and uncertainty management (the project owner and/or representative, the design team and the project delivery entity) have usually done so separately and in isolation. Each entity attempts to shift risk and uncertainty to the party that can best manage it. The party that accepts this burden builds in a contingency reserve (time, money and other resources) to second-guess the implications of risk and uncertainty on disruptions and potential negative impact to the planned delivery schedule and budget. In many ways the term ‘*risk management*’ could be called ‘*risk avoidance*’ when considered from the perspective of many risk averse project owners who seek to shift risks to the contractor [5]. However, the fragmented and isolated approach to traditional project delivery in the construction sector has been challenged and modified through the concept of integrated project delivery (IPD) whereby the project owner, the design team and delivery entity collaborate and share the responsibility for risk and uncertainty [6–8]. A recently developed relationship based procurement (RBP) taxonomy [8], which could also be viewed as a collaboration framework, suggests a range of possible forms of project collaboration that can be used to proactively address the management of risk, uncertainty and

ambiguity. Effective collaboration between the client, design team and contractor has been shown to enhance addressing risk and uncertainty through improving the dynamic capabilities of project participants [9]. For this reason, the RBP taxonomy [8] is referred to as the RBP framework, or the framework, within this paper. This framework helps visualisation of the extent of collaboration between various project teams in delivering projects.

Brady et al. [10], in their discussion of Klein and Meckling's seminal paper [11] that focuses on trial and error problem-solving processes and strategies, note that the terms risk and uncertainty are often, though erroneously, used synonymously. Often unexpected events open up opportunities for innovation and learning. Identifying a risk should not automatically result in attempts to expunge it; rather the risk context and issues may be explored to see if these open up unforeseen opportunities [12]. Additionally, uncertainty often has an unspoken acknowledgement of ambiguity that may be referred to as people/process and situational ambiguity [13], where what is believed to be certain, known, and common knowledge between people is in fact interpreted quite differently. Thus it constitutes an unidentified risk and may lead to later uncertainty once any discrepancy in understanding results in unintended consequences.

Forms of uncertainty, whether identified or as unidentified ambiguity, are inevitable in the delivery and management of projects. This is because, by definition, this process is one in which a need (the project output) is realised through designed action (the project) over time. What was envisaged in terms of assumptions and planned for, before the start of a project, inevitably ends up being at variance with reality. Uncertainty can be viewed as a problem to be solved so that any expected detrimental impact can be minimised through risk management strategies. Alternatively, uncertainty can be embraced and viewed as a learning experience and innovation opportunity [14]. This provides a way of creating advantages and opportunities for positive value out of what may otherwise be considered as adverse conditions. This is what Hällgren et al. [15] refer to as embracing uncertainty.

This paper suggests that an effective way to cope with uncertainty is to deliver complex projects through adopting an integrated form of project delivery. Departing from traditional approaches, the project owner, designer and delivery teams collaborate closely, minimising or eliminating uncertainty and ambiguity. The paper does this by offering a practical solution for effectively achieving an integrated project delivery approach. The three parties bring to the table diverse sets of perspectives and potential problem solutions when facing unexpected situations and when preparing for uncertainty while also taking advantage of opportunities that arise from uncertainty. A recent study of integrated forms of project delivery in which 50 subject experts were interviewed and transcripts of the interviews analysed resulted in the development and validation of a collaboration framework that identifies 16 elements that may be used to explain how complex construction projects can best cope with risk, uncertainty and ambiguity [8]. That framework was originally developed as a means of classifying RBP forms. This paper reports on efforts to explore whether the framework has wider potential application, including providing a better understanding of how uncertainty management may be advanced. The contribution made by this conceptual paper is that it explores this framework to extend its potential applicability from a risk-uncertainty perspective, to add to its use as a project procurement classification tool.

This paper extends the use of the RBP framework to explore collaboration [8] by investigating how it can be used to answer the research question:

How can uncertainty best be managed in complex projects?

Complex projects are referred to as being projects with substantial technical, relational and system-integration challenges that need to be overcome due to the presence of many unknown knowns or unknown unknowns [16,17].

2. The Purpose of This Paper

The research question discussed in this paper presupposes that risk, uncertainty and ambiguity are not inherently bad. The purpose of this paper is to examine and answer the question from a risk-uncertainty perspective. In doing so, the RBP framework [8] is used as a more general collaboration tool that can be fruitfully viewed from a risk-uncertainty perspective to better understand how to manage uncertainty through forms of integrated project delivery.

The greater body of project management (PM) literature recognises the presence of risk and uncertainty, and the principal PM body of knowledge [18], has a significant focus on risk management. More recently, the PM literature has shifted its focus from one of a *managing* risk through planning and control by top-down mechanisms to *coping with* uncertainty and opportunities revealed through unexpected events and situations (cf. [19]). This may be achieved through bottom-up mechanisms based on collaboration with those who can react to and take positive advantage of (cope with) a situation to maintain the overall objective in a reflexive and adaptive way (cf. [20]). Aaltonen et al. [21], for example, argued that closer stakeholder engagement might be used to both identify unexpected events and provide resources and mechanisms to deal with them through collaboration. This uses the ‘muddling through’ [22,23] approach. Muddling through is far from a haphazard approach. Lindblom [22,23] makes it clear that understanding the context of a situation, as well as having a clear knowledge of the desired outcome, can lead to people taking an adaptive strategy in working around difficulties in a highly pragmatic and innovative way to overcome obstacles and achieve the objective. It is a more reflexive and resilient approach than the rigid plan and control approaches, but still retains an overall plan in terms of clear objectives, potential means, likely strategies, and an array of creative thinking ploys that can be marshalled when required. At its heart, it requires close collaboration between those parties that can help obviate problems and respond to challenges in a positive way.

A clear logic arises to answer RQ1 posed above.

- (1) Uncertainty in complex situations requires a *capacity* to access a range of perspectives about the nature and source of problems, range of available solutions, and how best to apply them;
- (2) There needs to be a *capability* present to realise access to that capacity. Capability includes the knowledge, skills, attributes and experience (KSAEs) of marshalling people and other social capital resources to address the task of managing uncertainty [24]. These KSAEs are likely to be dispersed across multi-disciplinary teams; not available from any one individual or narrow team of people. The richer the depth of understanding of uncertain situations, the more comprehensive will be the response options;
- (3) A further necessary condition is that those with the above capacity that are capable to collaborate to manage uncertain situations need institutional *enablers* and foundational facilities that support and sustain motivation to collaborate.

Key to any collaborative approach to risk and uncertainty management is the initial act of gaining a deep and sophisticated understanding of the situation context, the way that various influencing forces interact, and how those interactions may play out in the form of implications for achieving the desired project outcome. It is important to frame the problem situation effectively and accurately so that the right question is asked and the correct action followed to answer the question. This is how risk and uncertainty may be reformulated into opportunity [9].

Once a deep understanding of a situation is gained, ideas of how to better deal with the situation can emerge; ideas that often may be an improvement on the original plan. Being mindful of assumptions, potential bias, and cognitive dissonance [25] that lead to a plan can help assessment of potential risks that may ensure those plans become more realistic. Once people grappling with developing a response to uncertainty and risk have access to a *range* of potential expertise about a situation, they are free to discuss their perspectives. They are then more likely to gain a richer, more coherent picture of the scale, its likely cause and impact, and options to overcome that potential risk. If plans are seen as starting or launching points, and not constraints, then reviews and revision of

these plans that consider risk and uncertainty can take place in a mature manner [26], where an open and honest, collaborative approach prevails.

The main challenge faced in PM is that people initially do *not plan* for uncertainty, they tend to rarely view plans as *tentative coping platforms*. Dwight Eisenhower is reported to have said that ‘In preparing for battle I have always found that plans are useless, but planning is indispensable’ [27]. In other words, plans should not be viewed as end points to conform to. More broadly, collaboration and planning are necessary per se for sound risk and uncertainty management but are insufficient by themselves. Quality of information and knowledge exchange, together with the motivation to find common ground in developing an acceptable, if not optimal, way forward is the essential ingredient of effective risk and uncertainty management. In this way, reframing problems as potential opportunities becomes a natural process than merely participating in risk mitigation strategies.

Snowden, in his Cynefin Framework [16,17], recommends that when managing complexity leadership needs to ‘probe, sense, respond’, and in chaotic situations the appropriate response is to ‘act, sense respond’. Similarly Kutsch et al. [19] recommend treating risk and uncertainty management through a resilience lens by noticing, interpreting, preparing, containing and recovering from adverse situations. What is common to both these approaches is the concept of mindfulness [28]. This requires careful consideration about a situation from a number of perspectives made jointly through collaboration, with close scrutiny of likely consequences of any action taken.

The question posed is how can uncertainty be effectively managed in complex projects? This may be regarded as best undertaken with an ability to visualise managing uncertainty. Walker and Lloyd-Walker developed a visualisation tool [8] that facilitates graphically seeing how various forms of collaboration function. This has been done using the lens of interaction of three collaboration components comprising 16 elements. The components are foundational platform facilities, behaviours and processes, and routines and means that drive collaboration. The RBP framework [8], thus, provides a useful visualisation tool for perceiving how effective management of uncertainty may be achieved through mindful collaboration. This is explained in more detail later.

3. The Adopted Research Methodology

The research project that resulted in the original RBP taxonomy was in part funded by an internationally contested competitive grant by the Project Management Institute (PMI) and mainly funded through an Australian Research Council Linkage grant. The research was undertaken during 2012–2014 with the purpose of finding a way to classify forms of RBP that exist around the world. These RBP forms are notorious for changing over time. Additionally, terms used in one country at one particular time may be understood quite differently in another location and/or at a different time. Rather than rely on a RBP form title, such as ‘partnering’ or integrated project delivery or project alliance (PA) being used, a framework should be developed that provides elements or features/characteristics of the RBP form [8]. These should have measurement descriptors that could be used to map out a visualisation of any particular project delivery form to enable evolving and bespoke delivery forms to be more clearly recognised and understood [8].

The framework was developed by adapting the Wittgenstein Family Resemblance model, used for describing partnering characteristics by Nyström [29,30], and the engagement platform concept, used in analysing partnering by Jacobsson and Roth [31]. The research method adopted involved re-analysing transcripts and interview recordings taken with 50 subject experts, of which 14 were academics who had written widely on this area of research and 36 practitioners that played senior roles in collaborative forms of project delivery. Interviews, averaging around 60 min each, were recorded and transcribed. The transcripts were re-analysed and coded using NVivo10 to develop themes and sub-themes, with a specific focus and intent on identifying the way of coping with risk, uncertainty and ambiguity. This required thinking about the data in a more specific and targeted way whereas the previous analysis needed a more general ‘helicopter-view’ focus. Validation of the framework was undertaken at a series of workshops, conferences and academic conferences held in the USA, UK,

Belgium, several Nordic Countries, and in Australia. More details on their research approach may be found in their book (see [8] (pp. 97–104, Chapter 5)).

4. Explaining the Framework in Relation to Collaboration and Uncertainty

The RBP [8] collaboration framework is based on three components comprising 16 elements that broadly explain how collaboration occurs on complex infrastructure projects. Component one is a *platform facilities* (five elements) that support collaboration; component two comprises *behavioural factors* (five elements) that drive normative practices; and the third component is composed of *processes, routines and means* (six elements) that provide the ‘teeth’ that reinforces collaborative behaviours to transform idealised behaviour into active behaviour. This framework, which may be viewed as a taxonomy of requisite elements, also provides suggested measures for each element and when each of these is rated they provide a visualisation of the extent of collaboration. Rating may take place to design a desired form of collaboration (from low to high level) or to compare and contrast multiple forms of collaboration or to monitor and manage collaboration over the project lifespan.

5. Explanation of Platform Facilities

Figure 1 illustrates five elements that form the platform facilities. Element 1 relates to the motivation and context that define the circumstances that lead to an observed level of collaboration. There are seven sub-elements to element 1, not elaborated upon here, that explain a rated level of motivation to collaborate specifically relating to risk and uncertainty. For example, the presence of unknown risks is one sub-element and this may provide a dominant rationale for the project owner, design team and delivery team to closely collaborate. A research participant quote [8] (p. 170) illustrates an example of this as follows.

‘Effective unknown risk management is about maintaining confidence in cross-team collaboration and freedom of action to deal with risks as they emerge’. Then citing from transcript P24 ‘What would inevitably happen is you would get the tunnellers go through and excavate the tunnel. They hand over to their civil fit-out crew, and at the same time that the civil fit-out crew get access to the tunnel the M&E subcontractor is also expected to be in there. . . . there’s a lot of technology, a lot of integrated equipment that has to be built in the latter stages normally of a project installed, pre-tested and then commissioned. So it’s a massive amount of complicated work at the backend of a project that’s on a very tight time curve’.

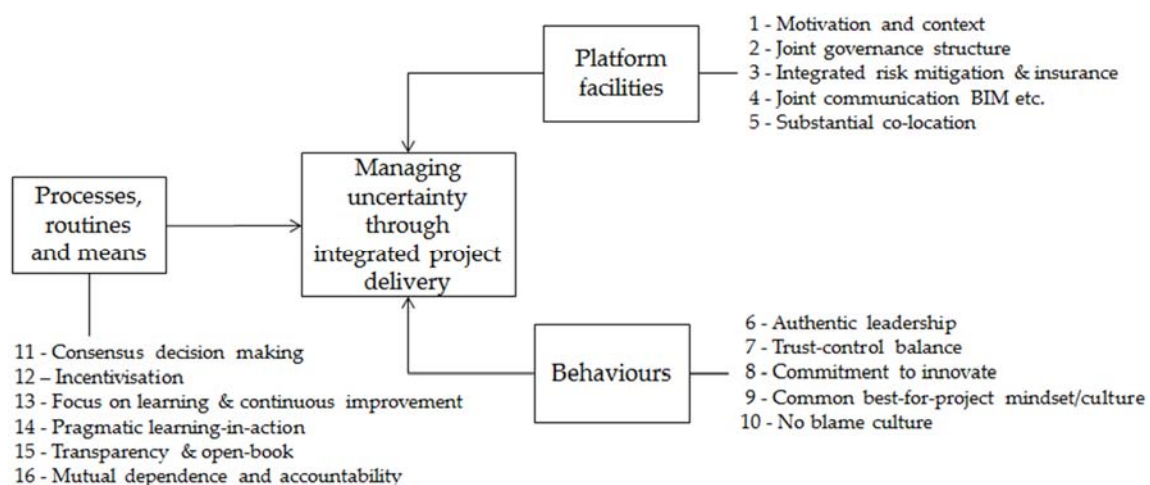


Figure 1. Elements from the RBP [8] Collaboration Framework.

In rating this element the project team, being mindful of the implications of this type of unknown risk, may decide that a high level of collaboration would be necessary to deal with this uncertainty. They may rate the above situation at 5 out of 5 (very high). Alternatively, the team may consider that this is a situation in which strong and vigorous hierarchical control of the participants may be better handled through strict adherence to contract conditions to effectively shift risk to the M&E subcontractors, therefore rating the need for collaboration to be relatively low (perhaps 2 out of 5).

The situational analysis and rating exercise is conducted by a team that mindfully undertakes the exercise to consider the situation. This team should comprise the client representative (if that entity wants to be part of the risk sharing arrangement), the design team (likewise), and the contractor team (which in the case of close integrated project delivery forms, such as alliances, may comprise the main contractor and several key sub-contractors forming the alliance). A low rating (say 1 or 2 out of 5) may be envisaged as typical for a traditional project delivery form with low levels of collaboration. A high rating (say 4 or 5 out of 5) is appropriate for alliances and high levels of IPD. In this way, each element may be rated to produce a visualisation of the level of collaboration that will best suit the chosen project delivery form.

Element 2 relates to developing a joint governance structure. It refers to the extent to which there is a unified and complimentary way that each project delivery team party legitimises its actions through interacting by rules, standards and norms, values and coordination mechanisms [32]. The better the quality of common understanding about how each participant fits into the overall project picture, the less likely the chance of there being ambiguity of role and process about how to cope with uncertainty. High rating for Element 2 implies closely aligned governance rules and processes etc. whereas a low rating suggests wide variance in these governance arrangements across project teams.

Element 3 is about the extent to which risk and mitigation strategies are integrated or aligned between parties. It relates to developing a common understanding of, and the quality of, explicit understanding of how to collaboratively manage risk and uncertainty and potentially gain advantage from an integrated one-team project-wide approach to risk management. This may be manifested by a project-wide insurance policy and mature conversation about how to match and align strategies across and between participants for coping with risk and uncertainty. Integrated risk mitigation relies on understanding each party's capability and capacity to respond to risk. This may vary across the project lifecycle and so this element requires a dynamic not static or once-off strategy.

Element 4 relates to the extent to which the project participants share common protocols and approaches to communicating. This applies to use of common or compatible tools, such as information communication technology, as well as procedures and protocols. For example this can range from common building information modelling software or email systems for a high rating; for a medium rating there may be compatible but awkward communication exchange, and a low rating may suggest the use of incompatible hardware and software by project teams. Speed and accuracy can be affected by 'noise' or system interference, as well as by the data connection and exchange speed, thus adversely impacting the rating of this element. Similarly communication process alignment is important so that each party understands what is expected of them in their cross-team communications and interactions. This impacts the quality of explicit understanding of how teams should collaborate and communicate.

Element 5 relates to co-location both in a physical sense as well as from an information and power distance perspective. Physical co-location allows immediate interaction between collaborating parties. While modern electronic technology such as virtual meetings and presence can be preferable to asynchronous interaction the sense of a physical presence that this tends to build better understanding of strengths and limitations is missing; this requires what Perks and Halliday [33] refer to as *fast trust*. Additionally, element 5 refers to co-location in terms of the ease and comfort with which people of lower hierarchical status can interact with those of higher hierarchical status, based on task/issue knowledge rather than position power.

These five elements pertain to platforms that may enable collaboration to be facilitated. The study [8] found that for high levels of collaboration support there needed to be high or very

high levels achieved for each of these five elements. If one or more levels were rated medium, or not high, then compensating measures needed to be put in place to effectively change the characteristics of the element to align with other parties to ensure collaboration was not undermined. For example, if critical team members could not be co-located (element 5) then a virtual presence would need to be supplemented with frequent face-to-face meetings or other forms of trust and credibility building measures would be needed.

This platform facilities component of the framework, as illustrated in Figure 1, may account for much of the preparatory collaboration infrastructure cost and effort. If it is skimped on then it may undermine the ability for behaviours and enabling means and routines to carry collaboration at a high level. Platform facilities may directly underpin and support behaviours although they are independent factors to those behaviours. These platform facilities also may underpin or undermine processes, routines and means that align and reinforce behaviours to permit collaboration to flourish. High rating levels indicate improved potential for higher collaboration levels.

6. Explanation of Collaborative Behaviours

Five behavioural elements were identified and assigned measures in the framework. These are explained as follows.

Element 6 is authentic leadership and this is further categorised by seven qualities that comprise sub-elements: reflectiveness; pragmatism; appreciativeness; resilience; wisdom; spirit; and authenticity. In essence, collaboration leadership behaviour is exhibited not just by the person who appears to be 'in charge' but by all team participants that are engaged in collaborating. This factor is rated from a low level of these behaviours negatively impacting upon the propensity of all project teams to collaborate to a high level of leadership that supports high levels of collaboration. A relevant quotation [8] (p. 181) illustrating higher level leadership is useful in explaining what high level authentic leadership may look like.

Participant 30 discussed the ability of project participants who did not have prior PA experience to reflect on how working within a PA context presented challenges to them. He observed that

'... you've got to have people that have got a pretty good degree of experience in the organisation that they represent. That they know their policies, they know their practices and procedures, they know what the intent is and be flexible and agile enough to move into a different team environment which has got a different set of policies potentially but making sure that they can marry up with the home based policies so that you're not contravening them' [8].

Element 7 relates to the level of balance exhibited between trust and control. High trust is essential for high levels of collaboration. Trust relates to a sense of benevolence between the person trusting the person being trusted, confidence in performance so that what is promised is delivered and integrity of the parties [34]. Trust is generated at both an individual and organisational level [35]. We can trust a person's willingness to do what they commit to but we may be sceptical about whether organisational or other external factors may undermine that willingness. Trust, therefore needs to be tempered by mechanisms that monitor and control the outcome of trust-testing events. Collaboration flourishes at a pragmatic level when there is a sophisticated and deep rather than shallow level of understanding of not only 'good intentions' but also environmental (political, economic, cultural etc.) influences that may mitigate willingness to act on commitments [36,37]. Naïve trust can soon lead to disappointment whereas sophisticated trust is more enduring and supports people to understand the bigger 'trust' picture [37].

Element 8 is a measure of a team's commitment to be innovative. According to a recent literature review of innovation in the construction industry, innovative behaviour is closely tied to a willingness to try new approaches and test new technologies with an open and inquisitive mind [38]. These behaviours are driven by understanding what facilitates and what undermines novel

approaches to working. A high rating in this element is associated with openness, willingness and an ability to be reflective and a critical thinker. A low level for this element is associated with unreflective caution, fear of failure, and high information and power asymmetries. Highly collaborative people frequently bubble with enthusiasm, exhibit passion, and are comfortable with being faced with the unexpected and unknown [39]. However, the person-environment fit is vital. This element needs to be not only supported by foundational elements such as co-location and joint communication infrastructure but also by organisational routines that will be discussed later.

Element 9 behaviour demonstrates a common best-for-project mindset and culture that encourages collaboration. One significant differentiator between highly collaborative forms of project delivery and business-as-usual transactional approaches is the way that a common goal is perceived by various project team participants. Cox is sceptical about the nature of the reality of win-win outcomes [40–42]. He more generally takes a commercial perspective of desirable outcomes but recognises that in a relational context, genuine common goals can be achieved. These goals may be valued by different parties in different ways, but can still lead to more holistic win-win outcomes. High levels of collaboration to achieve a sound project outcome for parties involved in a construction project lasting several, or many, years can deliver many non-monetary benefits. Sweeney [43] studied various construction project delivery approaches and found that from a transaction cost economics perspective, win-win outcomes through more collaborative forms of delivery can result in considerable benefits relating to: Financial savings; more effective direction of management attention; and reduced need for effort directed at countering opportunistic behaviour. He also highlighted benefits gained through collaboration in learning and competitive advantage through shared perspective on what each party in a project actually values. A focus on a project best outcome, even at the expense of short-term firm-individual optimisation of performance, can lead to longer-term benefits. The process of aligning objectives between collaborating parties opens up opportunities to better understand each party's culture, values and opportunities to synergise efforts for greater mutual benefit. The challenge to achieve excellence in overall project outcomes through collaboration can prompt parties to confront uncertainty by creating opportunities for innovation or improved productivity, which would not otherwise be considered.

Element 10 may be considered the most challenging behaviour needed for high levels of collaboration. A no-blame culture flies in the face of many project team members' experience. No-blame does not equate to no-accountability or no-responsibility though if handled mindlessly, establishing a no-blame culture can result in lack of responsibility and accountability [44]. It is essential to foster a culture where it is safe to fail (as long as knowledge gained can be garnered to improve future experimentation) if innovation and productivity improvement is to be achieved [45–50]. Two important aspects of no-blame behaviour are to understand its rationale and how to facilitate a no-blame culture through collaboration.

The above behavioural elements illustrate how a willingness to be collaborative can facilitate coordinated and focused action that might better enable the broad project team to better cope with risk and uncertainty than they might as individual firms. To be able to convert this willingness to action, even when underpinned by strong foundational facilities, requires institutionalised measures to be put in place to ensure that good intention is matched by requisite action. The last six elements within the processes, routines and means component of the model provide a framework for turning intended action in reality.

7. Explanation of Collaborative Processes, Routines and Means

These last six elements link intent to action, underpinned by supportive foundational facilities. Coping with uncertainty and managing risk are important goals that can be achieved through close positive collaboration between teams with varied skills and expertise. This component of the model illustrates how optimising collaboration to better tackle challenges can be achieved.

Element 11—consensus decision making—is tightly linked to a no-blame culture. This element lies at the heart of innovation through collaboration and provides the means to support the no-blame culture element 10. Element 11 measures the presence of procedural requirements for parties to form a consensus position, in alliancing at the alliance management team and alliance leadership team levels, by arguing through issues until agreement is reached. It is a fixed requirement only in high-level collaboration project delivery forms such as alliancing [51] and ‘Collaboration Level 3’ for IPD [7]. In partnering forms it is a ‘nice-to-have’ feature but is not mandated [30] and is deemed completely unnecessary for most forms of project delivery based on a belief that each party in a project is designated to control risk they accept in a way that best suits them [52]. Therefore this element helps define project delivery forms at the highest collaboration end of the continuum. The rationale behind consensus is that if everyone agrees to an action then no one person or group can logically blame another because all participants had collectively agreed to a joint course of action.

Element 12, Focus on learning and continuous improvement, encompasses a number of routines and means that may be deployed to encourage, facilitate, and develop innovation and continuous improvement. For example, to support and encourage innovation on most alliance projects there is a requirement to maintain an innovation log, or register, and recording mechanism. In many alliances, particularly service or program alliances that cover a period of time and involve numerous projects within a program of works, a highly proactive approach is mandated. In one alliance in Victoria, Australia, a case of a highly advanced web portal being developed has been reported. It included training and interactive community of practice approaches to disseminate and encourage innovation that have in turn generated very high safety outcomes, while reducing waste and improving productivity [53].

Element 13, incentive arrangements, measures the nature and intent of incentive arrangements that define the level of pain and gain sharing. These are explained in terms of the way that incentives are framed. For example, in alliance and ‘Collaboration Level 3’ IPD projects there is a subtle but critical orientation in the key performance indicators (KPIs) being set on a holistic overall project result, such as the entire project being ahead/behind target cost/time budgets [54,55] and this varies considerably in intention when compared to *each team* having targets. KPIs and incentives are worded to encompass the whole project. The implication of this is that if one participant team is experiencing difficulties then other teams will proactively assist to help overcome any problems encountered by the struggling team. This is because there is a common interest at stake. When KPIs relate only to individual participant team performance there is little or no incentive to step in and help struggling participants. This element has a profound impact on the project workplace culture and ‘we sink-or-swim together’ behaviours. Uncertainty, risk and ambiguity are likely to be treated quite differently under these contrasting means and contractual arrangements. Attitudes towards innovation are also likely to be positively affected by a joint ‘one-team’ approach.

Element 14, a focus on ‘learning-in-action’, relates to the routines and means that enable learning to be embedded in project organisations then continued as a whole of workplace culture. This element moves beyond being innovative to a focus on internalising learning and this may have profound impact on how uncertainty and risk is viewed by project participants. The protocols put in place encourage learning-in-action as a natural way to conduct work. They become important drivers of an innovation mindset, particularly when no-blame behaviour supportive routines are effectively applied. Researchers have reported on the effectiveness of innovation adoption and learning on the approach taken on the T5 Heathrow Terminal project for example [56–58] and flowing from that the Crossrail Project in London [39,59]. In these examples we see contractual arrangements that encourage experimentation, trialling, expected learning from mistakes and having measures in place to avoid blame for experimental failure. Experimental action is recast as a process of learning and improvement. Other forms of means and routines include mentoring and coaching as well as specific periodic workshops on how to establish continuous improvement. The perception of uncertainty as

being a threat or opportunity is quite different under the two extreme rating measures offered by the RBP framework.

Element 15, transparency and open-book access, have a set of organisational routines to permit the project owner (PO) and other participants access to accounting records and other documentation. A distinguishing feature of alliance type project arrangements, including level-3 IPD (there are three levels of collaboration intensity defined of which level 3 is the most like an alliance [7]) and the T5 type contract arrangements (British Airport Authority Terminal 5 agreement), when compared with less integrated collaborative forms of project delivery reveals that these high-end collaboration types *start* with development and agreement of realistic key results areas (KRAs), including a target outturn cost and time. Performance against these KRAs is mediated by pain and gain sharing arrangements. This is designed to produce a realistic target that allows greater exploration of risk and uncertainty to reduce the level of unknowns and to encourage the development of innovative solutions to cope with anticipated challenges. This also requires that parties place all assumptions and information and knowledge ‘on the table’ in a transparent way. It also requires deep levels of accountability. Less integrated collaborative delivery models, such as design and construct, partnering, etc., assume that each party takes over its own risk and uncertainty management. In this situation there is little need for routines to demand high levels of accountability and transparency [60].

Element 16, mutual dependency and accountability, relates to protocols and routines that reinforce openness and transparency behaviours. These protocols specifically relate to means to ensure that participants behave in a ‘we all sink-or-swim together’ mode; not in an individual team prioritised manner. This helps focus the overall project ‘one-team’ concept and brings wider perspective, knowledge and information to bear on identifying potential uncertainty and risk and also helps to remove ambiguity through more in-depth exploration of what is assumed to be known by parties. Sub-elements identified in the RBP framework relate to means and routines that enhance enablers and to reduce barriers to participants having a sense of mutual dependency. The intent for high-end collaboration is to ensure that a ‘one-team’ focus prevails and that mutual interest ensures that a broad perspective of uncertainty is explored and analysed [9].

The processes, routines and means component of the framework provides a vital cementing and enacting impetus to ensure that good intentions through positive behaviours are not only expected but structurally designed to be adopted. The pain and gain sharing arrangements provide a stick-and-carrot approach that imposes sanctions and penalties, whereas the other elements help explain why alliances usually exhibit far greater commitment to and achievement of collaboration than does partnering, for example. This has a profound impact upon managing and coping with risk and uncertainty.

8. Discussion and Reflection

Coping with risk, uncertainty, and ambiguity in complex and chaotic projects is perhaps a more accurate term to use than that of *managing*. Managing infers reaction requiring avoidance, mitigation or heroic overcoming of challenges. However, the term *coping* with risk, uncertainty, and ambiguity suggests that this presents wonderful opportunities to review and revise assumptions, objectives, proposed methods or approaches [61]. Problems may then be reframed in a positive new light. To do so, however, requires exposure to new ways of seeing, new perspectives, and the development of skill sets that have not traditionally been part of curriculum within project management education and training [62]. Coping infers use of an emergent strategy whereas managing may be associated with use of a more rigid and prescriptive approach to strategy development. Effective collaboration between the project design and delivery team has been argued as being central to effective project delivery [63–67]. The inclusion of the PO in the collaborative process has also been shown to be essential so that real value is generated for the project outcome [68–70].

Many POs know what they want but not all know what they need. All POs need an open and collaborative environment that supports sophisticated discussion of various project delivery options. However, achieving effective collaboration between a PO, design team and project delivery team

needs more than good intentions. The RBP framework [8] provides a useful tool, one that enables a better understanding of how various elements of the collaborative process may be assembled and configured. The process will then not only encourage more effective uncertainty management and coping mechanisms, but also may provide a stronger link between intent and outcome. Alliance forms described by authorities that have the greatest experience with these arrangements [43,51,71,72] detail how behaviours need to be supported by protocols and routines that ensure consistency between intent and the messages that guide this intent. Similarly the IPD approach developed in the US that operates at their defined 'Level 3 collaboration' also aligns behaviour with contractual arrangements to ensure collaboration [7]. The features of the T5 form of contract, and its subsequent evolved versions for Crossrail in the UK, also align intent with action [39,59].

How does the above discussion align with effective management of uncertainty? One way is to apply an opportunity-threat perspective to coping with and managing the effort. Here effort and energy may be directed toward coping with or managing risk to maintain a plan, or particular vision of how that plan may unfold through balancing fact with faith (or hope) as argued by Geraldo and Adlbrecht [73] from their research into complex projects. Equally, there are opportunities for unthought-of or emerging possibilities that can be explored with similar effort and energy expenditure. Human energy and effort through '*hoping*' is derived from three possible sources: (1) the depth of motivation to collaborate with others; the (2) extent to which people are serious about marshalling the required knowledge and social capital necessary to explore options and make decisions; and (3) incentive systems that drive the motivation to collaboration and commit knowledge and social capital. These incline individuals, teams, and as a result, the whole project organisation to be motivated to behave in a specific way.

Hope is transformed into intended action through a process of '*ensuring*' that the intended result is realised. This in more general terms can be seen as a governance and leadership issue. Müller [74] (p. 4) explains the term governance as '... the value system, responsibilities, processes and policies that allow projects to achieve organizational objectives and foster implementation that is in the best interest of all the stakeholders, internal and external, and the corporation itself'. This view of governance fits with the RBP [8] framework foundational element of a joint governance system (described earlier) as well as element 15 in particular in which the level of transparency and open-book arrangements fit the designed collaboration intensity specified through the contractual form and its application for the level of pain-gain sharing agreed upon. The level of enacted innovation that can be expected to match the hoped for innovation level is governed by a series of protocols, such as element 11, consensus decision making, that support element 10 no-blame behaviours, discussed earlier. These shape a set of support systems with the emphasis on *systems*. The way that the workplace setting and its ambience is affected by participant behaviour and interaction as well as the way that the project organisation presents itself, both to itself and to outsiders [75]. For highly integrated project delivery forms, such as alliances and the T5 type arrangements [58], the project team is badged by a common logo, entity and set of project specific values. This common sense of purpose through design and the 'one-team' ethos provides an ensuring mechanism that crystallises intent into action.

The RBP framework provides a useful tool to more clearly illustrate how the elements may be visualised from an opportunity/threat perspective. In the following hypothetical example two contrasting intensities of collaboration are presented. The RBP [8] framework has measures for each element that can be rated and they suggest that, ideally, when designing a collaboration intensity form for a project, key staff from the collaborating organisations should engage in the rating process to form a consensus view about each element.

The framework and its visualisation tool may be used in several ways that can address developing an environment or project delivery situation in which risk and uncertainty may be more effectively addressed. Its primary use as proposed by Walker and Lloyd-Walker was to facilitate comparing project delivery forms more accurately than simply referring to descriptive terms such as 'partnering' or 'design and construct' or 'alliancing'. They argued [8] that by rating each of the 16 elements for

a specific project delivery strategy that it would be possible to more clearly appreciate potential implications for each potential project delivery choice in how the project would be managed and how that would affect the project workplace culture. For example the visualisation could make it clearer how typical partnering may differ from alliancing and how that may impact team behaviours and governance requirements. They also argue that the tool may be used to design a procurement approach as an adaptation of an existing form, for example adapt a form of partnering that more closely resembles alliancing in several of the critical behavioural dimensions. Additionally, they suggest that the tool could be used for benchmarking purposes. In this paper we suggest that the visualisation tool may be used to 'design' or to identify and address gaps between what may be intended to create in a project delivery situation to best address risk and uncertainty from what may be observed at any particular time during project delivery.

Figure 2 presents a hypothetical 'as is' project situation versus a 'preferred' project map in which the authors have rated each element in the framework based on their understanding of the literature on RBP forms in the construction sector and similar PM sectors. This illustrates how this tool may be used to benchmark an 'as is' project situation to compare with a 'preferred' situation and then to use this to develop strategies to move from the 'as is' to 'preferred' one. This may involve designing, adapting or shaping an existing project delivery choice, for example moving from a more traditional partnering type delivery arrangement to an alliancing or integrated project delivery situation. There are many variations in partnering arrangement projects from 'hard money', in which there may be a form of partnering imposed on somewhat unwilling participants through to whole hearted alliances where there is a strong and committed enthusiasm for genuine collaboration. It can be assumed that in both alliances and partnering, for example, the rated element values may vary. This is demonstrated by the experience and expert opinion documented in numerous partnering studies [76–79] that report on quite a varied level of commitment to best-for-project outcomes and studies of alliancing [51,70,80–83]. While the cited studies present some general picture that can be interpreted in the ratings presented in Figure 2 we acknowledge that these may vary by at least one point in the scales. Given that caveat, Figure 2 provides a map that at least provides a general scope indicator. Some inferences can be made that are of value.

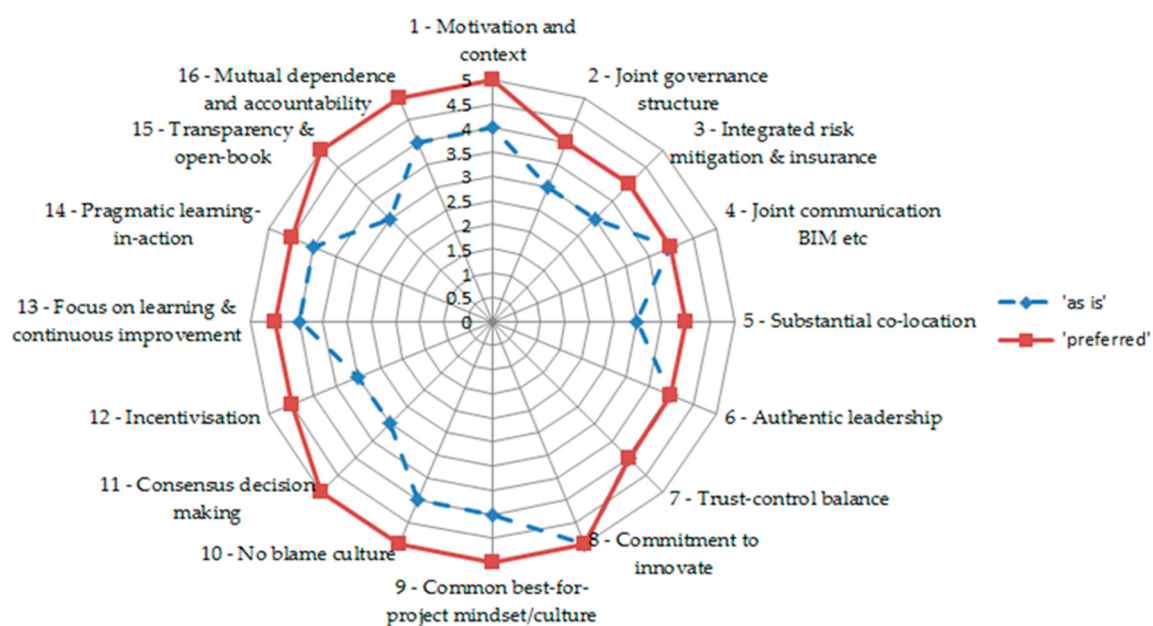


Figure 2. Hypothetical Partnering V Alliancing Collaboration Framework Visualisation.

First, it is clear that several of the elements have a wide gap (2 rating levels) between the 'preferred' and 'as is' situation. This would suggest that either the procurement form or the project situation

(its level of complexity or workplace relationship or contractual constraints) needs to be adjusted and addressed to align the 'as is' with the preferred element ratings. Identifying these gaps offers opportunities to develop a planned approach to address core issues that shape the 'as is' situation. The purpose of Figure 2 is to suggest in a highly visual way how depth of collaboration may be understood using a visualisation tool. What may be focussed on from such representations that can be of value is where elements have gaps of 2 or more rating points. For example, Figure 2 suggests that consensus decision making (element 11), incentivisation (element 13), transparency and open book (element 15), integrated risk mitigation strategy (Element 3), and joint governance structure (element 2), have the significant gaps. If the ratings do not represent a party's desired approach for one or several elements, two or more possible actions may ensue. The chosen procurement form may need to be reconsidered, or steps taken within the chosen form to align more closely with the desired level for each, or any, particular element.

This tool (the map based on rating the framework) can be used for sense-making to analyse a project and how risk and uncertainty is coped with or it can be used more pro-actively to 'design' or customise a project procurement system and its governance arrangements to fit a desired collaborative outcome. This aspect was only briefly referred to as a potential contribution by Walker and Lloyd-Walker [8] and so this paper extends their ideas in a specific way that relates to managing and coping with risk and uncertainty.

This tool, and/or adaptations that are subsequently made, could provide a contribution to advancing not only the way that collaboration forms are analysed, but how they may be projected to fulfil a highly customised need. The purpose of this paper was not to promote any one form of integrated project delivery but to provide a discussion of options that are available that could and should be considered. What is important, particularly from a risk, uncertainty and ambiguity perspective, is that project delivery forms take into account the characteristics of how foundational elements, behavioural elements and the processes, routines and means designed to reinforce behaviours are structured to fulfil a project delivery strategy.

9. Conclusions

This paper builds upon the RBP framework [8] by taking a perspective of coping with uncertainty. While their RBP framework has been used to assist categorisation of project procurement and delivery types in the complex infrastructure project sector, it has not previously been explained from a specific risk-uncertainty perspective. This paper provides a theoretical contribution by conceptualising the framework as a useful risk-uncertainty framework. The paper's objective was to explain and illustrate how the [8] RBP framework can be used to answer the question *How can uncertainty best be managed in complex projects?* It answered that question and extended the range of ways that the RBP framework visualisation tool may be used to help dichotomise or customise various project delivery approaches from a risk-uncertainty perspective. This was illustrated in Figure 2 by comparing a hypothetical 'as is' with a 'preferred' project situation to clearly emphasise major differences in collaboration between project delivery strategies.

Each of the 16 elements [8] were explained from a risk-uncertainty perspective and the analysis approach provides a PM practice contribution by offering another tool that may be used in coping with uncertainty, as well as for risk management to be used in complex and chaotic situations. Most risk management tools, used for modelling with commercial products, such as @risk or Monte Carlo simulation, have been developed as problem-solving tools [84,85] but are silent on how to assemble the requisite expertise, knowledge and social capital to be able to effectively use those tools. These tools, while highly appropriate in simple/standard or complicated situations as argued by Snowden in his Cynefin Framework [16,17], are not appropriate for complex or chaotic situations where use of 'best practice' tools is often dangerous because they support delusions of control in highly unordered situations.

Uncertainty presents different challenges to risk because while risk can be known and anticipated (highly relevant in simple/standard or complicated situations), uncertainty throws project team members and leaders into the unknown. This paper also drew attention to the positive aspects of uncertainty; an aspect that offers the prospect of opportunities, a concept that Olsson [86,87] has discussed at length. This paper's focus is on people coping with uncertainty in complex situations and what they can offer through deep and effective collaboration. The map illustrated in Figure 2 is highly relevant to practitioners who may wish to either adopt or design a bespoke collaboration form by considering several archetypes of project delivery as a starting point to understanding how they may effectively collaborate. The RBP framework presented in Figure 1 is reinforced by discussions around the way that uncertainty can be effectively managed to highlight the importance of *ensuring* that *hoped-for* behaviours and human contribution to effective planning and decision making are realised. Thus, a considerable practice contribution may be seen to have been made by this paper.

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References

1. Flanagan, R.; Norman, G. *Risk Management and Construction*; Blackwell Science Publications: Oxford, UK, 1993; p. 208.
2. Ward, S.C. Assessing and managing important risks. *Int. J. Proj. Manag.* **1999**, *17*, 331–336. [[CrossRef](#)]
3. Zwikael, O.; Smyrk, J. Project governance: Balancing control and trust in dealing with risk. *Int. J. Proj. Manag.* **2015**, *33*, 852–862. [[CrossRef](#)]
4. Kerzner, H. *Project Management—A Systems Approach to Planning, Scheduling, and Controlling*, 7th ed.; John Wiley & Sons Inc.: Toronto, ON, Canada, 2001; p. 1203.
5. Hodge, G.A. The risky business of public-private partnerships. *Aust. J. Public Adm.* **2004**, *63*, 37–49. [[CrossRef](#)]
6. American Institute of Architects—AIA California Council. *Integrated Project Delivery: A Guide*; American Institute of Architects: Sacramento, CA, USA, 2007; p. 57.
7. National Association of State Facilities Administrators (NASF); Construction Owners Association of America (COAA); The Association of Higher Education Facilities Officers (APPA); Associated General Contractors of America (AGC); American Institute of Architects (AIA). *Integrated Project Delivery for Public and Private Owners*; National Association of State Facilities Administrators: Lexington, KY, USA, 2010; p. 40.
8. Walker, D.H.T.; Lloyd-Walker, B.M. *Collaborative Project Procurement Arrangements*; Project Management Institute: Newtown Square, PA, USA, 2015.
9. Davies, A.; Dodgson, M.; Gann, D. Dynamic capabilities in complex projects: The case of london heathrow terminal 5. *Proj. Manag. J.* **2016**, *47*, 26–46. [[CrossRef](#)]
10. Brady, T.; Davies, A.; Nightingale, P. Dealing with uncertainty in complex projects: Revisiting klein and meckling. *Int. J. Manag. Proj. Bus.* **2012**, *5*, 718–736.
11. Klein, B.; Meckling, W. Application of operations research to development decisions. *Oper. Res.* **1958**, *6*, 352–363. [[CrossRef](#)]
12. Hillson, D.; Dalcher, D. *Managing Risk in Projects*; Ashgate Publishing Ltd.: Farnham, UK, 2009; p. 127.
13. Walker, D.H.T.; Davis, P.R.; Stevenson, A. Coping with uncertainty and ambiguity through client, design and construction team collaboration in construction projects. In Proceedings of the 2015 EURAM Conference: Uncertainty Is a Great Opportunity, Warsaw, Poland, 17–20 June 2015.
14. Lehtiranta, L. Risk perceptions and approaches in multi-organizations: A research review 2000–2012. *Int. J. Proj. Manag.* **2014**, *32*, 640–653. [[CrossRef](#)]
15. Hällgren, M.; Jacobsson, M.; Söderholm, A. Embracing the drifting environment. *Int. J. Manag. Proj. Bus.* **2012**, *5*, 695–713.
16. Kurtz, C.F.; Snowden, D.J. The new dynamics of strategy: Sense-making in a complex and complicated world. *IBM Syst. J.* **2003**, *42*, 462–483. [[CrossRef](#)]
17. Snowden, D.J.; Boone, M.E. A leader's framework for decision making. *Harv. Bus. Rev.* **2007**, *85*, 69–76.

18. PMI. *A Guide to the Project Management Body of Knowledge*, 5th ed.; Project Management Institute: Sylva, NC, USA, 2013; p. 589.
19. Kutsch, E.; Hall, M.; Turner, N. *Project Resilience the Art of Noticing, Interpreting, Preparing, Containing and Recovering*; Gower: Surrey, UK, 2015; p. 222.
20. Hällgren, M.; Maaninen-Olsson, E. Deviations and the breakdown of project management principles. *Int. J. Manag. Proj. Bus.* **2009**, *2*, 53–69. [[CrossRef](#)]
21. Aaltonen, K.; Kujala, J.; Lehtonen, P.; Ruuska, I. A stakeholder network perspective on unexpected events and their management in international projects. *Int. J. Manag. Proj. Bus.* **2010**, *3*, 564–588. [[CrossRef](#)]
22. Lindblom, C.E. The science of “muddling through”. *Public Adm. Rev.* **1959**, *19*, 79–88. [[CrossRef](#)]
23. Lindblom, C.E. Still muddling, not yet through. *Public Adm. Rev.* **1979**, *39*, 517–526. [[CrossRef](#)]
24. Winch, G.; Leiringer, R. Owner project capabilities for infrastructure development: A review and development of the “strong owner” concept. *Int. J. Proj. Manag.* **2016**, *34*, 271–281. [[CrossRef](#)]
25. Krizan, Z.; Windschitl, P.D. The influence of outcome desirability on optimism. *Psychol. Bull.* **2007**, *133*, 95–121. [[CrossRef](#)] [[PubMed](#)]
26. Jarzabkowski, P. Strategy as practice: Recursiveness, adaptation, and practices-in-use. *Organ. Stud.* **2004**, *25*, 529–560. [[CrossRef](#)]
27. Eisenhower, D.D. In preparing for battle I have always found that plans are useless, but planning is indispensable. In *The American Presidency Project*; Peters, G., Woolley, J.T., Eds.; University of California, Santa Barbara: Santa Barbara, CA, USA, 1947; p. 4.
28. Weick, K.E.; Sutcliffe, K.M. Mindfulness and the quality of organizational attention. *Organ. Sci.* **2006**, *17*, 514–524. [[CrossRef](#)]
29. Nyström, J. *Partnering: Definition, Theory and the Procurement Phase*; Licentiate, Royal Institute of Technology (KTH): Stockholm, Sweden, 2005.
30. Nyström, J. *Partnering: Definition, Theory and Evaluation*. Ph.D. Thesis, Royal Institute of Technology (KTH), Stockholm, Sweden, 2007.
31. Jacobsson, M.; Roth, P. Towards a shift in mindset: Partnering projects as engagement platforms. *Constr. Manag. Econ.* **2014**, *32*, 419–432. [[CrossRef](#)]
32. Scott, W.R. *Institutions and Organizations*, 4th ed.; Sage: Thousand Oaks, CA, USA; London, UK, 2014; p. 345.
33. Perks, H.; Halliday, S.V. Sources, signs and signalling for fast trust creation in organisational relationships. *Eur. Manag. J.* **2003**, *21*, 338–350. [[CrossRef](#)]
34. Mayer, R.C.; Davis, J.H.; Schoorman, F.D. An integrated model of organizational trust. *Acad. Manag. Rev.* **1995**, *20*, 709–735.
35. Rousseau, D.M.; Sitkin, S.B.; Burt, R.S.; Camerer, C. Not so different after all: A cross-discipline view of trust. *Acad. Manag. Rev.* **1998**, *23*, 393–405. [[CrossRef](#)]
36. Sheppard, B.H.; Sherman, D.M. The grammars of trust: A model and general implications. *Acad. Manag. Rev.* **1998**, *23*, 422–437.
37. Smyth, H. Measuring, developing and managing trust in relationships. In *The Management of Complex Projects: A Relationship Approach*; Pryke, S., Smyth, H., Eds.; Blackwell Publishing: Boston, MA, USA, 2006; pp. 97–120.
38. Rutten, M.E.J.; Dorée, A.G.; Halman, J.I.M. Innovation and interorganizational cooperation: A synthesis of literature. *Constr. Innov.* **2009**, *9*, 285–297. [[CrossRef](#)]
39. Davies, A.; MacAulay, S.; DeBarro, T.; Thurston, M. Making innovation happen in a megaproject: London’s crossrail suburban railway system. *Proj. Manag. J.* **2014**, *45*, 25–37. [[CrossRef](#)]
40. Cox, A. *Win-Win? The Paradox of Value and Interests in Business Relationships*; Earlsgate Press: Stratford-upon-Avon, UK, 2004.
41. Cox, A. *Sourcing Portfolio Analysis Power Positioning Tools for Category Management & Strategic Sourcing*; Earlsgate Press: Stratford-upon-Avon, UK, 2014.
42. Cox, A.; Watson, G.; Lonsdale, C.; Sanderson, J. Managing appropriately in power regimes: Relationship and performance management in 12 supply chain cases. *Supply Chain Manag. Int. J.* **2004**, *9*, 357–371. [[CrossRef](#)]
43. Sweeney, S.M. *Addressing Market Failure: Using Transaction Cost Economics to Improve the Construction Industry’s Performance*. Ph.D. Thesis, University of Melbourne, Melbourne, Australia, 2009.
44. Provera, B.; Montefusco, A.; Canato, A. A ‘no blame’ approach to organizational learning. *Br. J. Manag.* **2010**, *21*, 1057–1074. [[CrossRef](#)]

45. Leonard, D.; Rayport, J.F. Spark innovation through empathic design. *Harv. Bus. Rev.* **1997**, *75*, 102–113. [PubMed]
46. Manley, K.; Mcfallan, S. Exploring the drivers of firm-level innovation in the construction industry. *Constr. Manag. Econ.* **2006**, *24*, 911–920. [CrossRef]
47. Maqsood, T.; Walker, D.H.T.; Finegan, A.D. Facilitating knowledge pull to deliver innovation through knowledge management: A case study. *Eng. Constr. Archit. Manag.* **2007**, *14*, 94–109. [CrossRef]
48. Peansupap, V.; Walker, D.H.T. Innovation diffusion at the implementation stage of a construction project: A case study of information communication technology. *Constr. Manag. Econ.* **2006**, *24*, 321–332. [CrossRef]
49. Utterback, J.M. *Mastering the Dynamics of Innovation: How Companies Can Seize Opportunities in the Face of Technological Change*; Harvard Business School Press: Boston, MA, USA, 1994; pp. xxix, 253.
50. Von Krogh, G.; Ichijo, K.; Takeuchi, H. *Enabling Knowledge Creation*; Oxford University Press: Oxford, UK, 2000; p. 192.
51. Ross, J. Introduction to Project Alliancing. In Proceedings of the Alliance Contracting Conference, Sydney, Australia, 30 April 2003; p. 43.
52. Cox, A.; Ireland, P.; Townsend, M. *Managing in Construction Supply Chains and Markets*; Thomas Telford: London, UK, 2006.
53. Love, P.; Ackermann, F.; Teo, P.; Morrison, J. From individual to collective learning: A conceptual learning framework for enacting rework prevention. *J. Constr. Eng. Manag.* **2015**. [CrossRef]
54. Lahdenperä, P. Making sense of the multi-party contractual arrangements of project partnering, project alliancing and integrated project delivery. *Constr. Manag. Econ.* **2012**, *30*, 57–79. [CrossRef]
55. Ross, J. Gainshare/Painshare Regime—Guidance Paper with Sample Model/Drafting. Available online: http://www.pci-aus.com/Downloads/PCI_Gainshare-GuideModel_A_07Feb2011.pdf (accessed on 11 January 2013).
56. Gil, N.; Miozzo, M.; Massini, S. The innovation potential of new infrastructure development: An empirical study of heathrow airport's t5 project. *Res. Policy* **2012**, *41*, 452–466. [CrossRef]
57. Brady, T.; Davies, A. From hero to hubris—Reconsidering the project management of heathrow's terminal 5. *Int. J. Proj. Manag.* **2010**, *28*, 151–157. [CrossRef]
58. Doherty, S. *Heathrow's T5 History in the Making*; John Wiley & Sons Ltd.: Chichester, UK, 2008; p. 358.
59. Gil, N.; Lundrigan, C. *Crossrail: The Perfect Storm (a)*; Megaproject Leadership and Governance Case Study Series; The University of Manchester: Manchester, UK, 2013; p. 33.
60. Boukendour, S.; Hughes, W. Collaborative incentive contracts: Stimulating competitive behaviour without competition. *Constr. Manag. Econ.* **2014**, *32*, 279–289. [CrossRef]
61. Hällgren, M.; Wilson, T.L. Mini-muddling: Learning from project plan deviations. *J. Workplace Learn.* **2007**, *19*, 92–107. [CrossRef]
62. Crawford, L.; Morris, P.; Thomas, J.; Winter, M. Practitioner development: From trained technicians to reflective practitioners. *Int. J. Proj. Manag.* **2006**, *24*, 722–733. [CrossRef]
63. Ibrahim, C.K.I.; Costello, S.; Wilkinson, S. Key indicators influencing the management of team integration in construction projects. *Intern. J. Manag. Proj. Bus.* **2015**, *8*, 300–323. [CrossRef]
64. Anvuur, A.; Kumaraswamy, M. Better collaboration through cooperation. In *Collaborative Relationships in Construction: Developing Frameworks and Networks*; Smyth, H., Pryke, S., Eds.; Wiley-Blackwell: Chichester, UK; Malden, MA, USA, 2008; pp. 107–128.
65. Cicmil, S.; Marshall, D. Insights into collaboration at the project level: Complexity, social interaction and procurement mechanisms. *Build. Res. Inf.* **2005**, *33*, 523–535.
66. Dewulf, G.; Kadefors, A. Collaboration in public construction—Contractual incentives, partnering schemes and trust. *Eng. Proj. Organ. J.* **2012**, *2*, 240–250. [CrossRef]
67. Gottlieb, S.C.; Haugbølle, K. Contradictions and collaboration: Partnering in-between systems of production, values and interests. *Constr. Manag. Econ.* **2013**, *31*, 119–134. [CrossRef]
68. Alliancing Association of Australasia. *Collaboration Where It Matters: In Planning and Design*; Alliancing Association of Australasia: Sydney, Australia, 2012; p. 13.
69. Clegg, S.R.; Pitsis, T.S.; Rura-Polley, T.; Marosszeky, M. Governmentality matters: Designing an alliance culture of inter-organizational collaboration for managing projects. *Organ. Stud.* **2002**, *23*, 317–337. [CrossRef]
70. Lahdenperä, P. *In Search of a Happy Medium: Price Components as Part of Alliance Team Selection*; VTT: Espoo, Finland, 2014; p. 72.

71. Hutchinson, A.; Gallagher, J. *Project Alliances: An Overview*; Phillips Fox Lawyers and Alchimie Pty Ltd.: Melbourne, Australia, 2003; p. 33.
72. Department of Infrastructure and Transport. *National Alliance Contracting Policy Principles*; Department of Infrastructure and Transport A.C.G., Commonwealth of Australia: Canberra, Australia, 2011; p. 18.
73. Geraldi, J.G.; Adlbrecht, G. On faith, fact, and interaction in projects. *Proj. Manag. J.* **2007**, *38*, 32–43. [[CrossRef](#)]
74. Müller, R. *Project Governance*; Gower: Surrey, UK, 2009; p. 105.
75. Walker, D.H.T.; Lloyd-Walker, B.M. The ambience of a project alliance in australia. *Eng. Proj. Organ. J.* **2014**, *4*, 2–16. [[CrossRef](#)]
76. Arup. *Partnering Contract Review for Office of Government Commerce*; Ove Arup & Partners Ltd.: London, UK, 2008; p. 158.
77. Bresnen, M. Deconstructing partnering in project-based organisation: Seven pillars, seven paradoxes and seven deadly sins. *Int. J. Proj. Manag.* **2007**, *25*, 365–374. [[CrossRef](#)]
78. CII (Construction Industry Institute). *The Partnering Process—Its Benefits, Implementation, and Measurement*; CII Source Document 102-11; CII, Bureau of Engineering Resources, University of Texas at Austin: Austin, TX, USA, 1996.
79. Dombberger, S.; Farago, S.; Fernandez, P. Public and private sector partnering: A re-appraisal. *Public Adm.* **1997**, *75*, 777–787. [[CrossRef](#)]
80. Chen, G.; Zhang, G.; Xie, Y.-M.; Jin, X.-H. Overview of alliancing research and practice in the construction industry. *Archit. Eng. Des. Manag.* **2012**, *8*, 103–119. [[CrossRef](#)]
81. Davis, P.R.; Love, P.E.D. Alliance contracting: Adding value through relationship development. *Eng. Constr. Archit. Manag.* **2011**, *18*, 444–461. [[CrossRef](#)]
82. Hauck, A.J.; Walker, D.H.T.; Hampson, K.D.; Peters, R.J. Project alliancing at national museum of australia—Collaborative process. *J. Constr. Eng. Manag.* **2004**, *130*, 143–153. [[CrossRef](#)]
83. Ibrahim, C.; Bin, C.K.I. Development of an Assessment Tool for Team Integration in Alliance Projects. Ph.D. Thesis, The University of Auckland, Auckland, New Zealand, 2014.
84. Ward, S.C. *Project Risk Management: Processes, Techniques, and Insights*; Wiley: New York, NY, USA, 1997.
85. Ward, S.C.; Chapman, C. Transforming project risk management into project uncertainty management. *Int. J. Proj. Manag.* **2003**, *21*, 97–105. [[CrossRef](#)]
86. Olsson, N.O.E.; Magnussen, O.M. Flexibility at different stages in the life cycle of projects: An empirical illustration of the “freedom to maneuver”. *Proj. Manag. J.* **2007**, *38*, 25–32. [[CrossRef](#)]
87. Olsson, R. In search of opportunity management: Is the risk management process enough? *Int. J. Proj. Manag.* **2007**, *25*, 745–752. [[CrossRef](#)]



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