UTS ePRESS

Construction Economics and Building

Vol. 17, No. 2
June 2017

Citation: Lahdenperä, P. 2017. Towards a Coherent Theory of Project Alliancing: Discovering the System's Complex Mechanisms Yielding Value for Money. *Construction Economics and Building*, 17:2, 41-61. http://dx.doi.org/10.5130/AJCEB.v17i2.5292

ISSN 2204-9029 | Published by UTS ePRESS | ajceb.epress.lib.uts.edu.au

RESEARCH ARTICLE

Towards a Coherent Theory of Project Alliancing: Discovering the System's Complex Mechanisms Yielding Value for Money

Pertti Lahdenperä

VTT Technical Research Centre of Finland Ltd, Finland

Corresponding author: Pertti Lahdenperä, VTT Technical Research Centre of Finland Ltd, Finland, P.O. Box 1300, FI-33101 Tampere, Finland. pertti.lahdenpera@vtt.fi

DOI: http://dx.doi.org/10.5130/AJCEB.v17i2.5292
Article History: Received 06/12/2016; Revised 26/03/2017; Accepted 01/04/2017; Published 22/06/2017

Abstract

Alliancing is a relatively new construction project delivery method receiving increasing interest globally while also eliciting many questions about its effectiveness. That is why its operating logic should be clarified beyond the currently existing general views. Correspondingly, this paper aims to define the means and mechanisms which influence the capacity of alliancing to produce value for money. The work establishes the interlaced impact chains between formal basic solutions of alliancing and the key result areas defining the value-for-money ratio. This is made by focussing on a single alliance project and its procedural solutions and experiences. The case project of the study was an urban road tunnel under a city structure and the impact chains were explored by interviewing all eight members of the alliance leadership team covering all contracting parties. The two-stage personal interviews were conducted in accordance with the systematic modelling procedure resulting in eight cognitive maps which were then combined into a group map. The resulting model included around one hundred interlinked concepts initially, but was streamlined for the paper. Accordingly, alliancing offers a concrete framework which gives better than normal chances of success in the case of complex, challenging projects fraught with much uncertainty. Many diverse basic alliance solutions/features contribute to success, while each feature also seems to strengthen the impact of the others. This suggests that, at its best, pure project alliance is not only a coherent but also a holistic solution to challenging projects.

Keywords

Project alliance, alliancing, transport infrastructure, cognitive mapping, value for money.

DECLARATION OF CONFLICTING INTEREST The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. **FUNDING** The author(s) received no financial support for the research, authorship, and/or publication of this article.

Introduction

Demanding construction projects, their conditions and input data are fraught with great uncertainty. The numerous designers and implementers, many interest groups, technical challenges and systems and linkages to existing infrastructure, especially in the case of horizontal infrastructure projects, increase their complexity. Traditional project delivery methods based on a transactional approach and a strict distribution of responsibilities have been found to be poorly suited for projects of this type. The uncertainty is reflected in extensive risk contingencies while the primary interest of the parties is to safeguard their own interests. Moreover, the possibilities from combining versatile expertise and collaborative work are not seized.

On the other hand, in Project Alliance (alliance contracting) designers, contractors and the project owner form a joint project organisation and work in open collaboration. All benefit from the success of the project entity and there is neither need nor opportunity for company-specific sub-optimisation. Moreover, alliance contracting makes effective use of the early co-operation of the actors by integrating versatile expertise for the development of the project solution. Thereby it is believed to enable better innovative development and more effective project implementation than traditional delivery methods in challenging projects.

The impact of the procedures followed in alliancing on the success of projects is not yet fully clear and undisputed. The presented arguments and causal relationships often remain independent general principles, although the influential factors and impact chains are very diverse. Therefore, those who value traditional delivery methods find it hard to believe that refraining from pure price competition and risk transfer can improve project implementation from the viewpoint of the owner. As a result, the functional connection between the various alliance principles and results should be assessed and clarified in addition to comparing the results achieved by alliancing to those produced by other delivery methods. Ultimately, only the conformity of functional arguments and achieved results proves proper functioning. However, in a world of individual projects it is very hard to make indisputable comparisons of results which emphasises the importance of theoretical examination focussing on causal relationships. Yet, no systematic and comprehensive description of the value-creation mechanisms of alliancing exists.

Thus, this study aims to determine the means and mechanisms of alliancing that impact its ability to provide value for money. It intends to outline the impact chains between the individual basic solutions of alliancing and the key result areas determining the value-for-money ratio (cost-efficiency, schedule, quality, etc.); basic solutions consist of selections regarding formal organisation, process and conditions of contract. However, the impact chains are not independent but closely interconnected. Thus, the entire impact network must be identified to create an overall picture of the value-creation mechanisms of alliancing.

The research focusses mainly on a single alliance project and its practices; broadly speaking on so-called 'pure' alliance. External factors have been excluded from impact assessments (e.g. market conditions and political decision making). Impact chains are studied by interviewing alliance leadership team members using a systematic modelling method (so-called cognitive maps). The conducted interviews were two-stage personal interviews but their results are presented as a combined view.

The paper proceeds as follows. The next section briefly introduces project alliancing, with main emphasis on the review of literature about how the alliance provides value for money. Then the study methods and the alliance case project on which the study is based, are introduced, after which the next section (Compiled cognitive impact map) shows the results, i.e. the streamlined group map of the executives of the case project. The paper ends with a discussion and conclusions.

Present knowledge

The project alliance system evolved from the need to improve the implementation of demanding investment projects (see Ross, 2003; Lahdenperä, 2012). In such projects involving much uncertainty (due to, for instance, new technology and project conditions or interfaces), risk premiums and/or adversarial and opportunistic behaviour characteristics of traditional contracting would lead to an uneconomical result from the viewpoint of the owner (see e.g. Sweeney, 2009; Bajari and Tadelis, 2001; Bajari, Horton and Tadelis, 2014). The low bid syndrome especially can be recognised as a major determinant behind the customary adversarial behaviour leading to failure (Weston and Gibson, 1993; Scott, 2001, Stehbens, Wilson and Skitmore, 1999; Nicholson, 1991, Loraine, 1994) while sequential involvement of the parties does not allow mutual exchange of information and collaboration for the benefit of the project.

Project alliance is a project delivery method (typically) based on a *joint contract* between the key actors to a project (owner, designer, constructor), where the parties assume *joint responsibility* for the design and construction of the project to be implemented through a *joint organisation*, and where the actors *bear* both positive and negative *risks* related to the project *jointly* and observe the principles of *information accessibility* and *unanimous decision-making* in pursuing close collaboration (Lahdenperä, 2009). The system enables the owner to combine broad, versatile expertise to benefit the project and to harmonise the actors' interests regarding reaching the aims of the project and, therefore, particularly to improve the economic aspects of risky projects. An authoritative introduction to alliancing is given by Australian national guidelines (DIRD, 2015) since the system in its current form is above all an Australian innovation applied in hundreds of projects so far (DTF, 2006; 2009).

The alliance contract has been the subject of active research since the first projects that used it (e.g. Clegg et al., 2002; Ross, 2003; Walker and Hampson, 2003; Hauck et al., 2004). These and many later project-specific case studies (e.g. Jefferies, Rowlinson and Schubert, 2012; Walker and Jacobsson, 2014; Morwood, Scott and Pitcher, 2008; Ibrahim et al., 2016b) focussed on principles of operation while also trying to assess the results achievable by alliancing. Belief in the excellence of the system is strong in general, but a systematic and comprehensive description of the value-for-money creation mechanisms of project alliancing has not been produced so far.

Also as concerns assessment of performance, the study is mainly qualitative except for occasional cost savings estimates. Walker, Harley and Mills, (2015) and Sweeney (2009) are among the rare studies based on a broad stock of projects and exact data. The results speak for the excellence of alliancing as earlier studies. DTF (2009) also examines project outcome data but mars the otherwise positive picture by questioning alliancing based on non-price selection. The significance of the underlying project-specific challenges and conditions, however, remains unclear (cf. Rooney, 2009) while the view tends to be contrary to more dominant insight (e.g. Manley and Chen, 2016).

Alliance research has also been conducted from the viewpoints of various disciplines. One starting point are formal contractual solutions and their impacts, such as the no-dispute clause (Rowlinson et al., 2006) and sharing of risks (Love et al., 2011; Laan, Voordijk and Dewulf, 2011). Other major themes are development of the parties' co-operation relations (Davis and Love, 2011; Ibrahim, Costello and Wilkinson, 2016a), the alliance's operating culture (Walker and Lloyd-Walker, 2014; Lloyd-Walker, Mills and Walker, 2014), and the significance of trust in the organisation's operations (Strahorn, Gajendran and Brewer, 2013; She, Doloi and Mills, 2012). Thus, human factors and their contribution to success are also strongly emphasised along with the formal organisation, the letter of the agreement and the phases and tasks of the process.

The alliance theme has also generated much doctoral research (Davis, 2005; Davies, 2008; Sweeney, 2009; MacDonald, 2011; Chen, 2013; Vilasini, 2014; She, 2014; Ibrahim, 2014). Related study in general has focussed on finding the success factors of the alliance (Jefferies, Brewer and Gajendran, 2014; Mistry and Davis, 2009). These studies also emphasise the characteristics of the alliance which some other research efforts have attempted to define (Chen and Manley, 2014; Walker and Lloyd-Walker, 2015; Chen et al., 2012). From the viewpoint of this study, the contribution of literature has probably been the greatest on the level of alliance principles where it offers an unambiguous knowledge base of the characteristics of alliancing.

In general, the presentation of alliance research is pronouncedly verbal and modelling has only been applied to the project process (MacDonald, 2011; MacDonald, Walker and Moussa, 2013), albeit from the viewpoint of ensuring value creation. Although the published works are meritorious overall, the picture provided by them is unclear from the viewpoint of formal modelling, which means that it is difficult to establish an overall view of the value-creation mechanisms of an alliance based on them. Naturally, the presented review is only an example, but it builds on wider mapping.

Research method

RESEARCH APPROACH

The value-creation mechanisms of alliancing were examined based on the experiences from a single alliance project. Thus, the results were achieved primarily by means of trying to understand, interpret and evaluate a case. Case study is well suited to research areas where existing knowledge is insufficient from the viewpoint of goal setting (Eisenhardt, 1989) and we are seeking answers to 'how' and 'why' questions related to contemporary phenomena (Yin, 2014).

The data of the case study were collected through expert interviews. The experts were senior executives of the alliance leadership team providing leadership and governance to the alliance while not participating in the everyday management of the project. All eight members of the leadership team, at least one expert from each partner organisation, were interviewed. Each member was interviewed separately to provide as comprehensive and authentic a picture as possible (cf. Gray, Zanre and Gray, 2014: emphasis on distinct aspects; risks of group dynamics at joint events). Use of experts from a single project ensured the common experiential background of interviewees which enhanced the creation of a coherent view concerning a theme allowing several interpretations. It also eliminated guesswork about the variations of alliancing since the interviews focussed on procedural solutions of the target project. This is important because alliancing can take many forms.

There were two rounds of interviews to ensure better mapping of a range of factors influencing value creation at separate phases. The first interview was conducted at the beginning of the alliance development phase and the second one after the alliance had determined that readiness to launch the implementation phase existed. There was a one year interval between the rounds of interviews. Individual interviews lasted on average two hours (80–140 min.) and took a total time of about 30 hours.

Data collection was supported using a formal method of description. The views of interviewees were collected into so-called *cognitive maps* that describe the process characteristics (concepts) and the impact relationships between them (causal links; linkages). The interviews were also recorded for later analysis. This verbal argumentation complemented the comprehensive examination in the original report (Lahdenperä, 2015a) and enabled thorough content analysis which was a prerequisite for integration and streamlining of the maps without erroneous interpretations.

The starting point of the interviews were the seven key result areas (to be listed below in 'The case project' section) presented by the owner in the request for proposals which are normal in alliance projects (cf. Walker, Harley and Mills, 2015). Characteristics describing the activity and applied solutions, that were believed to have had an impact on the key result areas (outcome concepts; heads), were sought initially in the interviews. Then, reasons for or enablers of the emerging characteristics were sought until it was possible to start dealing with the structural and formal solutions (initial concepts; tails) instead of e.g. viewpoints related to attitudes and culture.

The interviewee could see a developing map in front of him throughout the interview to ensure the validity of the forming cognitive map. Factors deemed fit for inclusion (concepts to be modelled) were not predetermined or standardised (as is sometimes done when aiming for a combination model) but all issues considered important by the interviewee were included to promote building of the most comprehensive picture possible (cf. Gray, Zanre and Gray, 2014). In other words, the interviewees had to identify the concepts for the model based on their experience.

The interviewees were also to evaluate the strength of the impacts of identified concepts to allow later evaluation of the significance of several factors (initial concepts) and performance expectations (outcome concepts) quantitatively. They were particularly reminded of the fact that the impacts can also be negative (detrimental) and such items should also be expressed when putting together the cognitive map.

In the second round of interviews, modelling was continued based on the result of the first round. The map was complemented with new observations and experiences and the weights describing the strength of the impact relationships were balanced for the entire impact network.

COGNITIVE MAPPING

A *cognitive map* is generally a formal, visual representation of an individual's 'mental model' construct consisting of nodes and arrows depicting the relationships between them (Eden, 2004; Gray, Zanre and Gray, 2014). The maps are typically hierarchical, proceeding mainly from causes to consequences (as all those of this study). Traditional cognitive maps do not identify differences in the strength of relationships between nodes (except as positive/negative). On the other hand, so-called fuzzy cognitive mapping represents a procedure where the degree of influence is identified in the simplest form by a given numerical value

(Kosko, 1986). In this study, the influence could strengthen (+) or weaken (–) the characteristic depicted by the receiving concept while the strength of the relationships between concepts was assigned an integer value, the absolute value being 1 (low), 2 (significant) or 3 (crucial).

Eight parallel cognitive maps were made into a single comprehensive *social cognitive map* or *group map* which, despite its name, does not refer to a map prepared jointly by the group (Özesmi and Özesmi, 2004; Gray, Zanre and Gray, 2014). When putting together the combination model, concepts with the same content were combined so that the resulting combined concept retained all linkages to concepts that would remain original (not combined ones) unchanged, and the strengths between two pairs of combined concepts were added up to produce a new impact value (see Kosko, 1988).

Table 1 presents indicators of individual experts' cognitive maps and the group map produced by combining them. Comparison of the indicators to those of maps, prepared as part of other studies (Özesmi and Özesmi, 2004), seems to suggest that the scope of individual maps corresponds at least to the general level attained using the method. On the other hand, the time spent preparing the maps of this study has been greater than in the case of the reference values which gives reason to expect thoroughly thought-out descriptions of mechanisms.

The maps were also analysed by a very straightforward calculation method. For instance, in 'top-down' calculation evaluating the significance of alliance characteristics (initial concepts), each relationship directly linked to key result areas (outcome concepts) was first assigned a relative weight equal to the value of the link in relation to the sum of all impacts linked to outcome concepts. Then, the map was calculated against the impact direction so that in each case the sum of the weights of all outbound relationships of an intermediary concept, which constitutes the weight of the intermediary concept, was divided between the incoming relationships of the concept in proportion to their original values. The weight of an initial concept is the sum of the weights of its outgoing linkages. 'Bottom-up' calculation followed a similar logic, but the direction of calculation was the opposite. These calculations were run on both the combination model (original group map) and separately on each expert's individual model (cognitive map), and in the latter case the results were calculated as an average of the individual calculations.

Decision Explorer software was used in modelling the maps although the quantitative approach required developing a separate Excel application. Decision Explorer enables several types of map analyses but they were used only to verify the quantitative analysis (for the part of network structure) since the software does not identify differences in impact strengths

Table 1 Indicators of the cognitive maps prepared in the study

[No.]	Expert-specific maps				Combined map	
	Min.	Max.	Mean	Std Dev	Original	Streamlined
Outcome concepts	7	7	7,0	0.0	7	4
Intermediary concepts	11	20	14.6	3.1	80	49
Initial concepts	3	7	5.0	1.5	14	14
Concepts, total	21	34	26.6	4.2	101	67
Linkages	33	58	44.8	9.0	296	153

(see Decision Explorer, 2002). The results of this phase are presented comprehensively in an industry report (Lahdenperä, 2015a) that includes also the original combination model and the key interview quotes.

Then, the work was continued by streamlining the model (for this paper). The original combination model was put together without any content changes, and is partly unclear, since different experts perceive things differently. Therefore, all related concepts could not be integrated in the original model serving as the basis of the quantitative analysis. In the streamlining stage, these related concepts were also integrated. At the same time, many short-cuts by interviewees were eliminated whenever it was apparent that the actual impact chain runs through other concepts and has already been described in the model as it is. This was done closely in accordance with the content analysis of interviews but the weightings of impact relationships (numerical) were no longer clear which meant that their description had to be abandoned. Yet, creation of an understandable overall picture required compaction.

THE CASE PROJECT

The case project of the study was the Tampere Road Tunnel implemented by an alliance. It involved relocating a stretch of Highway 12 (which ran along the shore of Lake Näsijärvi above ground) in a pair of tunnels in the centre of the City of Tampere (Alliance Executive Team, 2013). New road and street arrangements, relocation of utilities/services networks, and interchanges at both ends of the tunnel were also part of the project (4.2 km of highways, 4.0 km of streets, seven new bridges). Both directions of travel have their separate 2.3 km tunnels with three lanes (one being a safety lane). Several passageways with fire and smoke compartmentation were built between the tunnels, and traffic control and guidance systems played a significant role in the project. The initial road-plan phase cost estimate was MEUR 185 (ELY, 2011; March 2011 price level) while an updated (due to indexing and missing items) estimate of MEUR 204 (at May 2013 price level; i.e. at the time the target cost was set) offers a more appropriate point of comparison.

All in all, we are speaking of a demanding project that was fraught with much uncertainty and numerous constraints which is why project alliance was applied in the project. The owner's view that guided project preparation was that smooth co-operation between the partners would allow achieving better than conventional results since a diverse project enables searching for different alternative solutions (FTA, 2012b). The project's request for proposals and road plan defined its technical requirements and goals. The owner also set the following key result areas for the implementation (FTA, 2012b):

- Cost-efficiency (cost-effective implementation that yields value for money).
- Schedule (commissioned on schedule, optimised implementation phase duration).
- Environment (minor environmental impacts from construction and the end-product).
- Quality (excellent quality of design and construction).
- Safety (excellent project safety).
- Traffic (least possible disturbance; uninterrupted usability on completion).
- Image (favourable public image).

The alliance procurement started in December 2011. The service providers were chosen in a competition which required the candidates to have both the competence to design and construct the project (i.e. *consortium selection*). Accordingly, the participants themselves had to form teams that took part in the competition, typically as groups of companies.

In the stage-wise process, selection was eventually based on capability and fee (company-level overhead plus expected profit; see Lahdenperä, 2015b). The chosen parties signed the development agreement in July 2012. Two public owners, two design offices and one construction company constituted the alliance partners.

Development-phase planning (to determine the project solution and corresponding target cost), which ended the following June, led to the signing of an alliance implementation contract in October 2013 (after some political wrangling; see Vainio, 2015). At that time, the road section was expected to be ready for use in May 2017, and the finishing work was to end about a year later; the key result areas became part of the incentive scheme of the agreement, meaning that the compensation of service providers was partly performance-based (Alliance Executive Team, 2013). The target cost was MEUR 180 (at May 2013 price level). Subsequently, the tunnel was completed and opened for traffic in November 2016, with some finishing works still to be completed.

Compiled cognitive impact map

STRUCTURE OF THE MAP

The cognitive impact model created by the study describing the value-creation mechanisms of the alliance is analysed in Figures 1-4. Figure 1 shows the outcome concepts derived from the key result areas (in blue) as well as all the intermediary concepts directly linked to key result areas (in red). Generally, intermediary concepts are ones with both inbound and outbound relationships while outcome concepts only have inbound relationships depicted by arrows. Thus, *arrows* describe a relationship between two concepts acting in the direction of the arrow and strengthening the characteristic of an inbound concept since all relationships are positive (while outcome concepts described by neutral terms refer here also to remarkable success with respect to the described characteristic). Four of the seven original key result areas are shown combined since the underlying factors are much the same.

Figures 2-4 show views of the rest of the impact network. Each figure presents more closely interrelated initial concepts depicting the formal characteristic of the alliance (in green; with only outbound relationships) as well as the chain of intermediary concepts leading from

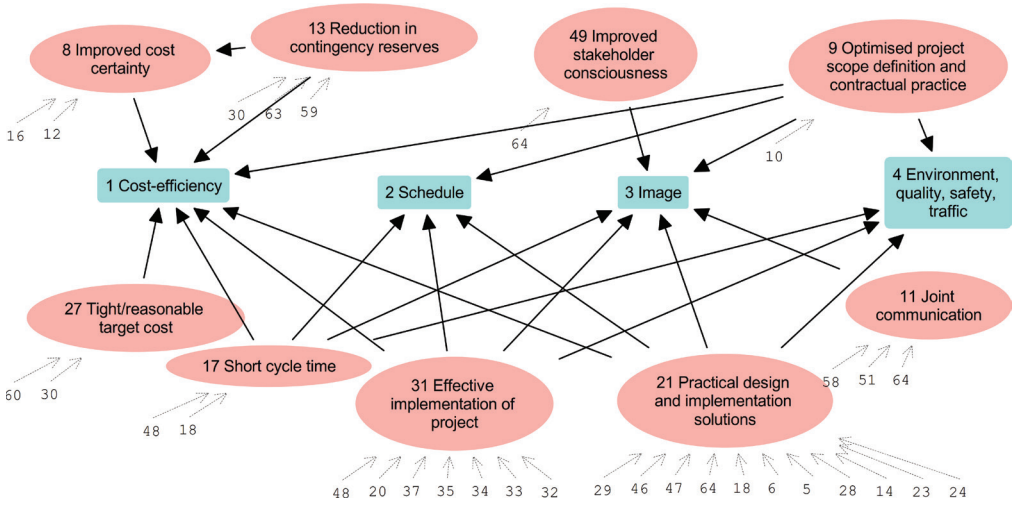

Figure 1 Outcome concepts and factors contributing to their successful achievement

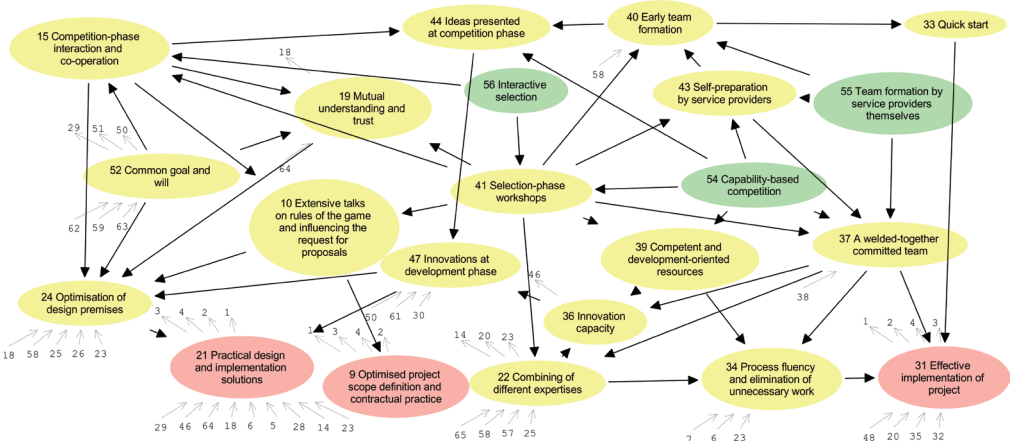

Figure 2 Rationality of selection

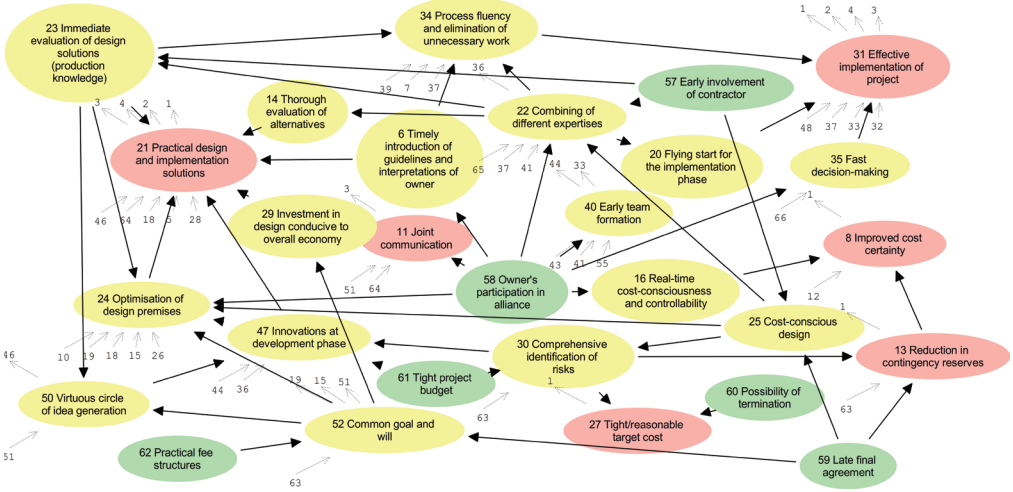

Figure 3 Effectiveness of development

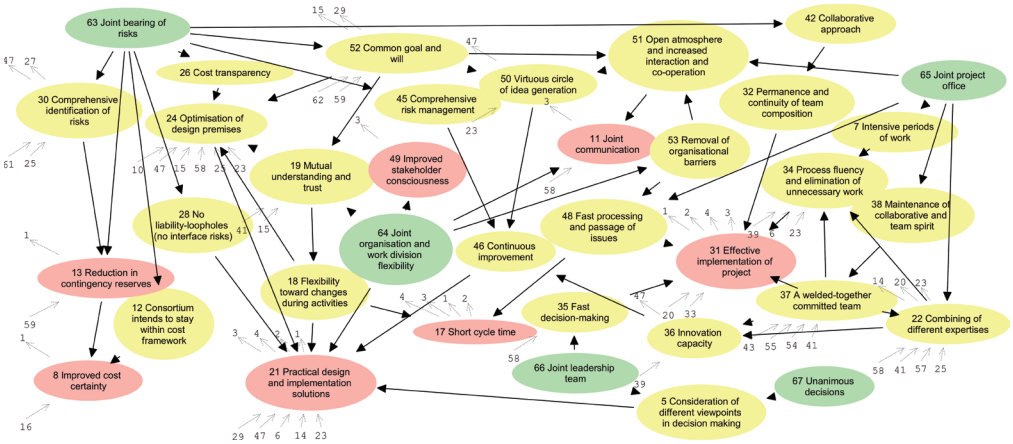

Figure 4 Efficiency of implementation

them to outcome concepts (in yellow excl. concepts common with Figure 1 in red). In the compilation of Figures 2-4, the starting point was that, besides the concepts, also all impact relationships (arrows) are shown at least once in parallel with both of their adjoining concepts, and that none of the impact relationships are presented only in connection with the linkages

between concepts presented in different figures indicated by short dashed arrows and related concept numbers (where the inbound impact is depicted under each concept and the outbound one above it). Therefore, some intermediary concepts are shown in the series of pictures several times, unlike the outcome and initial concepts that appear only once.

IMPACT MECHANISMS

Formal characteristics concerning the alliance organisation, process and conditions of contract and their impact on the alliance's capacity to yield value for money are explained below by three model views (Figs. 2-4). The views are based roughly on the alliance's phases although especially the last presented factors impact project implementation even earlier. A written presentation complements the model views although such a compressed presentation cannot, unfortunately, fully depict all the insight included in the comprehensive model.

Selection phase (Figure 2)

Forming a project organisation mainly through *capability-based competition (Concept 54)* ensures that capable and development-oriented resources can be committed to the project. Thereby the problems often ensuing from full price competition affecting implementation and the resulting negative development trend in general can be avoided. To succeed in capability-based competition, service providers also prepare and form teams before actual selection starts, which, for its part, improves the chances of success and accelerates launching of effective work. As concerns team formation, this is true especially in the case of consortium selection where the proposer must have resources for both design and construction, which means that the companies seek partners already before registering for the competition. When there is sufficient supply, such *team formation by service providers themselves (55)* creates the most favourable conditions for finding the most efficient compositions to implement a project.

A key element of capability-based competition is selection workshops where the tendering consortium's qualifications, ability to co-operate and innovativeness are determined by a variety of tasks (not merely based on documents), even by a psychologist's statement. Team formation with the owner organisation starts at the same time, which allows combining distinct types of expertise for the benefit of the project. Moreover, *interactive selection (56)*, which is partly based on the workshop procedure, improves together with other process properties, the possibility of finding development ideas and functioning rules of the game since, in addition to the possibility of improving the cost estimate and the project solution, the rules of implementation, risk sharing and project scope definition are examined together with several competitors. Functioning rules of the game, numerous development ideas and a development-oriented organisation that integrates expertise, provide a good starting point for project work after the selection phase.

Development phase (Figure 3)

Service provider selection is followed by signing of the alliance's development-phase agreement, which launches joint development without delay, since earlier input of resources in team formation and interactive selection have created favourable conditions for co-operation and clear rules of the game. At the same time, *early involvement of contractor (57)* ensures access to cost and constructability information and thereby also immediate feedback for design process management. A capable team, better resourcing and overall competence attained by

combining different expertise, provide better than normal chances for developing project solutions.

Owner's participation in alliance (58) and joint development with the service providers supplements knowledge and allows changing design premises in case it is to the advantage of the project. It can be accomplished smoothly and quickly since the owner knows about the project's details and the actual costs of the changes: they are based transparently on earlier realised costs and prices quoted by subcontractors. Thereby development work is not limited by preset impractical assumptions and boundary conditions guided by the customary information asymmetry and the resulting distrust. Presently, trust and mutual respect are important contributing factors and their emergence is supported e.g. by joint work and active, open communication which, again, are underpinned using independent, third-party estimators and audits. Thus, smooth collaboration is the only way service providers can eventually improve their bottom line.

Other drivers promoting the success of the project include the *late final agreement (59)* to be signed only after the development phase, and the related *possibility of termination (60)* of the liaison by the owner. These factors also make service providers pay attention to the success of the project already at the development phase. A *tight project budget (61)* evaluated by many aspirational candidates as early as the competition phase, perhaps even made tighter consequently, has a similar influence. Consequently, the expectation at the development phase is that the advantageousness of the project solution improves. On the other hand, during project pricing, design has already advanced far enough to allow avoiding significant risk contingencies through comprehensive joint risk identification and management, and elimination of interface risks. This naturally helps in finding an advantageous solution as do *practical fee structures (62)*: the designer's fee is generally percentage-based and that of the contractor (relatively) fixed, agreed already at the tender phase. Thereby the fee structure does not reward the contractor for expanding the project or raising the quality level, which increases costs (in contrast to a percentage-based fee), but as the designer's work focusses largely on the development phase, said fee structure spurs investing enough in reviewing options if the parties otherwise jointly consider it practical; after all, design only accounts for a relatively small share of overall costs.

Implementation phase (Figure 4)

The implementation phase begins if, and when, the parties consider the development phase goal to have been fulfilled and reach agreement e.g. on the project's target cost level. Then, the key factor guiding implementation is *joint bearing of risks (63)* which makes the objectives of the parties congruent as they all share e.g. in target cost over- and underruns. Along with target cost-based cost risk, rewarding systems related to qualitative result areas ensure the best possible realisation of the project's diverse goals. The common goal guides the activity towards good collaboration and effective and efficient implementation for which the foundation has been laid by other solutions (described below). Common will gives rise to a positive development trend which leads to continuous improvement for the benefit of the project.

Knowledge of the introduction of joint bearing of risks at the implementation phase results in openness and comprehensive risk analysis and mitigation already at the development phase which, for its part, leads to a reduction in risk reserves and an economical solution even before this principle is literally in force. Conventional interface risks resulting from strict limits on liability have also been eliminated, and company-specific sub-optimisation typical

of traditional delivery methods no longer guides alliance activities. This is underpinned by *joint organisation and work division flexibility (64)* which remove barriers and make work more effective while improving the possibility of tending to the concerns of stakeholders.

A *joint project office (65)* naturally also increases interaction and makes for smoother co-operation while also promoting an atmosphere of trust, and helping maintain it. A *joint leadership team* (66), for its part, ensures that different views are considered in decision making, especially since *unanimous decisions (67)* are the default. The continuity of the leadership team's involvement and the ensuing knowledge about project-related matters create conditions for quick decision making. The mechanism, considering joint bearing of cost risk, is such that all parties suffer from delayed decisions, meaning that it is not a traditional zero-sum game but supports efficient implementation. This is most obvious in the implementation phase, but these solutions are, in fact, in use already at the development phase to boost its realisation.

SIGNIFICANCE OF PRIME FACTORS AND PERFORMANCE EXPECTATIONS

The original group map, or the impact network it describes, was also subjected to quantitative analysis since the understanding of the overall functioning of an extensive network is otherwise difficult. The analysis was based on weighting of relationships as explained in the chapter on research methods. The results should be considered indicative since the method is only able to reveal order of magnitude level understanding. At this level, the results produced by different approaches are consistent.

Examination of the formal characteristics of the alliance (initial concepts) showed some carry more impact than others (by 'top-down' calculation). *Joint bearing of risks (63)* considered to be responsible for 20% of the success of an alliance was found most important. Another keystone of success is *capability-based competition (54)*. The next key factors were related to the multi-sectoral, integrated organisation: *early involvement of contractor (57)* and *owner's participation in alliance (58)* accounted for about 10% each of the overall impact. *Joint organisation and work division flexibility (64)* as well as *joint project office (65)* are nearly as important. The other characteristics seem to be less significant.

On the other hand, if we assess the hypothetical value creation of the alliance (by 'bottom-up' calculation), the result is strongly positive with respect to all key result areas (outcome concepts). Especially *cost-efficiency (1)* and *schedule (2)* stand out: at least 30% of the benefit from using alliancing would seem to come in the form of higher cost-efficiency while schedule would contribute 15%. The share of other key result areas is around 10%. To be sure, the balancing of goals is generally some kind of a project optimisation challenge, and as such an issue of valuation and selection.

A path analysis of the network also provides a complementary explanation for the performance expectations of key result areas. A survey of the network behind each outcome concept (by Decision Explorer) reveals that nearly three quarters of the intermediary and initial concepts affect the out-turn of all (ungrouped) outcome concepts. Since the network, with its numerous linkages, is also complex and the chain to outcome concepts runs through highly general concepts, it is natural that key result areas such as the *environment*, *quality*, *safety* and *traffic (4)* are assigned about the same impact value.

Yet, there are differences between parts of the network behind other outcome factors. Some concepts may be found behind *image (3)* that have a stronger impact only on this key result area. Likewise, *cost-efficiency* and *schedule* have common background factors, which the others do not have, that emphasise effectiveness thinking. Moreover, impact chains and concepts

solely related to the outcome concept of *cost-efficiency* lie behind it. The initial factor *possibility of termination (60)* is not even linked to other key result areas meaning that its practical significance is related specifically to cost control, although the precondition for continuation of the project is that development phase goals are met as to all key result areas. Separately recognised cost- and schedule-related drivers also indicate that the favourable performance expectations for these result areas are well grounded and not merely based on general assumptions.

Discussion

REVIEW IN RELATION TO PROJECT PERFORMANCE

One aspect of verifying the conceptual model's logic is its examination in relation to the results of the case study project. After all, the conceptual model gives an indication of the alliance's ability to perform well which should, therefore, have been realised also in practice.

The plans produced by the alliance (Alliance Executive Team, 2013) as well as the published value-for-money reports (Alliance Executive Team, 2014; 2017) signal remarkable success of the project. First, they show that plenty of recorded development ideas were born during the alliance's development phase (Alliance Executive Team, 2013), about half of which were also accepted for use already at that stage. The cost-benefit impacts of adopted ideas were reported to be 9% along with a notably shortened schedule (Alliance Executive Team, 2014) while there were also other innovations that were implemented mainly due to their positive value effects.

In the implementation phase, the alliance could reach the targets set at the development phase (Alliance Executive Team, 2017). The construction phase was speeded up further in a way that enabled opening the tunnel for traffic half a year earlier than anticipated in the schedule completed at the development phase. The out-turn cost of the original scope of works under-runs the target cost slightly. Safety performance was also clearly better than the industry average while none of the other indicators indicate inadequate performance. In other words, quality or other key goals have not been sacrificed to achieve savings or faster completion.

Thus, the successful realisation of the case study project gives no reason to doubt the authenticity of the solely positive insights of the interviewed experts about the impact of alliancing on project performance. On the other hand, public image and usability related key performance indicators still need to be monitored after substantial completion and opening for traffic (reached at the time of finalising this study/paper).

The innovation processes and development phase results of the case study project have been reviewed also in a parallel study (Lahdenperä, 2016) where practical experts assessed the alliance's performance in relation to other delivery methods (Design-Build, Design-Bid-Build, Construction Management). Regarding alliancing, experts emphasised its great ability to generate innovations that are a key to high economic efficiency. On the other hand, the development of a project solution is much more difficult when using the alternative delivery methods where the business logic and the competitive arrangements do little to support the presentation of ideas. All in all, the result was that an alliance creates the preconditions for achieving the highest economic efficiency particularly in demanding projects.

REVIEW IN RELATION TO CURRENT KNOWLEDGE

Existing literature offers another way of reviewing the work done. Literature has dealt widely with the alliance approach on a general level. Yet, the material is fragmented and reviewing

it all would be too random and speculative since comparable studies do not exist. Thus, this study concentrates on sources giving a comprehensive, condensed and unambiguous view of the principles of alliancing. Considering the development of procedures and increased understanding over time, the focus should be on recent publications. Accordingly, works by Walker and Lloyd-Walker (2015), Chen and Manley (2014), Chen et al. (2012) and DIRD (2015) take centre stage. All of them present an itemised list of the alliance's properties (nearly 50 in all) while many of the listed items have the same meaning despite being expressed differently in different publications. The study went through all these items one by one (cf. Lahdenperä, 2015a) even though only a summary of the review focussing on the differences is presented here.

Most of the listed *formal* properties of the alliance organisation or process are initial concepts of this study. Moreover, some intermediary concepts of the impact map/model – *cost transparency (26)*, *selection-phase workshops (41)* and *maintenance of collaborative and team spirit (38)* – are in line with the transparency and open book documentation and reporting principles (DIRD, 2015; Chen et al., 2012; Walker and Lloyd-Walker, 2015) and team workshops (Chen and Manley, 2014). Thus, all literature items on formal practice are included with one exception: issues such as commitment to no disputes and no blame culture (Chen et al., 2012; Walker and Lloyd-Walker, 2015; DIRD, 2015) are included in the concepts of the model in substance, but the fact that the parties agree to resolve all conflicts and disputes internally and not to litigate (Chen et al., 2012; DIRD, 2015) is missing from the developed model. To be sure, all these things, even *refraining from legal action* (except in cases of intentional damage and gross negligence) are emphasised also in the agreements of the case project (FTA, 2012a; 2012c) although the absence of the latter from the discussion about a development-oriented process and its functioning is as such natural. It should be further noted that literature distinguishes incentives related to cost-effectiveness and other key result areas just like the interviews of the study and the model's explanations although the formal concept map does not.

All the *informal* elements listed by the publications describing the character of the activity also appear in the map, at least in the background definitions of concepts (interviews), although these are by nature more broad-based issues subject to several interpretations and are difficult to define in unambiguous terms. In this regard, we are talking about the map's intermediary concepts which is consistent with the observation by Chen and Manley (2014): based on the path analyses they conducted, informal factors serve as mediators in the impact mechanisms of formal factors, basically between initial concepts and outcome concepts. They also stated (based on 320 questionnaire responses) that all listed factors contribute to an improved performance level. Thus, the study also supports the interpretation that the factors presented in this study are specifically ones that promote value creation.

A comparison in the opposite direction brings up a few initial factors of the concept map that are not emphasised in the reference material. The consortium selection (i.e. *team formation by service providers themselves (55)* and the related possibility of team optimisation) was identified as a key driver of good-value creation. The guidelines and examples lean toward the use of consortium selection (DTF, 2006; DIRD, 2015, Morwood, Scott and Pitcher, 2008) though the solution does not define alliance as the delivery method. On the other hand, *interactive selection (56)* and the ensuing possible redefinition of project scope and rules of the game, as well as clarification of document interpretation, were emphasised more in the study than the reference material. The *tight project budget* (61) and stage-wise nature of the alliance (*possibility of termination (60)*) also received emphasis in keeping with policies calling for

strong-willed leadership from the owner (Tamburro and Wood, 2014). The case study project also emphasised *practical fee structures (62)*: fixed for the contractor and percentage-based for the designer. Although the actual reference material does not take a stand on fee structures, some guidelines are in line with the recommendations of the study (DTF, 2006; Morwood, Scott and Pitcher, 2008) and consider such practical fee structures a conventional practice.

All in all, the findings of the study are consistent with earlier studies, but contribute to sector knowledge by linking the various components into a coherent system.

CLOSING THE DISCUSSION

The aim of the study was to determine the means and mechanisms which affect the capacity of the project alliance to generate value for money. The related work was done based on the views of the case study project's experts by systematically modelling them. Stage-wise personal interviews of experts allowed extensive mapping of impact chains without the interference of group dynamics, rutted thinking and unbalanced orientation affecting the results. The integration of individual cognitive maps produced an extensive, probably comprehensive group map which initially contained about 100 concepts. Streamlining of the map allowed highlighting essential factors without altering contents. Moreover, the relative significance of the basic alliance solutions exerting their influence in the background and the relative expected outcomes of the key result areas were also evaluated.

The result was achieved by a systematic, rigid process. The views of the interviewed experts were consistent and integratable. The impact model suggesting effective performance was also in line with the results of the case project (outcome; comparison with other delivery methods). These factors support the validity of the results in determining in detail the mechanisms that impacted the ability of alliancing to provide good value for money in the case project. The mechanisms of the impact model are also generally quite consistent with the big picture presented in literature, which means that there is no reason to harbour any major reservations about the results of the study.

Literature is also quite unanimous about the performance capacity of the alliance as suggested by the study. Therefore, the study strengthens the current theoretical view on the capacity of a collaborative, open process and an incentivized, integrated organization to provide competitive results in challenging projects by means of, for instance, certain informal factors that serve as mediators in the impact mechanisms of formal alliance factors. Moreover, the study increases our understanding of value creation mechanisms considerably as it describes the operating logic of the alliance in a detailed manner. Yet here we are only dealing with a single project which does not allow formulating a universal alliancing theory. More cases of diverse types in different regions with congruent results are required for generalization. Nevertheless, the fact that the results are based on a thorough analysis and are consistent with project performance and literature indicates that the model could serve as a basis for creating such a theory, which suggests that it would be worthwhile running further tests.

Thus, by providing the conceptual model, the study contributes to the knowledge about alliancing and potentially also lays the foundation for a more formal project alliance theory by explaining the capability of alliancing to produce value for money. The novelty value of the model lies primarily in that it connects the basic features, procedures and performance expectations of alliancing closely together, resulting in a comprehensive and coherent system description. No such specification of the alliance's operating logic is known to have been made since the subject has been mainly addressed at the level of individual alliance principles.

The system model emphasises the holistic nature of alliancing due to many mutually reinforcing interactions – the entity is more than the sum of its parts. In other words, a system has several parts each of which affects the behaviour of the whole, but the effect that each part can have overall depends on the behaviour or properties of other parts (Ackoff, 1974). Therefore, the performance of the system is dependent on each of its parts, and any change may have an extraordinary impact on the performance.

The practical implications of the work are related, firstly, to the fact that it is hard to make an outcome-based comparison of the performance of different project delivery systems that is indisputable in a world of individual projects, which is why the decision about using project alliancing may require more comprehensive understanding of the system's functioning. This study can help in that. Secondly, projects vary a lot as they have different goals and constraints. The details of the alliance must also be changed sometimes: non-adherence to individual principles might well be practical in some instances. The owner may wish, for instance, to select service providers separately (instead of a complete team) or use selection geared more toward full price. Then, the system model can serve as a tool of planning when pondering the functioning of different applications deviating from the described 'pure' alliance.

Conclusion

Use of the alliance can contribute to the achievement of better than usual outcomes in case of challenging, complex projects that involve much uncertainty. The value generation of an alliance is based, according to the study, on the following formal solutions related to organisation and the process:

- capability-based competition (54)
- team formation by service providers themselves (55)
- interactive selection (56)
- selection-phase workshops (41)
- early involvement of contractor (57)
- owner's participation in alliance (58)
- cost transparency (26)
- late final agreement (59)
- possibility of termination (60)
- tight project budget (61)
- practical fee structures (62)
  - contractor's fixed fee
  - designer's percentage-based fee
- joint bearing of risks (63)
  - target cost-based contract
  - incentive scheme for qualitative result areas
- joint organisation and work division flexibility (64)
- joint project office (65)
- joint leadership team (66)
- unanimous decisions (67), and
- refraining from legal action.

These factors are, with a few exceptions, initial concepts of the system model produced by the study (concepts represented by green ovals in Figs. 2-4). *Selection-phase workshops* and *cost*

transparency are, however, shown in the model as so-called (yellow) intermediary concepts, although they also are essential formal alliance solutions. The same applies to the principle of *refraining from legal action* though it was not raised at all when the model was being put together. The last two principles remind us about some other underlying precautions used in alliancing: financial audits, third party estimate reviews, etc. They may not improve the performance directly, but as a result, the option of wheeling and dealing is eliminated and successful implementation of the entire project is the only way for service providers to improve their bottom line. This is where the other listed formal solutions enter the picture to actively boost performance.

Accordingly, these formal (hard) process solutions should and will be complemented by other (softer) operational principles: innovation driven, committed, open and sincere co-operation are important for the success of an alliance project. In fact, the above formal factors are implemented to create common goals and interest in co-operation for the parties which supports the realisation of these softer principles (appearing as intermediary concepts in the model).

All in all, the basic idea of alliancing is to make it in the best interest of all parties to solve problems and develop the project, which is supported by the model's many parallel basic solutions synergistically and comprehensively. Thus, the pure alliance described by the system model provides a greater boost to the implementation of a project than the sum of its parts, and deviation from the presented principles, just in the case of an individual principle, poses some risk.

References

Ackoff, R., 1974. Beyond problem solving. In: A. Rapoport, ed. *General systems. Yearbook of the society for general systems research Part VI*. Washington DC, US: Society for general systems research Vol. 19, pp. 237-39.

Alliance Executive Team, 2013. *Rantatunneli Alliance Project. Project Plan*. Tampere: Tampere City, Finnish Transport Agency, Lemminkäinen Infra, Saanio & Riekkola and A-Insinöörit Suunnittelu.

Alliance Executive Team, 2014. *Rantatunneli Alliance Project. Value for money report, project development phase*. Tampere: Tampere City, Finnish Transport Agency, Lemminkäinen Infra, Saanio & Riekkola, A-Insinöörit Suunnittelu.

Alliance Executive Team, 2017. *Rantatunneli Alliance Project. Value for money report, project completion phase*. Tampere: Tampere City, Finnish Transport Agency, Lemminkäinen Infra, Saanio & Riekkola, A-Insinöörit Suunnittelu (Unpublished draft).

Bajari, P. and Tadelis, S., 2001. Incentives versus Transaction Costs: A Theory of Procurement Contracts. *RAND Journal of Economics*, 32(3), pp. 387-407. http://www.jstor.org/stable/2696361

Bajari, P., Houghton, S. and Tadelis, S., 2014. Bidding for Incomplete Contracts: An Empirical Analysis of Adaptation Costs. *The American Economic Review*, 104(4), pp. 1288-1319. https://doi.org/10.1257/aer.104.4.1288

Chen, G., 2013. *Cost management in project alliances: a framework based on interorganizational settings*. PhD. RMIT University.

Chen, G., Zhang, G., Xie, Y.-M. and Jin, X.-H., 2012. Overview of alliancing research and practice in the construction industry. *Architectural Engineering and Design Management*, 8(2), pp. 103-19. https://doi.org/10.1080/17452007.2012.659505

Chen, L. and Manley, K., 2014. Validation of an instrument to measure governance and performance on collaborative infrastructure projects. *Journal of Construction Engineering and Management*, 140(5), 04014006. https://doi.org/10.1061/(ASCE)CO.1943-7862.0000834

Clegg, S., Pitsis, T., Rura-Polley, T. and Marosszeky, M., 2002. Governmentality matters: designing an alliance culture of inter-organizational collaboration for managing projects. *Organization Studies*, 23(3), pp. 317-37. https://doi.org/10.1177/0170840602233001

Davies, J., 2008. *Alliance contracts and public-sector governance*. PhD. Griffith University.

Davis, P., 2005. *The application of relationship marketing to construction*. PhD. Royal Melbourne Institute Technology.

Davis, P. and Love, P., 2011. Alliance contracting: adding value through relationship development. *Engineering, Construction and Architectural Management*, 18(5), pp. 444-61. https://doi.org/10.1108/09699981111165167

Decision Explorer, 2002. *User's guide, version 3.2*. Kendal: Banxia Software Limited.

DIRD, 2015. *National alliance contracting guidelines. Guide to Alliance Contracting*. Canberra: Australian Government, Department of Infrastructure and Regional Development.

DTF, 2006. *Project alliancing. Practitioners' guide*. Melbourne: The Department of Treasury and Finance (DTF), State of Victoria.

DTF, 2009. *In pursuit of additional value. A benchmarking study into alliancing in the Australian public sector*. Melbourne: Department of Treasury and Finance (DTF), State of Victoria.

Eden, C., 2004. Analyzing cognitive maps to help structure issues or problems. *European Journal of Operational Re-search*, 159(3), pp. 673-86. https://doi.org/10.1016/S0377-2217(03)00431-4

Eisenhardt, K., 1989. Building theories from case study research. *Academy of Management Review*, 14(4), pp. 532-50. https://doi.org/10.2307/258557 and https://doi.org/10.5465/AMR.1989.4308385

ELY, 2011. *Tiesuunnitelman kustannusarvio ja kustannusjakoehdotus. Valtatie 12 (Tampereen rantaväylä) välillä Santalahti – Naistenlahti, Tiesuunnitelma. [Road plan-phase cost estimate and cost-sharing proposal. Highway 12 (Tampere Lakeside Road) Santalahti–Naistenlahti, road plan.]* Tampere: Pirkanmaa Centre for Economic Development, Transport and the Environment (ELY). (in Finnish)

FTA, 2012a. *Kehitysvaiheen allianssisopimus, luonnos. Vt12 Tampereen tunneli, Allianssiurakka [Development-phase alliance agreement, draft (provided as part of Request for Proposals). Vt12 Tampere Tunnel, an Alliance Contract]*. Helsinki: Finnish Transport Agency (FTA). (in Finnish)

FTA, 2012b. *Tarkennettu tarjouspyyntö. Vt12 Tampereen tunneli, Allianssiurakka [Revised Request for Proposals. Vt12 Tampere Tunnel, an Alliance Contract]*. Helsinki: Finnish Transport Agency (FTA). (in Finnish)

FTA, 2012c. *Toteutusvaiheen allianssisopimus, luonnos. Vt12 Tampereen tunneli, Allianssiurakka [Implementation-phase alliance agreement, draft (provided as part of Request for Proposals). Vt12 Tampere Tunnel, an Alliance Contract]*. Helsinki: Finnish Transport Agency (FTA). (in Finnish)

Gray, S., Zanre, E. and Gray S., 2014. Fuzzy cognitive maps as representations of mental models and group beliefs. In: E. Papageorgiou, ed. *Fuzzy Cognitive maps for Applied Sciences and Engineering – From fundamentals to ex-tensions and learning algorithms*. Berlin: Springer Publishing. pp. 29-48. https://doi.org/10.1007/978-3-642-39739-4_2

Hauck, A., Walker, D., Hampson, K. and Peters, R., 2004. Project alliancing at National Museum of Australia – collaborative process. *Journal of Construction Engineering and Managemen*t, 130(1), pp. 143-52. https://doi.org/10.1061/(ASCE)0733-9364(2004)130:1(143)

Ibrahim, C., 2014. *Development of an assessment tool for team integration in alliance projects*. PhD. University of Auckland. https://researchspace.auckland.ac.nz/handle/2292/22812

Ibrahim, C., Costello, S. and Wilkinson, S., 2016a. Application of a team integration performance index in road infrastructure alliance projects. *Benchmarking: An International Journal*, 23(5), pp. 1341-62. https://doi.org/10.1108/BIJ-06-2015-0058

Ibrahim, K., Costello, S., Wilkinson, S. and Walker, D., 2016b. Project Alliancing: The case of road infrastructure projects in New Zealand. In: Chan, P. and Neilson, C. eds. *Proceedings of the 32nd Annual ARCOM Conference*, Manchester, 5-7 September 2016. Association of Researchers in Construction Management, 1, pp. 175-84.

Jefferies, M., Brewer, G. and Gajendran, T., 2014. Using a case study approach to identify critical success factors for alliance contracting. *Engineering, Construction and Architectural Management*, 21(5), pp. 465-80. https://doi.org/10.1108/ECAM-01-2012-0007

Jefferies, M., Rowlinson, S. and Schubert, A., 2012. The procurement of indigenous social housing in Australia: a project alliance approach. *Joint CIB W70, W92 & TG72 international conference: delivering value to the community*. University of Cape Town, Cape Town, South Africa, 23-25 January 2012.

Kosko, B., 1986. Fuzzy cognitive maps. *International Journal of Man-Machine Studies*, 24(1), pp. 65-75. https://doi.org/10.1016/S0020-7373(86)80040-2

Kosko, B., 1988. Hidden patterns in combined and adaptive knowledge networks. *International Journal of Approximate Reasoning*, 2(4), pp. 377-93. https://doi.org/10.1016/0888-613X(88)90111-9

Laan, A., Voordijk, H. and Dewulf, G., 2011. Reducing opportunistic behaviour through a project alliance. *International Journal of Managing Projects in Business*, 4(4), pp. 660-79. https://doi.org/10.1108/17538371111164065

Lahdenperä, P., 2009. *Project alliance. The competitive single target-cost approach*. Technical Research Centre of Finland (VTT), Espoo. VTT Tiedotteita – Research Notes 2472. http://www.vtt.fi/inf/pdf/tiedotteet/2009/T2472.pdf

Lahdenperä, P., 2012. Making sense of the multi-party contractual arrangements of project partnering, project alliancing and integrated project delivery. *Construction Management and Economics*, 30(1), pp. 57-79. https://doi.org/10.1080/01446193.2011.648947

Lahdenperä, P. 2015a. Allianssiurakan arvontuoton mekanismit. Johdon sosiaalinen kognitiivinen kartta. [Value-creation mechanisms of alliancing. A social cognitive map of executives]. VTT, Espoo. *VTT Technology* 243. 66 p. + app. 10 p. (in Finnish) http://www.vtt.fi/inf/pdf/technology/2015/T243.pdf

Lahdenperä, P., 2015b. The beauty of incentivised capability-and-fee competition based target-cost contracting. In: *The 8th Nordic Conference on Construction Economics and Organization. Procedia Economics and Finance*, 21, pp. 609-16. https://doi.org/10.1016/S2212-5671(15)00219-1

Lahdenperä, P., 2016. Towards quantification of the economic efficiency advantage of alliancing in complex infrastructure projects. In: Saari, A., and Huovinen, P. eds. *Proceedings of the CIB World Building Congress 2016 Intelligent Built Environment for Life*, Tampere, Finland, 30 May – 3 June 2016. Vol. III. Tampere: University of Technology, Construction Management and Economics, Report 18. pp. 496-509. http://urn.fi/URN:ISBN:978-952-15-3743-1

Lloyd-Walker, B., Mills, A. and Walker, D., 2014. Enabling construction innovation: the role of a no-blame culture as a collaboration behavioural driver in project alliances. *Construction Management and Economics*, 32(3), pp. 229-45. https://doi.org/10.1080/01446193.2014.892629

Loraine, R., 1994. Project specific partnering. *Engineering Construction and Architectural Management*, 1(1), pp. 5-16. https://doi.org/10.1108/eb020989

Love, P., Davis, P., Chevis, R. and Edwards, D., 2011. Risk/reward compensation model for civil engineering infrastructure alliance projects. *Journal of Construction Engineering and Management*, 137(2), pp. 127-36. https://doi.org/10.1061/(ASCE)CO.1943-7862.0000263

MacDonald, C., 2011. Value for money in project alliances. PhD. RMIT University.

MacDonald, C., Walker, D. and Moussa, N., 2013. Towards a project alliance value for money framework. *Facilities*, 31(5/6), pp. 279-309. https://doi.org/10.1108/02632771311307179

Manley, K. and Chen, L., 2016. The impact of client characteristics on the time and cost performance of collaborative infrastructure projects. *Engineering Construction and Architectural Management*, 23(4), pp. 511-32. https://doi.org/10.1108/ECAM-06-2015-0084

Mistry, D. and Davis, P., 2009. A client's perspective of critical success factors in project alliances. In: Dainty, A. ed. *Proceedings of 25th Annual ARCOM Conference*, 7–9 September 2009, Nottingham: Association of Researchers in Construction Management, pp. 217-26.

Morwood, R., Scott, D. and Pitcher, I., 2008. *Alliancing. A participant's guide*. Brisbane: Maunsell AECOM.

Nicholson, J., 1991. Rethinking the Competitive Bid. *Civil Engineering*, 61(1), pp. 66-68.

Özesmi, U. and Özesmi, S., 2004. Ecological models based on people's knowledge: a multi-step fuzzy cognitive mapping approach. *Ecological Modelling*, 176(1-2), pp. 43–64. https://doi.org/10.1016/j.ecolmodel.2003.10.027

Rooney, G., 2009. Project Alliancing. The process architecture of a relationship based project delivery system for complex infrastructure projects. In: *The 1st AMA Conference*, Singapore, 4-5 June 2009. Singapore: Asian Mediation Association (AMA).

Ross, J., 2003. Project alliancing – a strategy for avoiding and overcoming adversity. In: *World Project Management Week*, 24-28 March 2003, Gold Coast, Australia.

Rowlinson, S., Cheung, F., Simons, R. and Rafferty, A., 2006. Alliancing in Australia – no-litigation contracts: a tautology? *Journal of Professional Issues in Engineering Education and Practice*, 132(1), pp. 77-81. https://doi.org/10.1061/(ASCE)1052-3928(2006)132:1(77)

Scott, B., 2001. *Partnering in Europe. Incentive based alliancing for projects*. London: Thomas Telford. https://doi.org/10.1680/pieibafp.29651

She, L.-Y., 2014. Understanding the conditions of trust between governance and management within project alliancing. PhD. University of Melbourne.

She, L.-Y., Doloi, H. and Mills, A., 2012. The soft systems approach to understanding trust in alliances in Australia. *The RICS Construction and Property Conference (COBRA)*, Royal Institution of Chartered Surveyors (RICS), 10-13 September 2012, Las Vegas.

Stehbens, K., Wilson, O. and Skitmore, M., 1999. Partnering in the Australian construction industry: breaking the vicious circle. In: Bowen, P. and Hindle, R. eds. *CIB W55 and W65 Joint Triennial Symposium Customer Satisfaction: a Focus for Research and Practice*, 5-10 September 1999, Cape Town, South Africa, pp. 195-201.

Strahorn, S., Gajendran, T. and Brewer, G., 2013. Mechanisms of trust and trust repair in relational contracting: a multiple perspective investigation of alliance projects. In: *Proceedings of the 19th CIB World Building Congress (CIBWBC2013)*, Brisbane, 5-9 May 2013.

Sweeney, S., 2009. Addressing market failure: using Transaction Cost Economics to improve the construction industry's performance. PhD. University of Melbourne.

Tamburro, N. and Wood, P., 2014. Alliancing in Australia: competing for thought leadership. *Management, Procurement and Law*, 167(2), pp. 75-82. https://doi.org/10.1680/mpal.13.00012 and https://doi.org/10.1680/mpl.14.00031

Vainio, T., 2015. Complex decision-making process of the public sector: case Tampere Rantaväylä. *8th Nordic Conference on Construction Economics and Organization*. Procedia Economics and Finance, 21, pp. 104-11. https://doi.org/10.1016/S2212-5671(15)00156-2

Vilasini, N., 2014. Generating value in alliance contracts through the lean concept. PhD. Auckland University of Technology.

Walker, D. and Hampson, K. eds., 2003. *Procurement strategies. A relationship-based approach*. Oxford: Blackwell Science.

Walker, D. and Jacobsson, M., 2014. A rationale for alliancing within a public-private partnership. *Engineering, Construction and Architectural Management*, 21(6), pp. 648-73. https://doi.org/10.1108/ECAM-09-2013-0087

Walker, D. and Lloyd-Walker, B., 2014. The ambience of a project alliance in Australia. *Engineering Project Organiza-tion Journal*, 4(1), pp. 2-16. https://doi.org/10.1080/21573727.2013.836102

Walker, D. and Lloyd-Walker, B., 2015. *Collaborative project procurement arrangements*. Newtown Square, PA: Project Management Institute.

Walker, D., Harley, J. and Mills, A., 2015. Performance of project alliancing in Australasia: a digest of infrastructure development from 2008 to 2013. *Construction Economics and Building*, 15(1), pp. 1-18. https://doi.org/10.5130/ajceb.v15i1.4186

Weston, D. and Gibson, G., 1993. Partnering-project performance in US Army Corps of Engineers. *Journal of Management in Engineering*, 9(4), pp. 410-25. https://doi.org/10.1061/(ASCE)9742-597X(1993)9:4(410)

Yin, R., 2014. *Case study research. Design and methods*. 5th edition. Thousand Oaks: Sage Publications.