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Abstract

Purpose – The purpose of this paper is to explore the applicability of the Alliance Team Integration Performance Index (ATIPI) model as an assessment tool to measure the performance of team integration in alliance road infrastructure projects in New Zealand.

Design/methodology/approach – This study takes a case study approach, using a qualitative research method. Three road infrastructure projects under project alliance from the New Zealand Transport Agency (NZTA) were selected as the cases. Data were collected through the interviews with a representative from the alliance management team from each case. Project records and documentation were also used to assist and support the actual data from the interviews.

Findings – The findings indicated that the ATIPI is performing as expected and found to be both practical and applicable to measure the team integration performance in light of real life case studies of alliance road infrastructure projects. Across the three case studies, there is evidence that high levels of integrated performance is consistently fostered by the project teams over the lifecycle of projects. In addition, based on the cross-case analysis from the application of the ATIPI on three cases, further work could enhance the probability of the utilization of the tool to manage different project alliance teams consistently and objectively.

Research limitations/implications – The study was limited to three alliance road infrastructure projects in New Zealand. Further research into different alliance projects is required to establish a comprehensive database of alliance team integration performance, so that the model could be more beneficial for owner and non-owner participants, for benchmarking purposes.

Practical implications – As team integration practice can directly result in high performing teams in alliance projects, the ATIPI is an ideal model to facilitate the continuous evaluation of team integration performance consistently and objectively over the lifecycle of the projects.

Originality/value – This study extends the team integration literature in construction research by providing significant insights into the empirical evaluation of alliance team integration performance, as well as providing added value for the enhancement of any future development of performance evaluation models in construction research.

Keywords Performance, Assessment, Team integration, Alliance

Paper type Research paper

Introduction

The growing emphasis on team integration practice in construction projects has been an on-going subject in the construction industry as a response to the fragmentation and lack of integration inherent in traditional procurement approaches. The increasing

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attention to the above issues have led to a number of alternative forms of construction procurement approaches (Lahdenperä, 2012). Previous scholars (e.g. Bresnen and Marshall, 2000; Chen *et al.*, 2012; Walker, 2015) emphasize that the use of relationship-based procurement approaches in particular, may contribute to improvement of project outcomes through successful collaboration and integration of diverse project teams. Relationship-based procurement approaches, such as a project alliance, are based on appropriate platforms, behaviours and processes of collaboration that has the potential to result in a high degree of integration between parties (Walker and Lloyd-Walker, 2015).

A project alliance is regarded as a procurement approach that fosters and embraces the team integration practice between diverse teams in delivering complex infrastructure projects (Love *et al.*, 2010; Jefferies *et al.*, 2014). Although team integration on alliance projects is widely seen as a positive practice towards achieving high performing teams, issues regarding the sustaining and consistency of the practice may restrict the ability of alliance teams to achieve the desired outcomes (Rooney, 2009; Laan *et al.*, 2011a, b). One possible reason for this on-going issue is that alliance teams are often isolated in environments where adversarial behaviour, as well as self-interest, still exist (Laan *et al.*, 2011a, b; Mills *et al.*, 2012; Walker *et al.*, 2015). In particular for large infrastructure projects where the task of coordinating, integrating and managing the extensive project parties is highly complex (Walker and Jacobsson, 2014), some individuals who are not fully knowledgeable of the alliancing environment (Yeung *et al.*, 2007a), as well as not possessing the required relationship-based attributes (Ibrahim *et al.*, 2013a) may contribute to the difficulty to integrate proactively and to move away from the adversarial behaviour (Reed and Loosemore, 2012).

With this in mind, the need for continuous high levels of integration performance over the course of an alliance project, mentioned by previous construction scholars (e.g. Rooney, 2009; Laan *et al.*, 2011a, b; Mills *et al.*, 2012), assumes a special significance to enhance the continuity of the integration within the alliance teams. Ibrahim *et al.* (2013a) argue that if continuous improvement in project alliances is to be achieved through the use of integrated teams, then a rational means of assessing how well teams integrate and how team integration changes over time, needs to be introduced.

Recognizing that there are no standard or accepted methods in the industry for performance evaluation of alliance team integration over the lifecycle of a project, Ibrahim *et al.* (2013a) have developed an integrated index model, the Alliance Team Integration Performance Index (ATIPI). It is increasingly evident that a standardised tool to continuously measure and monitor the performance of alliance team integration would be beneficial for both owner and the non-owner participants (NOPs) (Hauck *et al.*, 2004; Jefferies *et al.*, 2014), where the key to alliance success is the relationship, and extent of integration, between owner and NOPs (Love *et al.*, 2002).

This paper presents the development of the ATIPI, in a spreadsheet format, in order to provide a systematic way of collecting, retrieving and presenting graphically the team performance data. Although the creation of the ATIPI incorporated systematic methodologies (see Ibrahim *et al.*, 2013a, 2014, 2015a, b) to ensure its functionality, it does not constitute sufficient evidence that this assessment model is actually operating as intended or provides insight to the alliance teams on their integration performance. In order to ensure its functionality, this paper discusses the application of the developed ATIPI and how the model could potentially establish pattern variations of team integration performance, which in turn lead to identification of which indicators are dominant and subservient to their integration practice, thereby providing greater understanding and the ability to plan ahead for improvement. In addition, the feedback and outcomes from the application of the ATIPI on real life alliance projects could add value for the future development, not only of the ATIPI, but also of any similar type of index model.

Therefore, the purpose of this paper is to explore the applicability of the ATIPI model as an assessment tool to measure the performance of team integration in alliance road infrastructure projects in New Zealand. Consequently, the subsequent sections of the paper briefly provide an overview of literature on the existing research on team integration measurement and integrated performance index models, followed by a synopsis of the development of the ATIPI model. Further details on the research and development of the ATIPI model can be found in Ibrahim *et al.* (2013a, 2014, 2015a, b). Then, the findings of the detailed application of the model are presented through three cases from the New Zealand Transport Agency (NZTA), one of the major clients in road infrastructure projects in New Zealand. The first two case studies were conducted with on-going projects and the third involved a project that was recently completed, with the aim of testing the applicability of the model. Finally, a cross-case analysis of the case studies is discussed, followed by the conclusions.

Team integration measurement in construction

The growing necessity for an integrated environment in construction projects requires a suitable and proper way of measuring team integration. Over the past decades, much of the literature have focused on measuring team integration performance in construction projects.

Particular attention has been given by Baiden *et al.* (2006) to assessing the extent of team integration in design-build (DB) and construction management procurement approaches. Ten dimensions of integration were used for the assessment, as follows; single team focus and objectives, seamless operations, mutually beneficial outcomes, increased time and cost predictability, sharing information, team flexibility, single co-located team, no blame culture, equal opportunity for inputs, equitable relationship and respect. They emphasized that assessing these dimensions continuously over the lifecycle of a project is critical in order to manage the performance in a proactive way.

In another study, Korkmaz *et al.* (2013) focused on assessing the level of integration in affecting sustainability goals in the DB procurement approach. They measured the level of integration in terms of attributes such as early collaboration of the project's participants, method and timing of communication, and the chemistry among participants. They also found that some other delivery attributes such as owner commitment and team characteristics influence the level of integration achieved. Aapaoja *et al.* (2013) by contrast, examined the level of team integration practice in building projects procured by the integrated project delivery (IPD) method. By using characteristics almost identical to Baiden *et al.* (2006) with one additional dimension, namely, results and innovations, they emphasized that due to the integrated nature embedded in the IPD method, projects can be successful although some of the integration characteristics are not fully achieved.

Apart from the aforementioned studies, the importance of measuring specific indicators of team integration have also been acknowledged in the construction literature. For example, Zhang *et al.* (2013) focused on measuring team flexibility as one of the important elements of team integration practices. They measured two main aspects of team flexibility: first, response extensiveness to attended/unattended dynamics; and second, response efficiency to attended/unattended dynamics on a case study of an IPD project. The findings indicated that, in responding to the changing environment of construction projects, team flexibility is of greater importance for the integrated team and it intrinsically depends on tacit knowledge sharing at the early stage of construction projects. Another study by Senaratne and Hewamanage (2015), measured team leadership and team integration based on two case studies of green building projects in Sri Lanka. They found that the team integration practice and team leadership for both projects was at a higher level based on examination of four key elements: first, common project objectives; second, collective implementation; third, teamwork for win-win; and fourth, continuous learning and knowledge sharing. They also emphasized that not only team integration but also shared team leadership is required for achieving Leadership in Energy and Environmental Design certification in a green building project.

Overall, the issue of assessing team integration practice, objectively, remains elusive. Although the above studies made significant advances in the team integration practice literature, they mainly attempt to subjectively assess the integration rather than trying to assess the practice objectively and over the lifecycle of the project. As a result, it is very difficult to quantify an appropriate measure for team integration based on these findings, in particular for the alliance procurement approach.

Integrated performance index models in the construction literature

The ATIPI is developed based on the concept of integrated performance index model. Although similar types of models have been developed previously (i.e. Cheung *et al.*, 2003; Ng *et al.*, 2005; Lam *et al.*, 2007; Yeung *et al.*, 2007b, 2009; Xia and Chan, 2012; Ibrahim *et al.*, 2013a) they are all different in terms of their focus, scope and methodology, and hence result in different outcomes (see Table I). For example, Cheung *et al.* (2003) developed the system for monitoring the status of partnering in Hong Kong through the use of an index, based on the incorporation of an established partnering measure. Ng *et al.* (2005) established a safety performance evaluation index to evaluate the safety performance at the organizational and project levels in Hong Kong. Yeung *et al.* (2007a, b, 2009) focused on measuring the overall performance of a partnering project in Hong Kong and relationship-based procurement in Australia, by establishing a specific key performance indicator through the use of the Delphi method. Lam *et al.* (2007) applied the same concept to develop a project success index to benchmark the performance of DB projects in Hong Kong. In contrast, Xia and Chan (2012) focused on assessing the degrees of project complexity in China by identifying the complexity measures for building projects. Ibrahim *et al.* (2013a) further expand the concept of an integrated index model by identifying the most significant indicators and their appropriate weightings and then integrating these elements into an index model for measuring team integration performance for alliance projects in New Zealand.

Apart from Ibrahim *et al.* (2013a), none of the aforementioned studies systematically focus on the development of an integrated index model for the performance evaluation of team integration under the alliance procurement approach. The work by Ibrahim *et al.* (2013a), developed the ATIPI as a significant step towards achieving the above. To date, however, the ATIPI tool has not been trialled on a real life alliance project. In order to address this shortfall, the application of the ATIPI as an assessment tool of team integration performance in three real life alliance projects is presented in this paper.

References	Level of measurement	Subject focus	Locality of the study	Method adopted	Examples of indicators embedded in the index
Cheung *et al.* (2003)	Organization	Measuring partnering relationship	Australia	Using established indicator	Communication; time; cost; quality; safety; claim and issue resolution; environment; contract relations
Ng *et al.* (2005)	Project and organization	Safety performance	Hong Kong	Questionnaire survey	Administrative and management commitment, health and safety training, safety review, accident record
Lam *et al.* (2007)	Project	Measuring design-build performance	Hong Kong	Questionnaire survey	Time; cost; quality; functionality
Yeung *et al.* (2007b)	Project	Measuring partnering performance	Hong Kong	Delphi survey	Time; cost; top management commitment; quality; trust and respect; effective communication, innovation and improvement
Yeung *et al.* (2009)	Project	Measuring performance of relationship-based procurement	Australia	Delphi survey	Client satisfaction; cost; quality; time; effective communication; safety; trust and respect; innovation and improvement
Xia and Chan (2012)	Project	Measuring complexity building	China	Delphi survey	Building structure and function; construction method; the urgency of the project schedule; project size/scale; geological condition; and neighbouring environment
Ibrahim *et al.* (2013a)	Organization	Measuring team integration	New Zealand	Delphi survey	Team leadership, trust and respect, single team focus on project objectives and KRAs, collective understanding, commitment from Project Alliance Board

Table I. Previous construction studies on the integrated index model

Development of the ATIPI

The development of the ATIPI model integrates three main elements to measure the alliance team integration performance as follows.

The most significant key indicators of alliance team integration

Based upon an initial study, researchers extracted and consolidated information on the related KIs of successful team integration in construction projects (see Ibrahim *et al.*, 2013b, 2015a). Based on the preceding findings, the Delphi method was adopted with a panel of 17 experienced alliance practitioners to identify and weight the most significant KIs to measure the success of alliance team integration in road construction projects. Finally, the seven most significant KIs were identified and their weightings calculated in order to develop the ATIPI as shown in Equation (1). For a complete discussion on the seven weighted KIs included in the development of the ATIPI model, the reader is referred to Ibrahim *et al.* (2013a):

$$\begin{aligned}\text{ATIPI} = {} & 0.250 \times \text{Team leadership} + 0.214 \times \text{Trust and respect}\\ & + 0.179 \times \text{Single team focus on project objectives and KRAs}\\ & + 0.143 \times \text{Collective understanding}\\ & + 0.107 \times \text{Commitment from Project Alliance Board}\\ & + 0.071 \times \text{Creation of single and co-located Alliance Team}\\ & + 0.036 \times \text{Free flow communication} \qquad (1)\end{aligned}$$

The appropriate quantitative measures (QMs) for each of the KIs

Once the significant KIs for alliance project teams were identified, the next element in the development of the model, involved identification of appropriate measures, preferably objective measures, for those seven KIs. As suggested by Menches and Hanna (2006) and Yeung *et al.* (2008), it is preferable to use quantitative measurements to allow objective assessment in establishing a performance model. Consequently, a semi-structured interview with five experienced alliance practitioners was conducted to identify suitable, practical and objective measures to help evaluate the seven selected weighted KIs. As a result, a total of 29 QMs were proposed and recommended. Then, two rounds of Delphi questionnaire survey were undertaken with the same 17 Delphi experts to identify the most appropriate QMs for each KI (see Table II) based on their levels of importance, measurability and obtainability (see Ibrahim *et al.*, 2014).

The range of performance levels for each KI

The third element of development of the model, involved the development of an associated range of performance scales for each KI to indicate the boundaries of the different performance levels in the ATIPI. The performance levels establish the points at which alliance teams have demonstrated sufficient integration practice to be regarded as performing at a particular achievement level (see Ibrahim *et al.*, 2015b). Accordingly, the third element of the model development included a systematic procedure based on a questionnaire survey and fuzzy set theory, namely, the modified horizontal approach with bisector error method, to establish a range of scales for each QM within five levels of performance. The five performance levels designated are excellent, very good, good, average and poor. Insight into the meaning of these five performance levels is provided as follows:

(1) Level 5 (excellent): performance far exceeded expectations due to extremely high team performance achieved in all KIs, resulting in excellent progress toward targeted performance.

(2) Level 4 (very good): performance consistently exceeded expectations in all KIs, and good progress toward targeted performance was achieved.

(3) Level 3 (good): performance consistently met expectations in all KIs, at times possibly exceeding expectations, and reasonable progress toward targeted performance was achieved. Improvement may be needed in one of the KIs.

(4) Level 2 (average): performance did not consistently meet expectations in one or more of the KIs, and/or reasonable progress toward targeted performance was slightly achieved. Improvement needed in more than one of the KIs.

Table II. The most appropriate QMs and their range of performance levels for each KI

The most appropriate QMs for each KI		Range of scales of the performance levels: Poor	Average	Good	Very Good	Excellent
Team Leadership	Variation of actual time against programme expressed as a percentage of the project's progress	< −12%	⩾−12 to < −3%	⩾−3 to < 2.8%	⩾ 2.8 to < 13.5%	⩾13.5%
	Variation of actual cost against budget expressed as a percentage of the project's progress	< −6.5%	⩾−6.5 to < 0.5%	⩾−0.5 to < 2%	⩾ 2 to < 10%	⩾10%
Trust and respect	Survey of wider alliance teams' satisfaction on the level of trust and respect by using a Likert scale	< 4.9	⩾4.9 to < 6.3	⩾ 6.3 to < 7.5	⩾7.5 to < 9	⩾ 9
Single team focus on project objectives and KRAs	Survey of wider alliance teams' understanding on the project objectives and KRAs by using a Likert scale	< 4.8	⩾4.8 to < 6.2	⩾ 6.2 to < 7.2	⩾7.2 to < 9	⩾9
Collective understanding	Percentage of alliance team attendance in weekly project briefing	< 58%	⩾58 to < 74%	⩾ 74 to < 87%	⩾87 to < 92%	⩾ 92%
Commitment from Project Alliance Board (PAB)	Percentage of PAB members (original) attendance in PAB meetings	< 66%	⩾66 to < 75%	⩾ 75 to < 84%	⩾84 to < 91%	⩾ 91%
Creation of single and co-located alliance team	Number of staff allocated on-site against the overall number of staff expressed as percentage of single and co-located alliance team	< 61%	⩾61 to < 74%	⩾ 74 to < 82%	⩾82 to < 92%	⩾ 92%
Free flow communication	The turnaround time for Request for Information (RFI) and Design Engineering Instructions (DEI)	> 9	> 6 to ⩽ 9	> 5 to ⩽ 6	> 3 to ⩽ 5	⩽ 3

Notes: < represents "less than"; > represents "greater than"; ⩾ represents "greater than or equal to"
Source: Summarized from Ibrahim *et al.* (2014, 2015a)

(5) Level 1 (poor): performance was consistently below expectations in almost all of the KIs, and/or reasonable progress toward targeted performance was not achieved. Significant improvement is needed in most of the KIs.

Descriptors for each of the performance levels within each KI are shown in Table II. Their inclusion in the ATIPI reduces the reliance on subjective judgement of evaluators when assessing performance while still maintaining an objective and quantitative assessment process. Finally, the availability of a computerized rather than manual assessment tool is considered vital to encourage its uptake in the industry. Consequently, the next section provides a brief description of the development of the ATIPI in spreadsheet form.

Developing the computerized ATIPI

The development of the computerized ATIPI utilizes a widely recognized software package, Microsoft Excel™. Excel is a spreadsheet programme that has the robust capability to construct models using its built-in functions. The inputs of the aforementioned three elements were used to structure the model. The resulting tool comprises five tabs: overview; questionnaire survey; results; graph results; and summary report.

The introduction page is the default starting point of the tool, outlining the definition and function of the ATIPI model, as well as details on the origin of the assessment tool (see Figure 1).

When the user is ready to start entering data, they click the Start button at the bottom of the page and the user will be automatically taken to the Questionnaire Survey page. Alternatively they can click the Questionnaire Survey tab at the bottom of the screen. Before the user starts to key in the inputs from the survey, they need to enter some Background Information in the top half of the screen. This includes: first, the project name and details of the alliance team being assessed; second, the phase (e.g. planning, design, construction) of the project; and third, details of the user who performed the assessment (see Figure 3). Then, the user collects the information on the

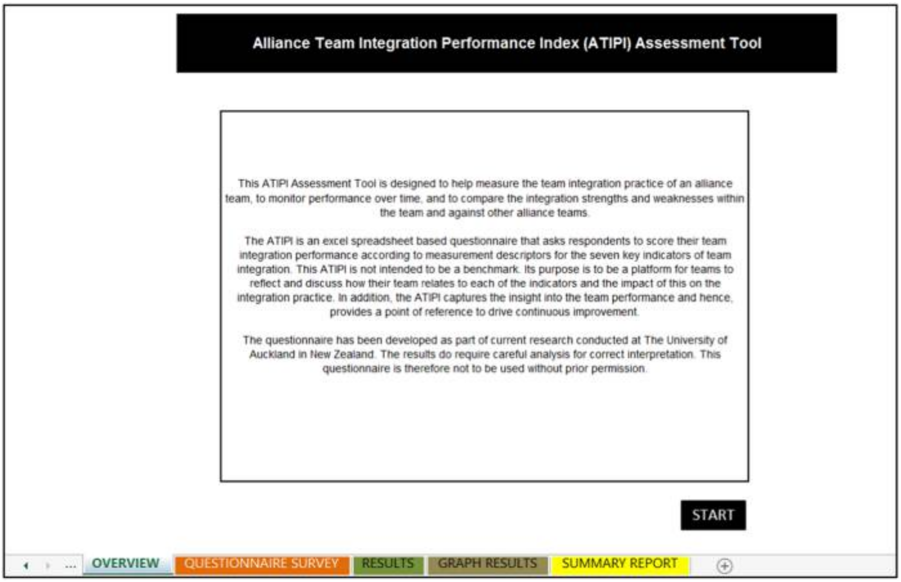

Figure 1.
Overview page of the ATIPI assessment tool

QM for each KI and, in bottom half of the screen, enters the respective score for each KI in the second column titled "your score" (see Figure 2).

Once the scores for the KIs have been inputted, each KI's performance level will automatically be shown in the final column (based on the range of scales for each of the five performance levels, as detailed in Table II). After all the necessary information on the survey has been recorded, the user can click on the Results tab to see the overall results of the integration performance for their alliance team (see Figure 3).

The overall performance level, titled "total", is calculated from the sum of the index values (shown in the final column). Each index value is calculated as the product of the normalized value (shown in column number 4) and the weightings of the respective KIs (see Equation (1)). For the ATIPI, the normalized units range from 1 (indicating "poor") to 5 (indicating "excellent"). In this section, one key indicator "Commitment from PAB" is calculated for illustration purposes. For example, the input for the key indicator "Commitment from PAB" is 85 per cent. In Table II, the value of 85 per cent lies within a range of 84 to 91 per cent which reflects "very good" performance. In the ATIPI, a level of very good performance is represented by the range value of 4-4.99. By using a basic mathematical linear equation, the exact value within the range of 4-4.99 was calculated. As a result, it can be determined that, when the recorded attendance of members in PAB meetings was 85 per cent, the normalized value of good performance is 4.143 (shown in column number 4 in Figure 3). In estimating the single index value for the Commitment from PAB, the value of 4.143 needs to be multiplied by 0.107, the corresponding weighted coefficient of the indicator. In order to estimate the overall

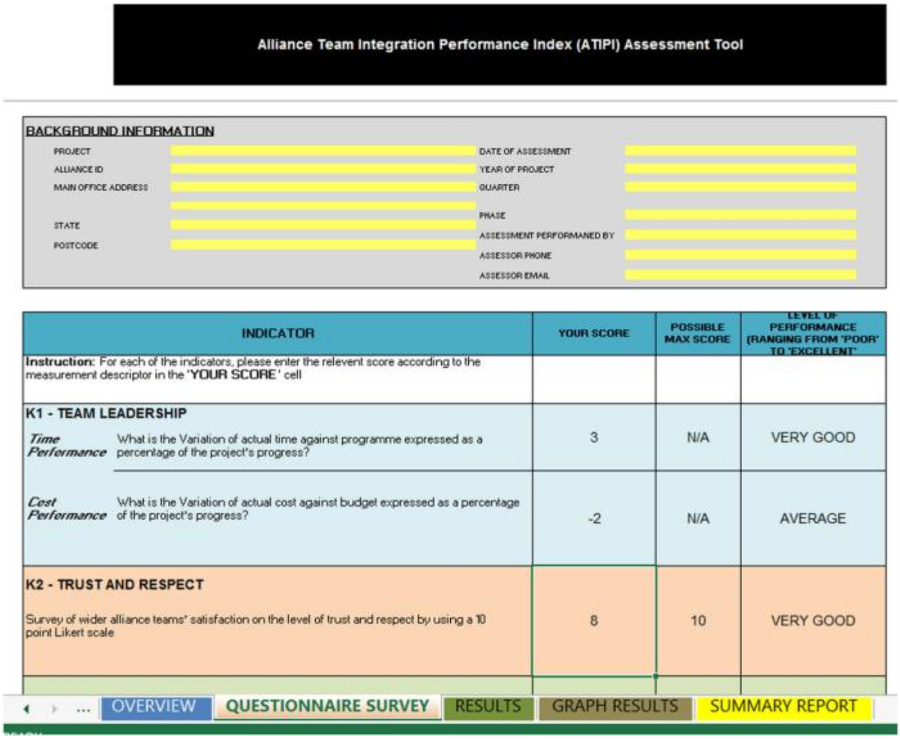

Figure 2. Data input on the background information and the questionnaire survey

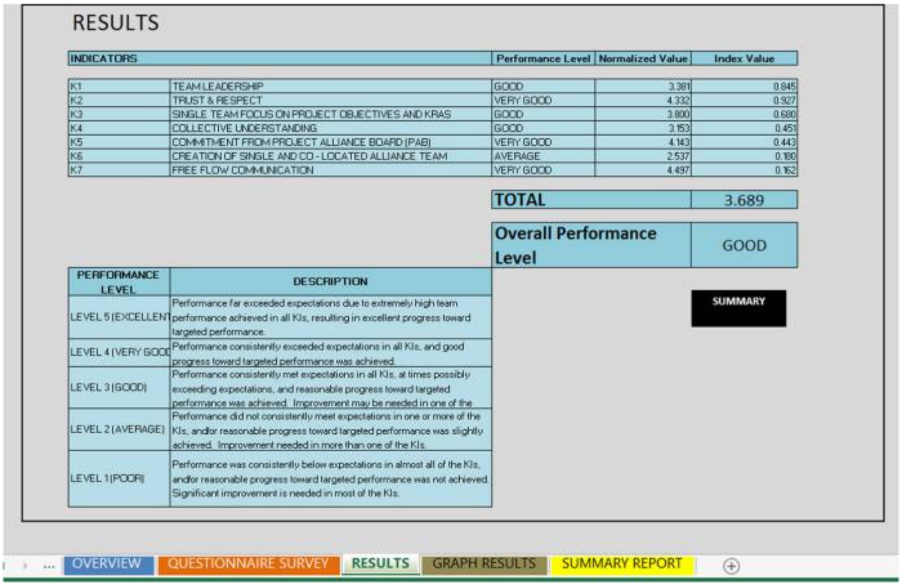

Figure 3.
The overall results page of the assessment tool

index value for the ATIPI, the exact performance level for each of the KIs needs to be calculated by similar steps as described in this paper.

A brief explanation of each performance level is provided below to assist the user with interpretation of the overall results of their performance. A score less than 2 represents "poor" performance, a score greater than or equal to 2 but less than 3 represents "average" performance, scores of 3 or greater but less than 4 and greater than 4 but less than 5 represent "good" and "very good" performance, respectively. Finally a score of 5 represents "excellent" performance in team integration practice.

Next, in order to represent the analysed data graphically, the user can click on the Graph Results tab to generate a spider web diagram (see Figure 4), which can be further analysed to compare the integration strengths and weaknesses within the team. A spider web diagram is graphical in nature and is easily understood due its ability to illustrate multiple dimensions simultaneously (Yang *et al.*, 2010). Hazir (2015) emphasized that any supporting tools for monitoring purposes should have a simplified and understandable method of presentation.

Alternatively, from the Results page (Figure 3), the user can just click the Summary Report button to go straight to the Summary Report page (see Figure 5) to see a summary of the assessment. The top left hand side of the page includes background information about the assessment, and the results of each of the seven KIs are shown below that, on the same side of the page. In addition, the overall ATIPI is presented on the top right hand side, and below the index is the spider web diagram showing the performance levels graphically. This summary report provides a structured representation of the performance information and can be used as a point of reference for further discussion with the team to drive continuous improvement.

The ATIPI excel spreadsheet was made available for download as open software via an established free file hosting website at the following link: www.mediafire.com/view/3p1jbkr76ctx8e0/ATIPI_Demo_Final_AiC.xlsx. The tool is still a prototype model and

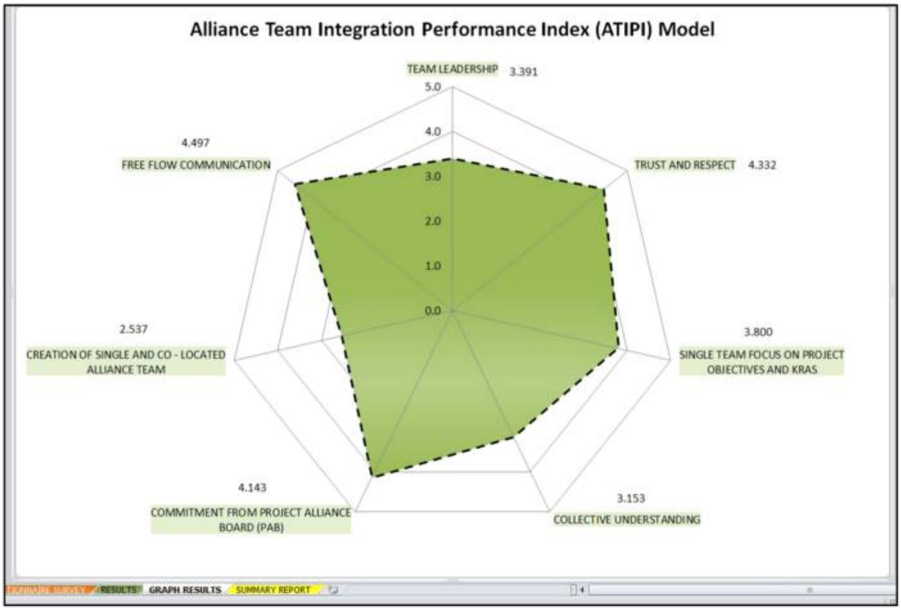

Figure 4. Graphical presentation of the assessment results

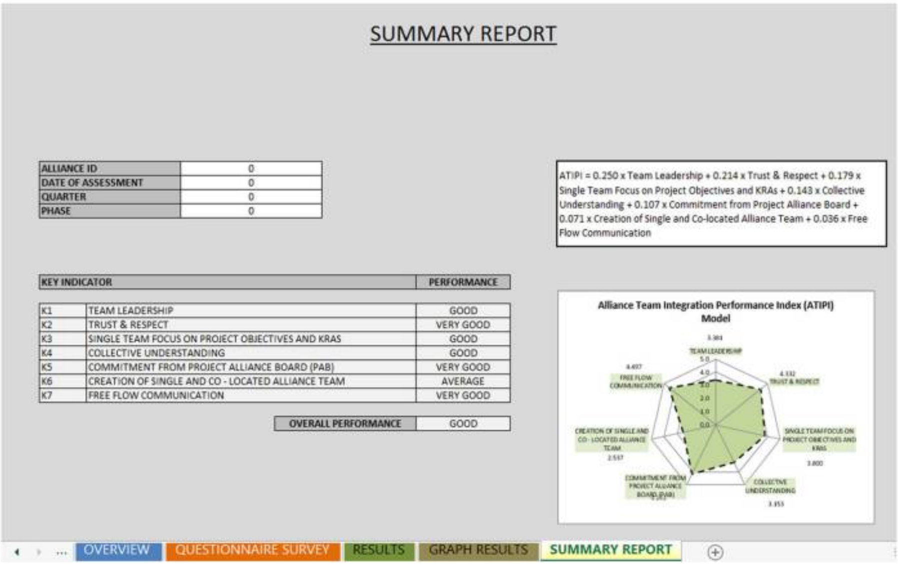

Figure 5. Summary report page of the ATIPI assessment tool

currently only allows entry of one set of assessment data. Future versions of the model will allow multiple assessments to be stored for a project, thereby allowing performance to be benchmarked over time. However, the tool does provide the first step in establishing a baseline for measuring the current state of integration performance of alliance teams.

Validation of the computerized ATIPI model

The validation process in construction research is a fundamental element of the process of scholarly endeavour (Lucko and Rojas, 2010). Consequently, the ATIPI model was validated using the face validity approach, through a structured interview technique. A total of 13 alliance experts were selected to participated in validating the model. These experts were selected based on two criteria: first, pertinent/relevant and verifiable previous experience in alliancing projects in New Zealand; and second, having recent/on-going and direct involvement on a Project Alliance Board (PAB) or Alliance Management Team (AMT).

Experts were asked to provide an evaluation of the ATIPI model based on five Likert scales for six validation aspects: first, degree of appropriateness: the relevancy of the KIs, QMs and ranges of scales for performance levels included in the ATIPI; second, degree of objectivity: the degree of objectivity in the assessment; third, degree of replicability: the ability of the tool to be replicated or used on other alliance projects; fourth, degree of practicality: the level of practicality of the tool to be used in actual alliance projects; five, overall reliability: the ability of the ATIPI to consistently perform its intended function; and six, overall suitability to be adopted as an assessment tool: the suitability of the ATIPI to be adopted as an assessment tool to measure the team integration performance of alliance teams.

Overall, it is worth noting that high ratings (mean rating $\geqslant$3.5) were achieved for all validation aspects. It should be highlighted that, in accordance with studies such as Yeung *et al.* (2009) and Ng and Skitmore (2014), mean ratings greater than 3.5 are adequate to warrant validation of a model. To summarize, the validation results have confirmed that the ATIPI model could assist in assessing the alliance team integration performance in road infrastructure projects. In addition, any variability in responses among experts did not affect the validation aspects of the ATIPI, as the responses were consistent based on statistical analysis.

Research method

To demonstrate the applicability of the model, case studies were performed on a variety of alliance projects. Based on Flyvbjerg's (2006) guidelines on strategies for case study selection, this study adopted a random selection approach. A stratified sample was used, as this study focused on selecting cases from different types of alliance projects and at different stages of completion. Initially, several potential alliance projects were identified by the authors for the exercise. From these, three case studies were examined based upon the following criteria: variation in project progress: each alliancing road construction project was unique and at a different stage of completion; variation of project location: the good geographical spread throughout New Zealand allowed for the influence of local environment and culture on implementing the working practices within the project alliance; and availability of resources: there was easy access to personnel, documents and information which was necessary for the investigative study.

The case study projects were identified in collaboration with the NZTA, who has been instrumental in promoting alliancing contracting in the New Zealand construction industry. Three case studies, referred to as Cases (1)-(3), were road infrastructure projects currently being undertaken or recently completed under the alliancing procurement approach at the time of this study. Table III shows the summary of the background information, the results of different KIs and the overall ATIPI of these three case studies.

	Case (1)	Case (2)	Case (3)
Project ID			
Assessment phases	First year of (Quarter 3) of project progress	Last quarter of project completion	Second year (Quarter 4) of project progress
Approx. Target Outturn Cost (NZD)	220 million	150 million	1.4 billion
Brief description of project	Upgrading motorway and stormwater infrastructure	Earthworks, expressway and bridges	Motorway, bridges and tunnel
Type of alliance	Pure	Competitive	Competitive
Numbers of NOPs	Five	Two	Six
Location	Auckland	Hamilton	Auckland
KIs			
Team leadership			
Time performance	12%	17.5%	0%
Cost performance	0%	1.6%	−8%
Trust and respect	9.5	9.5	8
Single team focus on project objectives and KRAs	5.5	9.5	8
Collective understanding	96%	90%	70%
Commitment from Project Alliance Board (PAB)	95.5%	100%	95.5%
Creation of single and co-located alliance team	96%	96%	65%
Free flow communication	3 days	1.5 days	4 days
ATIPI	4.309	4.798	3.540
Performance level	Very good	Very good	Good

Table III. Summary of the background information and the results of different KIs and overall ATIPI of three projects

A structured interview was used for data collection with representatives from each of the case studies. Initially, the development of the ATIPI was briefly explained. Then, a computerized ATIPI was presented in order to assist the representatives in providing the necessary inputs for each of the KIs. Apart from the representatives' own opinion and experience in providing the input, documentation such as project performance records; alliance health survey results (to help asses trust and respect and singe team focus on project objectives); attendance records (for assessing collective understanding and commitment from PAB); and staff records (to assess the co-location of the alliance team), were used to assist and support the actual data from the project. Each case evaluation was saved and later transcribed into a written summary. The summary for each case was sent to the respective interviewees for validation. The alliance practitioners involved are not individually identified in this study, due to confidentiality reasons, although the nature of their designation is described, along with details of each case study, in the following subsections.

Case (1)

This road infrastructure project represents the fifth competitive alliance project in New Zealand infrastructure investment. The Case (1) project comprises upgrading of approximately 4.2 km of twin three lane motorway. The project also widens and raises this section of the motorway, and safeguards it against future coastal erosion and flooding. The Case (1) alliance comprises of owner and five NOPs bringing together specialist skills, including engineering design, construction, and environmental protection. The Target Outturn Cost (TOC) of the project is $220 million. The Case (1) project was awarded in March 2013, the timetable for the project sees construction beginning in May 2013 and completed by late 2016. The assessment phase for Case (1) at the time of study was for the third-quarter of the first year of the project progress. The information gathered for this assessment was provided by the members of the AMT, specifically the consents assurance and key results manager and the quality assurance and systems manager. The results reveal, for the third-quarter of the first year of the project, the alliance team had a good level of team leadership, with the project 12 per cent ahead of schedule and still running on budget (0 per cent). The trust and respect score was 9.5 out of 10, while the score for single team focus on projects objectives and KRAs was 5.5 out of 10, indicating a poor performance. One possible explanation is that the alliance team were still trying to tighten the team focus on the KRAs. The collective understanding received a score of 96 per cent attendance at project briefings. A score of 95.5 per cent was recorded for PAB attendance in PAB meetings during the quarter assessed. The score for creation of single and co-located alliance team was 96 and the free flow communications score was within three days. As a result, the ATIPI score for the third-quarter of the first year of the project was 4.309 out of a total of 5, thus indicating a "very good" performance.

Case (2)

This is the eighth alliance (second under competitive alliance) that the NZTA has engaged, its premium delivery model for large, complex and risky projects where early collaborative involvement with designers and constructors is vital. This 8 km expressway with an original TOC of $150 million is jointly funded by the NZTA and local councils. The Case (2) project involves the construction of six bridges and two interchanges, as well as a 6.5 km expressway on a green field site. A 1.5 km stretch of two-lane road will be extended to four lanes to relieve traffic congestion. In addition to the construction of infrastructure, there will be 1.3 million cubic metres of earthworks completed, with two-thirds of it being imported fill material. The Case (2) alliance comprises of owner and two NOPs which includes the main contractor and consultant. The assessment phase for Case (2) at the time of the study was for the last quarter of the project completion. The information gathered for this assessment was provided by the alliance manager. Started in February 2010, Case (2) is an extremely successful alliancing project with high team leadership performance, it was constructed ahead of schedule by 17.5 per cent (project was completed in December 2012, seven months ahead of schedule) and the estimated budget under-run was 1.7 per cent (saving of 2.5 million out of 150 million). Trust and respect and single team focus on project objectives and KRAs both received scores of 9.5 out of 10. The collective understanding received a score of 90 per cent attendance. There was 100 per cent of PAB attendance in PAB meetings in the last quarter of the project completion. The score for creation of single and co-located alliance team was 96 per cent. In addition, the free flow communications score was within 1.5 days. One of the possible reasons for such fast response times was because of the co-location of the team and the location of the main office on the site. In summary, the ATIPI score for the last quarter of the project completion was at 4.798 out of a total of 5, thus indicating a "very good" performance.

Case (3)

The $1.4 billion Case (3) project is New Zealand's biggest and most complex road project undertaken by NZTA. The project involves a 4.8 km, six lane motorway connection that includes New Zealand's longest and deepest road tunnel. The project involved construction of 2.4 km of road tunnelling that used two parallel 14.1 m diameter tunnels, the tenth biggest ever used in the world. The Case (3) alliance comprises of owner and six NOPs which includes representatives from the main contractor, civil infrastructure contractor, civil consultant, mechanical and electrical consultant, and tunnel construction experts. Started in early 2012, the project will be completed by early 2017. The information gathered for this assessment was provided by the Sub Alliance Manager, Design Manager and Design Director. The results indicate that the alliance team had an average level of team leadership performance, with the project progressing on time (0 per cent), and it was estimated that it currently had an over-run cost of 8 per cent. The trust and respect score was eight out of ten, as was the score for single team focus on project objectives and KRAs. There was 70 per cent of alliance team attendance in project briefings to reflect the collective understanding. A score of 95.5 per cent was recorded for PAB attendance in PAB meetings during the quarter assessed, as one of the PAB members was unable to attend due to other work commitments. The score of creation of single and co-located alliance team was 65 per cent, which indicates poor performance. The low percentage of staff allocated on-site was due to the complexity of the project and the location of the project (situated in the business district and residential areas) which required the separation of the site offices. In addition, the free flow communications score was within four days. Overall, the ATIPI score for the fourth-quarter of the second year of the construction phase was 3.540 out of a total of 5, thus indicating a "good" team integration performance.

Cross-case analysis

Together, the three cases provide a brief explanation and understanding of the current status of their team integration performance. The variation in alliance team performance within and between the three case studies is graphically represented in Figure 6. The three case studies provide an interesting comparison of team integration performance. For some indicators, the alliance teams performed similarly, regardless of the phase of the project. For example, in the case of trust and respect and commitment from PAB, all alliance teams received high scores. This result is in line with the fact that trust is a critical element and precondition of successful alliances (Yeung *et al.*, 2007a; Walker *et al.*, 2015;

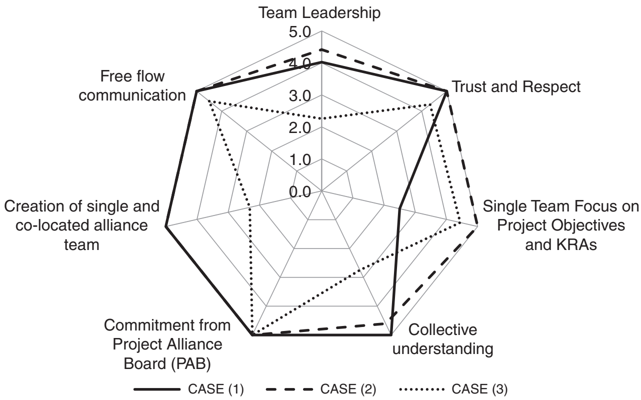

Figure 6.
The team integration performance of the three alliance project case studies

Walker and Lloyd-Walker, 2015) and closer integration between the alliance team and board members is critical to inspire the development of a committed, collaborative, collegial and cooperative culture at the heart of the alliance (Mills *et al.*, 2012).

For other indicators the alliance teams performed differently. For example, the alliance team in Case (1) performed better in terms of team leadership (reflecting the cost and time performance of the project) compared to the alliance team in Case (3). One possible reason Case (1) was on budget and ahead of schedule was because the Case (1) project was still in its infancy (e.g. just entering construction phase), whereas the Case (3) project was at a critical stage of construction. The exception to this pattern is Case (2), which showed strength of performance in the majority of the indicators where they received "very good" towards "excellent" levels of performance. This overall performance of Case (2) reflects the fact that the alliance team successfully delivered the project under TOC (saving around 2 per cent of original TOC) and seven months ahead of schedule. In addition to that, the Case (2) alliance team won the Regional Council's Erosion and Sediment Control Site of the Year Award for two consecutive years in 2011 and 2012 for consistent excellent standards, as well as commitment to best design and construction practices.

Another significant observation of the results is that the performance of creation of single and co-located alliance team appears to be correlated with the characteristics of the project. While Cases (1) and (2) achieved higher scores due to the fact that both projects have the main office at the site location, the Case (3) project has a number of project offices, resulting in a lower percentage of allocated staff on-site. In general, the establishment of project offices are normally dictated by the nature and characteristic of the project. For example, for Case (1) and Case (2), the size of the project and the number of project offices are much smaller than Case (3). In addition, the Cases (1) and (2) projects are located outside congested urban areas while the Case (3) project is located in New Zealand's largest urban area. Finally, Case (3) is by far the most complex, involving the construction of a tunnel. All of these factors contribute to the difficulty of locating in one specific place. The co-location factors could also affect the collective understanding (i.e. percentage of attendance at project briefings) and the free flow of communication (i.e. turnaround time for information) performance, resulting in a lower score for both indicators for Case (3). Designing and constructing such a complex project would require the co-location of a variety of expertise in order to develop a highly integrated team (Bygballe *et al.*, 2015). Creating spaces for multi-disciplinary project teams to have regular interactions and meetings, both formal and informal, helps create a sense of unity that will potentially result in effectiveness and responsiveness in decision making, as well as improving the lines of communication between operational (site) staff and head office (Chinowsky and Rojas, 2003; Tennant *et al.*, 2011). As emphasized by Chinowsky and Rojas (2003), persons who are part of the project team but separated geographically from other members of the team are less likely to establish the relationships and integrate effectively, and hence could lose focus of the overall goals and objectives of the project. Thamhain (2004) further stated that professionals who are unable to integrate could contribute to the communication barriers, decreasing the tolerance for conflict and risk taking, and the desire to succeed. The lower scores for these three indicators (i.e. collective understanding, co-location and communication) could potentially affect the current status of the Case (3) project performance (the project is on schedule but the cost over-run is about 8 per cent).

Another comparison is on the free flow communication. Across the cases, Case (3) received the highest turnaround time of information (i.e. four days) compared to the other cases. This could be due to the complexity of the project itself, as well as the size of the project teams, where the project has six NOPs with different expertise and from different countries. Case (2) in contrast, indicated that they only required 1.5 days for the turnaround time for information. Fast response of the information in Case (2) is because of the fact that their project team is small and co-located in one office. Several scholars (e.g. Mills *et al.*, 2012; Jefferies *et al.*, 2014) described that excellence in interaction and communication between alliance teams could enhance the intensity of integration performance.

Overall, the pattern shown by alliance teams in these three cases indicate that the performance of team integration varies due to factors such as the size and complexity of the project, as well as the characteristics of the alliance participants (e.g. the number of NOPs in a particular project and the number of experienced NOPs in the alliance). The previous degree of experience between the NOPs could also contribute to the performance results. Previous studies have shown that high levels of integration and closer interaction between alliance teams contribute to achieving better project performance (see Mills *et al.*, 2012; Walker *et al.*, 2015; Walker, 2015). The three case studies in this research indicated that in project alliances high levels of integrated performance are consistently fostered by the project teams to achieve the desired performance. This is a reflection of the significance of relationships and the commitment engendered by successful alliances.

Lessons from the application of the ATIPI on real life alliance projects

The assessment results across the case studies indicated that the ATIPI model shows great promise in assisting with the assessment of the alliance team integration performance in road infrastructure projects. It is worth noting that the ATIPI is not a direct measure of successful team performance, as a whole. Rather, it is a proactive management approach focused on measuring team integration performance consistently and objectively. However, it is worth highlighting that every performance model has its own limitations which can be exacerbated, unless methodological considerations are carefully followed and applied under suitable settings (Yang *et al.*, 2010). Across the cases, the interviewees said that the ATIPI model facilitated the project team to capture and monitor their current status of team integration performance, making it easier to get initial insight into their performance. Nevertheless, the interviewees stated there were some elements of the model that could be improved, in order to enhance the applicability of the model.

Notably, during the application exercise, the importance of having comprehensive coverage of QMs was emphasized by the interviewees as a key element in the ATIPI model. In particular, the interviewee from Case (3) stressed that more comprehensive QMs need to be incorporated as it is difficult to justify on how a single QM could directly measure what can be a complicated KI. This is a potential limitation of the ATIPI model, in that certain aspects of the KI may not be captured effectively with just one QM. The issue on the capacity to have more than one QM for each KI is desirable based on comments by interviewees, as it may provide greater coverage of the influencing factors for the KI. For example, the establishment of a lead and lag QM, with a combination of quantitative and qualitative measures, if applicable, for each KI would help to enhance the characteristics of the assessment tool. Yeung *et al.* (2013) stated that the ability to incorporate leading and lagging performance indicators will provide early warnings, identifying possible problems that could lead to opportunity for organizational change. In particular, the interviewee from Case (3) suggested that the measure of cost and schedule performance could fully represent the team leadership as a lag measure, but that and the need for a lead measure for team leadership could be more important as this indicator is more abstract and harder to quantify. As Grint (2005) stated, the basic definition of leadership has yet to be agreed, let alone whether it can be measured, despite vast research into the application of leadership skills to project teams (Walker, 2015). Nevertheless, the interviewees believe that while the recommended QMs covered the range of possibilities of appropriate QMs, the final selection of the QMs for inclusion in the ATIPI may have been influenced by the experience of the alliance experts (participants in the development of ATIPI) in measuring such an indicator in their alliance projects.

In general, the interviewees stressed that despite the ability of the model to provide an insight towards their integration performance, the incorporation of suggestions for continuous improvement for each KI into the model would be beneficial to the team, as well as top management, as it could also provide a point of reference for managing the least performing KIs. This could be improved by adding more empirical evidence which implies more engagement in a longitudinal research project to determine if intangible and tangible factors, that might affect the integration performance, could be identified. Such studies would help to refine the measurement indicators or reveal other key indicators which can impact on team integration and isolate the lessons learned and best practices from different types of alliances.

In addition, the interviewees in all cases acknowledged that although the development of the ATIPI into an online model is beyond the scope of this study, they recommended that further enhancement of the model's functionality with more adaptive capabilities and the establishment of an integrated online-based platform is established. Thus, the accessibility of the model would be greatly improved and the administration of the domain knowledge of the model can be enhanced. Furthermore, the enhanced ability to collect and disseminate performance data instantly will allow performance benchmarking to evolve to the point where organizations can obtain comparison performance data for benchmarking either for internal or external entities (Maleyeff, 2003).

Limitations of the study and future research

Although there is strong evidence from the case studies that the ATIPI has the potential to function as an assessment tool to aid in the measurement of the current state of alliance team integration performance, the difficulty lies in gauging the extent of the empirical results due to the limited sample of three alliance road infrastructure projects in New Zealand. As such, the findings of this study may not represent the views of the entire construction industry.

For the ATIPI to become a powerful benchmarking tool and provide a comprehensive database of team integration performance, information from many more alliance projects is required. Such information is best gathered through widespread use of the tool. For this to realistically happen, the ATIPI needs to be developed into a web-based application whereby the data from all participants are stored for benchmarking purposes. Such a database would be extremely valuable and beneficial for owner and NOPs, for benchmarking purposes. Future research could also focus on incorporating the lessons learned from the tool's application (e.g. coverage of QMs and accessibility) in order to enhance the applicability of the tool as well as improving the characteristics of the tool.

Finally, although the developed ATIPI is designed for measuring team integration performance in alliance projects, future research could focus on other types of relationship-based procurement approaches (e.g. partnering and IPD projects) by using the same methodologies, and then comparing the similarities and differences of the KIs, QMs and the range of scales of performance levels.

Conclusions

The ATIPI aims to provide the means to assess alliance team integration consistently and objectively over the lifecycle of projects. The application of the ATIPI to case studies demonstrated its merit as an assessment tool, enabling alliance teams to self-diagnose, which is much needed by industry to assist in measuring how team integration changes over time. The findings across the case studies illustrate how the ATIPI model unfolds the current state of team integration performance in alliance projects as the project team seeks to cultivate an integrated spirit, foster learning and increase the awareness of their integration performance. The usage of the model facilitates prompt managerial response to the strengths and weaknesses of their team's performance, and enables them to plan ahead for the improvement process. In all three cases, the performance of team leadership, trust and respect, single team focus on project objectives and KRAs, collective understanding, commitment from PAB, creation of single and co-located alliance team, free flow communication were considered high, providing evidence that high levels of integrated performance is consistently fostered by the project teams over the lifecycle of projects.

Furthermore, because of constraints due to the characteristics of the model, some improvements and fine tuning were suggested to further enhance the reliability and applicability of the model. It is further suggested that a process of continuous improvement and enhancement of the ATIPI is required, as alliance teams become more familiar with the ATIPI, their own teams, and the specific characteristics of their alliance projects. These will help improve not only the current ATIPI, but also act as a point of reference for development of any performance evaluation models, as well as add knowledge to our current empirical understanding of performance evaluation.

References

Aapaoja, A., Herrala, M., Pekuri, A. and Haapasalo, H. (2013), "The characteristic of and cornerstones for creating integrated teams", *International Journal of Managing Projects in Busniess*, Vol. 6 No. 4, pp. 695-713.

Baiden, B.K., Price, A.D.F. and Dainty, A.R.J. (2006), "The extent of team integration within construction projects", *International Journal of Project Management*, Vol. 24 No. 2, pp. 13-23.

Bresnen, M. and Marshall, N. (2000), "Partnering in construction: a critical review of issues, problems and dilemmas", *Construction Management and Economics*, Vol. 18 No. 2, pp. 229-237.

Bygballe, L.S., Dewulf, G. and Levitt, R.E. (2015), "The interplay between formal and informal contracting in integrated project delivery", *Engineering Project Organization Journal*, Vol. 5 No. 1, pp. 22-35.

Chen, G., Zhang, G., Xie, Y.M. and Jin, X.H. (2012), "Overview of alliancing research and practice in the construction industry", *Journal of Architectural Engineering and Design Management*, Vol. 8 No. 2, pp. 103-119.

Cheung, S.O., Suen, H.C.H. and Cheung, K.K.W. (2003), "An automated partnering monitoring system – partnering temperature index", *Automation in Construction*, Vol. 12 No. 3, pp. 331-345.

Chinowsky, P.S. and Rojas, E.M. (2003), "Virtual teams: guide to successful implementation", *Journal of Management in Engineering*, Vol. 19 No. 3, pp. 98-106.

Flyvbjerg, B. (2006), "Five misunderstandings about case-study research", *Qualitative Inquiry*, Vol. 12 No. 2, pp. 219-245.

Grint, K. (2005), "Problems, problems, problems: the social construction of leadership", *Human Relations*, Vol. 58 No. 11, pp. 1467-1494.

Hauck, J., Walker, D.H.T., Hampson, K.D. and Peters, R.J. (2004), "Project alliancing at national museum of Australia – collaborative process", *Journal of Construction Engineering and Management*, Vol. 130 No. 1, pp. 143-152.

Hazir, Ö. (2015), "A review of analytical models, approaches and decision support tools in project monitoring and control", *International Journal of Project Management*, Vol. 33 No. 4, pp. 808-815.

Ibrahim, C.K.I., Costello, S.B. and Wilkinson, S. (2013a), "Development of a conceptual team integration performance index for alliance projects", *Construction Management and Economics*, Vol. 31 No. 11, pp. 1128-1143.

Ibrahim, C.K.I., Costello, S.B. and Wilkinson, S. (2014), "Establishment of quantitative measures for team integration assessment in alliance projects", *Journal of Management in Engineering*, Vol. 31 No. 5, p. 04014075, available at: http://dx.doi.org/10.1061/(ASCE)ME.1943-5479.0000318

Ibrahim, C.K.I., Costello, S.B. and Wilkinson, S. (2015a), "A fuzzy approach for developing the scales of the performance levels of alliance team integration assessment", *Journal of Construction Engineering and Management*, Vol. 141 No. 5. doi: 10.1061/(ASCE)CO.1943-7862.0000958, 04014094.

Ibrahim, K.I., Costello, S.B. and Wilkinson, S. (2013b), "Key practice indicators of team integration in construction projects: a review", *Team Performance Management*, Vol. 19 Nos 3/4, pp. 132-152.

Ibrahim, K.I., Costello, S.B. and Wilkinson, S. (2015b), "Key indicators influencing the management of team integration in construction projects", *International Journal Managing Projects in Business*, Vol. 8 No. 2, pp. 300-323.

Jefferies, M., Brewer, G.J. and Gajendran, T. (2014), "Using a case study approach to identify critical success factors for alliance contracting", *Engineering, Construction and Architectural Management*, Vol. 21 No. 5, pp. 465-480.

Korkmaz, S.M., Swarup, L. and Riley, D. (2013), "Delivering sustainable, high-performance buildings: influence of project delivery methods on integration and project outcomes", *Journal of Management in Engineering*, Vol. 29 No. 1, pp. 71-78.

Laan, A., Voordijk, H. and Dewulf, G. (2011b), "Reducing opportunistic behaviour through a project alliance", *International Journal of Managing Projects in Business*, Vol. 4 No. 4, pp. 660-679.

Laan, A., Noorderhaven, N., Voordijk, H. and Dewulf, G. (2011a), "Building trust in construction partnering projects: an exploratory case-study", *Journal of Purchasing & Supply Management*, Vol. 17 No. 2, pp. 98-108.

Lahdenperä, P. (2012), "Making sense of the multi-party contractual arrangements of project partnering, project alliancing and integrated project delivery", *Construction Management and Economics*, Vol. 30 No. 1, pp. 57-79.

Lam, E.W.M., Chan, A.P.C. and Chan, D.W.M. (2007), "Benchmarking the performance of design-build projects: development of project success index", *Benchmarking: An International Journal*, Vol. 14 No. 5, pp. 624-638.

Love, P.E.D., Mistry, D. and Davis, P.R. (2010), "Price competitive alliance projects: identification of success factors for public clients", *Journal of Construction Engineering and Management*, Vol. 136 No. 9, pp. 947-956.

Love, P.E.D., Irani, Z., Cheng, E.W.L. and Li, H.A. (2002), "Model for supporting inter-organizational relations in the supply chain", *Engineering Construction and Architectural Management*, Vol. 9 No. 1, pp. 2-15.

Lucko, G. and Rojas, E.M. (2010), "Research validation: challenges and opportunities in the construction domain", *Journal of Construction Engineering and Management*, Vol. 136 No. 1, pp. 127-135.

Maleyeff, J. (2003), "Benchmarking performance indices: pitfalls and solutions", *Benchmarking: An International Journal*, Vol. 10 No. 1, pp. 9-28.

Menches, C. and Hanna, A. (2006), "Quantitative measurement of successful performance from the project manager's perspective", *Journal of Construction Engineering and Management*, Vol. 132 No. 12, pp. 1284-1293.

Mills, A., Walker, D. and Lloyd-Walker, B. (2012), "Developing infrastructure projects using alliances", in Stork, D.G. (Ed.), *Proceedings of the 56th AACE International Annual Meeting, WV, 8-11 July*, pp. 1-17.

Ng, S.T. and Skitmore, M. (2014), "Developing a framework for subcontractor appraisal using a balanced scorecard", *Journal of Civil Engineering and Management*, Vol. 20 No. 2, pp. 149-158.

Ng, T.S., Cheng, K.P. and Skitmore, R.M. (2005), "A framework for evaluating the safety performance of construction contractors", *Building and Environment*, Vol. 40 No. 10, pp. 1347-1355.

Reed, H. and Loosemore, M. (2012), "Culture shock of alliance projects", in Smith, S.D. (Ed.), *Procs 28th Annual ARCOM Conference, 3-5 September*, Association of Researchers in Construction Management, Edinburgh, pp. 543-552.

Rooney, G. (2009), "Project alliancing: the process architecture of a relationship based project delivery system for complex infrastructure projects", available at: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1809267 (accessed 6 January 2015).

Senaratne, S. and Hewamanage, P.R. (2015), "The role of team leadership in achieving LEED certification in a green building project", *Built Environment Project and Asset Management*, Vol. 5 No. 2, pp. 170-183, available at: http://dx.doi.org/10.1108/BEPAM-09-2013-0036

Tennant, S., Langford, D. and Murray, M. (2011), "Construction site management team working: a serendipitous event", *Journal of Management in Engineering*, Vol. 27 No. 4, pp. 220-228.

Thamhain, H.J. (2004), "Linkages of project environment to performance: lessons for team leadership", *International Journal of Project Management*, Vol. 22 No. 7, pp. 533-544.

Walker, D., Harley, J. and Mills, A. (2015), "Performance of project alliancing in Australiasian: a digest of infrastructure development from 2008-2013", *Construction Economics and Building*, Vol. 15 No. 1, pp. 1-18.

Walker, D.H.T. (2015), "Risk managing complex projects through alliancing", *Journal of Modern Project Management*, Vol. 2 No. 3, pp. 9-17.

Walker, D.H.T. and Jacobsson, M. (2014), "A rational for alliancing within a public-private partnership", *Engineering, Construction and Architectural Management*, Vol. 21 No. 6, pp. 648-673.

Walker, D.H.T. and Lloyd-Walker, B.M. (2015), *Collaborative Project Procurement Arrangements*, Project Management Institute, Newtown Square, PA.

Xia, B. and Chan, A.P.C. (2012), "Measuring complexity for building projects: a Delphi study", *Engineering, Construction and Architectural Management*, Vol. 19 No. 1, pp. 7-24.

Yang, H., Yeung, J.F.Y., Chan, A.P.C., Chiang, Y.H. and Chan, D.W.M. (2010), "A critical review of performance measurement in construction", *Journal of Facilities Management*, Vol. 8 No. 4, pp. 269-284.

Yeung, J.F.Y., Chan, A.P.C. and Chan, D.W.M. (2007a), "The definition of alliancing in construction as a Wittgenstein family-resemblance concept", *International Journal of Project Management*, Vol. 25 No. 3, pp. 219-231.

Yeung, J.F.Y., Chan, A.P.C. and Chan, D.W.M. (2008), "Establishing quantitative indicators for measuring the partnering performance of construction projects in Hong Kong", *Construction Management and Economics*, Vol. 26 No. 3, pp. 277-301.

Yeung, J.F.Y., Chan, A.P.C. and Chan, D.W.M. (2009), "Developing a performance index for relationship-based construction projects in Australia: Delphi study", *Journal of Management in Engineering*, Vol. 25 No. 2, pp. 59-68.

Yeung, J.F.Y., Chan, A.P.C., Chan, D.W.M. and Li, L.K. (2007b), "Development of a partnering performance index (PPI) for construction projects in Hong Kong: a Delphi study", *Construction Management and Economics*, Vol. 25 No. 12, pp. 1219-1237.

Yeung, J.F.Y., Chan, A.P.C., Chan, D.W.M., Chiang, Y.H. and Yang, H. (2013), "Developing a benchmarking model for construction projects in Hong Kong", *Journal of Construction Engineering and Management*, Vol. 139 No. 6, pp. 705-716.

Zhang, L., He, J. and Zhou, S. (2013), "Sharing tacit knowledge for integrated project team flexibility: case study of integrated project delivery", *Journal of Construction Engineering and Management*, Vol. 139 No. 7, pp. 795-804.

Further reading

Lendrum, T. (2011), *Building High Performance Business Relationships: Rescue, Improve, and Transform Your Most Valuable Assets*, 1st ed., Wiley, Milton, Queensland.

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