MEASURING THE ASSOCIATIONS BETWEEN COLLABORATIVE WORKING AND PROJECT PERFORMANCE

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There is evidence that higher degrees of collaborative working can produce more successful project performance, but there is only limited research to systematically examine the specific associations between collaborative working and project performance. In particular, there is a lack of exploration of appropriate approaches to test these associations. In order to test these associations in an appropriate approach, the concepts of collaborative working and project performance in this research are transformed into a measurable form in terms of the philosophy of AHP (analytic hierarchy process). In the process of measurement design for collaborative working and project performance, a Likert Scale is adopted. After refining the final measures through unidimensionality and reliability testing, as a part of PhD study, this paper presents the results of the association exploration between collaborative working and project performance. The produced conclusion is strongly supporting that there is a strong positive linear relationship between collaborative working and project performance.

Keywords: collaborative working, measurement, project performance, association.

INTRODUCTION

'Collaborate' Basically means working together and collaborative working is defined by Wu *et al.* (2008) as 'client and contractor jointly working together for mutual advantage, through which they can achieve greater benefits than by working separately'. In this research, collaborative working occurring in the traditional project procurement approach (e.g. competitive tendering) is referred to as 'traditional collaborative working' in which lots of criticism has been received because of cost and programme over-runs, poor quality and performance and a multitude of disputes. In recent years, there is a move from traditional, arms-length, contractual approaches towards more collaborative ones (e.g. partnering, alliancing etc.) which is called 'neo-collaborative working' in this research. It has been argued that, compared with the traditional competitive tendering, more collaborative approaches (e.g. partnering) can produce a substantial positive impact on project performance not only with regard to time, cost and quality objectives but also with regard to more general outcomes (e.g. greater innovation and improved user satisfaction) (CII, 1989; NEDO, 1991; Bennett and Jayes, 1995, 1998; Black *et al.*, 2000; Bresnen and Marshall, 2000a; Li *et al.*, 2001; Chan *et al.*, 2003). However, as Bresnen and Marshall (2002) argued, the most of the previous research is focused on benefits caused by reinforcing collaborative working (e.g. partnering) and being replete with case study examples of successful

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partnerships and alliances. Wood (2005) further argues that just focusing on the successes can disguise real problems and give a false impression of the contribution that collaborative working can actually make. Therefore, there is a need to systematically examine the impact of collaborative working on project performance in a more appropriate approach, which is the main aim of this research. In order to do so, associations between collaborative working (CW) and project performance (PP) are explored firstly based on previous research and then tested by correlation and regression analysis.

ASSOCIATIONS BETWEEN COLLABORATIVE WORKING AND PROJECT PERFORMANCE

In the traditional project procurement process, it is more likely to produce a low degree of collaborative working because project is normally procured in a competitive way and the involved parties are normally in a short term or one-off relationship which is defined by Sako (1992) as Arm's-length Contractual Relation (ACR). ACR normally is characterised by specific discrete transactions where there is no mutual trust and commitment. Therefore, it is less likely for client and contractor to make the current concession for future benefits. In this case, it is difficult to build or maintain a good or harmonious business relationship. In contrast, in the more collaborative project procurement process, it is more likely to produce a high degree of collaborative working because project is normally procured in a collaborative approach and the involved parties are normally in a long term relationship which is defined by Sako (1992) as Obligational Contractual Relation (OCR). OCR is typified by a high degree of interdependence, trust and mutual benefits. Therefore, in this case, it is more likely for client and contractor to consider long term benefits and build a more collaborative relationship.

Thus, collaborative working in this research does not refer to a single format but a range from the low to high degree of collaborative working. There has been evidence indicating that different degrees of collaborative working will produce different levels of project performance. Arguably, a lower degree of collaborative working (e.g. traditional tendering) is more likely to produce a lower level of project performance; a higher degree of collaborative working (e.g. partnering/alliancing) is more likely to produce a higher level of project performance. For example, Larson (1995) makes an investigation of 280 construction projects. He divides those 280 projects into four groups, namely adversarial (78), guarded adversarial (66), informal (77) and formal partnering (59). He finally discovers that the projects managed in an adversarial fashion have the lowest level of performance, followed by those using the guarded approach, the informal partnering approach, and finally the partnering approach, which has the best level of performance. More recent research by Phua and Rowlinson (2004) also identifies that collaborative working has very positive impacts on project cost, time and quality. Therefore, in this research, it is assumed that project performance is positively associated with collaborative working. Their relationships have been described in figure 1.

There are four grids in figure 1. A notional mean value of collaborative working and project performance is used as a reference line (see figure 3). Theoretically, collaborative working is positively associated with project performance, which can be reflected by Grid1 and Grid3. However, it has also been argued that the low degree of collaborative working (e.g. traditional tendering) does not necessarily result in poor performance and the high degree of collaborative working (e.g. partnering) cannot

guarantee effective performance (Green and McDermott, 1996; Bresnen and Marshall, 2000b). So, Grid2 and Grid4 represent the possible abnormal cases, however rare.

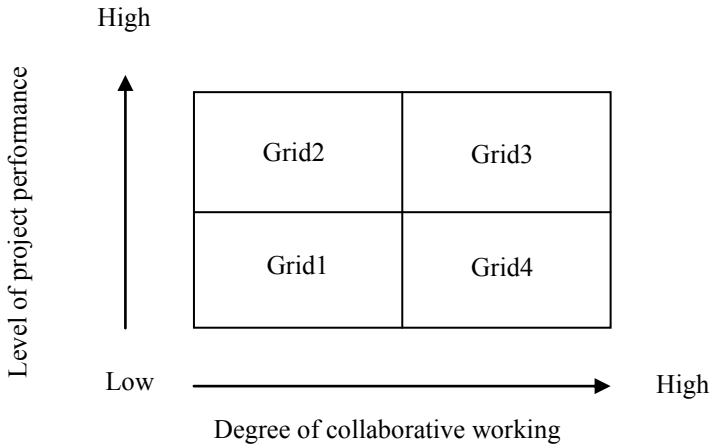

Figure 1 Collaborative working and project performance

In the exploration of association between collaborative working and project performance, correlation and regression analysis are conducted. Correlation analysis is used to evaluate the strength and direction of a correlated relationship between two variables. Regression analysis is then be used to explore any possible cause-effect relationship which indicates how well some variables (independent ones) are combined to explain the other variables (dependent ones). In order to facilitate the association-exploring, measurement of collaborative working and project performance is designed in the following section.

MEASUREMENT DESIGN

At the first step of measurement design, as De Vaus (2002) suggested, if the concepts are not able to be measured directly they need to be transformed into a measurable form. Therefore, the philosophy of analytic hierarchy process (AHP) is used in this research. AHP is referred to by Saaty (1980) as breaking a problem down into sub-problems and then aggregating the solutions of all the sub-problems into a conclusion. Applying the philosophy of AHP into measurement design, the two key concepts (collaborative working and project performance) are broken down into different indicators. Furthermore, each indicator such as trust, commitment (for collaborative working) and cost (for project performance) is broken down into different items (item statements) (see figure 2).

Based on those items, item statements are developed. The respondents from the target projects are invited to evaluate the collaborative working with their counterparts and project performance by showing the extent of their disagreement or agreement (from 1 to 7) on those item statements. This approach to measure collaborative working and project performance is described as a ‘Likert Scale’. For the details of measurement design, please see the paper by Wu and Udeaja (2008). In figure 2, there are total 14 attributes of collaborative working (9 positive attributes and 5 negative attributes) and 6 indicators of project performance. Positive attributes are used to evaluate the positive aspects of collaborative working and negative attributes are used to evaluate the negative aspects of collaborative working. Those attributes or indicators are viewed as variables in the following data analysis.

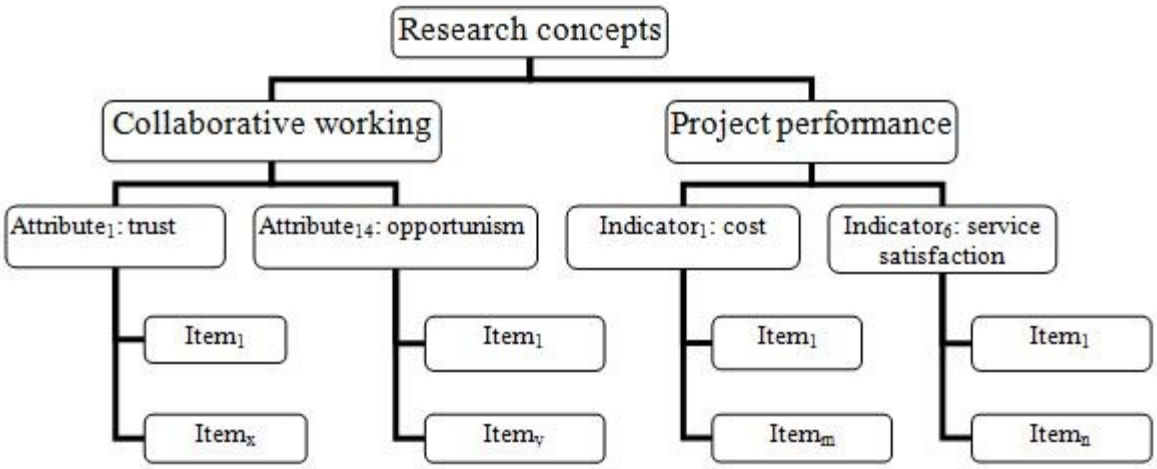

Figure 2 Utilisation of analytic hierarchy process in measurement design

STRATEGY OF DATA COLLECTION

Based on the item statements, a questionnaire is devised. After pilot study, the validity of questionnaire is improved. The questionnaire is administered mainly by the semi-structured interview. The target respondents are project managers or their equivalent. If the respondents are not available for interviews, questionnaires will be sent to them by email. After sending out the questionnaire, a reminder is sent after 2 or 3 weeks. Finally, 44 projects have been investigated. After finishing data collection, those measures used to evaluate collaborative working and project performance have been refined by reliability and unidimensionality analysis. The following analysis is based on the measures which have been refined and purified.

RESULTS OF CORRELATION ANALYSIS

As a part of association exploration, correlation analysis is used to evaluate the linear relationship between two variables (Pallant, 2007). The correlation coefficient (r) takes value from +1 to -1: '+' means a positive correlation and '-' means a negative correlation. As argued by Pallant (2007) through citing Cohen's (1988) work, there is a guide to interpret the value of correlation coefficients: small r = 0.10 to 0.29; middle r = 0.30 to 0.49 and large r = 0.50 to 1.0. The results of correlation analysis between attributes of collaborative working (CW) and project performance presented below are only focused on the stronger correlated relationship (i.e. r = 0.50 to 1.0) (see table 1).

In particular, the correlation coefficient r between collaborative working (summed scores of its attributes) and project performance (summed scores of its indicators) is 0.784 (p=0.01), which supports the hypothesis that project performance is strongly and positively correlated with collaborative working.

Table 1: results of correlation analysis

Project performance	Attributes of CW strongly correlated with project performance
Cost performance	Positively correlated with win/win (r=0.555), communication (r=0.506), mutual understanding/respect (r=0.534), problem solution (r=0.63) and sharing of risk and benefit (r=0.71); negatively correlated with problems and disputes (r=-0.683) and opportunism (r=-0.533).
Time performance	Positively correlated win/win (r=0.523), mutual understanding/respect (r=0.554), problem solution (r=0.661), sharing of risk and benefit (r=0.707) and innovation (r=0.551); and negatively correlated with problems and disputes (r=-0.537) and shortsightedness (r=-0.505).
Safety performance	Positively correlated with win/win (r=0.612) and problem solution (r=0.595); no negative attributes strongly and negatively correlated with safety performance.
Defects performance	No attributes strongly correlated with defects performance
Production satisfaction	No positive attributes strongly correlated with product satisfaction; strongly and negatively correlated with opportunism (r=-0.5).
Service satisfaction	Positively correlated with communication (r=0.785), win/win (r=0.685), mutual understanding (r=0.59) and problem solution (r=0.529); negatively correlated with shortsightedness (r=-0.532) and selfishness (r=-0.557).
Project performance (summed scores of its attributes)	Positively correlated with trust (r=0.536), win/win (r=0.673), mutual understanding (r=0.658), communication (r=0.649), problem solution (r=0.676) and sharing of risk and benefit (r=0.633); negatively correlated with shortsightedness (r=-0.6), problems and disputes (r=-0.587), selfishness (r=-0.581) and opportunism (r=-0.582).

Note: for Pearson r in table 1, all p value is 0.01.

RESULTS OF REGRESSION ANALYSIS

Table 2: Results of regression analysis

Entered variables	Coefficient value in the below regression models						
	Cost	Time	Safety	Defects	PS	SS	PP
RB	0.372	0.325	-0.229		0.246		1.176
ProDis	-0.361						-0.908
Communication	0.248	0.188				0.709	1.849
Innovation		0.292					
InterDP		-0.103					
Winwin			0.223			0.294	
ProbSol			0.357				
ShortSighted				-0.336			
Opportunism					-0.33		
Commitment					-0.289		
Constant	2.690	1.668	4.173	6.338	7.127	Unused (P>0.05)	19.205
R2	0.67	0.661	0.544	0.183	0.397	0.686	0.649

Note: RB: sharing of risk and benefit; ProDis: problems and disputes; Innovation: innovation/creativity; InterDP: interdependence; Winwin: win/win philosophy; ProbSol: problem solution; Shortsighted: shortsightedness; PS: product satisfaction; SS: service satisfaction; PP: project performance (the summed score).

This section addresses the cause-effect relationship between collaborative working and project performance. 'Stepwise' regression is first used to explore how well the attributes of collaborative working are combined to explain project performance (summed scores) and its indicators since stepwise procedure can produce a best-fit

model through adding those variables which can significantly improve the amount of variance accounted for and removing those insignificant variables (Greenwood, 2001). Meanwhile, the most important determinants for each project performance indicator and the whole project performance are identified. Through 'stepwise' regression, seven regression formulae are produced. All seven regression formulae have a very high significance level and in all cases the issue of collinearity has been considered. The related coefficients, constants and the corresponding value of R2 are summarised in the below table.

In table 2, model cost, time, safety, SS and PP are stronger since they all have a higher value of R2, which means they could give the more reliable prediction and estimation if performance cannot be directly evaluated. Between those regression models, the highest value of R2 is from model SS in which 68.6% variance of SS can be explained by 'Communication' and 'Win/win'. This is reasonable since a win/win attitude and effective and timely communication can benefit service satisfaction indeed. In model cost, its 67% variance can be explained by 'RB', 'ProDis' and 'Communication' although 'ProDis' is making a negative contribution. It is believed that a fair arrangement of risk and benefit allocation might be the biggest motivation to encourage the contractor to control cost performance, and if problems and disputes are not sorted out appropriately it will negatively affect the cost control. Moreover, there will be no big surprise on cost performance if client and contractor can communicate with each other effectively and timely. In model time, its 66.1% variance can be explained by the entered independent variables. Likewise, a fair arrangement of risk and benefit allocation might encourage contractor to control time performance. The effective and timely communication and more innovation/creativity can facilitate the time control. Interestingly, interdependence is making a negative contribution into model time, which is worthwhile to make further research. The fourth one is model PP in which 64.9% variance of PP can be explained by 'RB', 'ProDis' and 'Communication' although 'ProDis' is making a negative contribution. This indicates the whole project performance can be largely affected by the extent of the fairness of risk and benefit allocation and by the quality of communication. Meanwhile, if problems and disputes are not resolved appropriately project performance will be negatively affected. In model safety, its 54.4% variance can be explained by the entered independent variables. It indicates that a win/win attitude and a good problem solution can benefit the safety performance. Interestingly, 'sharing of risk and benefit' is making a negative contribution into model safety, which may need further exploration. Another two models (Defects and PS) are a little weaker due to the low value of R2, which means the prediction by them is less reliable. Noticeably, commitment is also making a negative contribution to model PS, which may need further research. In the above description, all the mentioned independent variables should be given more consideration when the related performance is emphasised. In particular, in terms of the frequency of entering into the regression model (RB is entered 5 times; communication is entered 4 times; ProDis and win/win are entered twice), client and contractor are suggested to pay more attention to develop and implement a fair arrange of risk and benefit allocation, to communicate with each other effectively and timely, to control the range/scope of problems and disputes and to bear a win/win philosophy in mind when only limited resource is available for the company.

In the process of exploring how well project performance (summed scores) can be explained by collaborative working (summed scores), 'enter' regression is conducted

since collaborative working is the only independent variable. When the summed score of collaborative working is used the scores of its negative attributes are reversed. Regression formula is listed as follows:

Project performance = 10.014+ 0.303*Collaborative working + ε (an unexplained residual factor) (formula 1)

In this formula, the value of R2 is 0.615, and this means 61.5% variance of project performance is explained by collaborative working. Meanwhile, formula 1 has a very high significance level (P=.000). Formula 1 is also placed on figure 3 as a 'fit line' (scatter plot is produced in terms of the score of collaborative working and project performance), which indicates the main pattern of data distribution. By formula 1, the level of project performance could also be predicted reliably in terms of the degree of collaborative working.

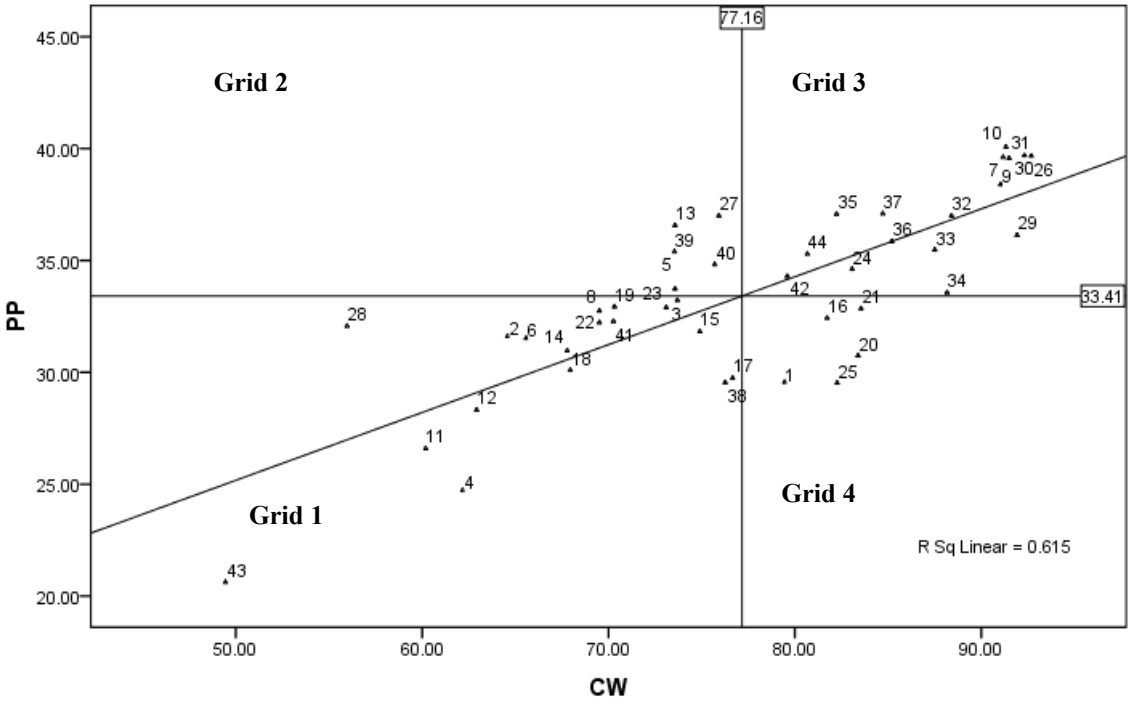

Figure 3: Scatter plot between collaborative working and project performance

In the above figure, CW represents collaborative working and PP represents project performance. Two reference lines represent the mean values which have been marked. It is clear there are four grids separated by two reference lines. Grid 1 is presenting low degrees of CW and low levels of PP, which includes projects 43, 4, 11, 12, 28, 2, 6, 14, 18, 8, 19, 22, 41, 3, 23, 15, 17 and 38. Grid 3 is presenting high degrees of CW and high levels of PP, which includes projects 42, 44, 24, 34, 33, 35, 36, 37, 32, 29, 30, 7, 9, 10, 26 and 31. This is very reasonable since the high positive correlation between collaborative working and project performance has been confirmed. In figure 3, grids 2 and 4 are representing the abnormal cases. However, it is difficult to say that the cases in grids 2 and 4 are abnormal because they are very close to fit line. So, the following discussion on grids 2 and 4 just expresses the intention of those cases rather than the real representation.

Grid 2 represents low degrees of CW but high level of PP, which includes projects 5, 39, 13, 27 and 40. In grid 2, client and contractor might not be in a harmonious relationship due to personality issue and the low degree of CW is perceived but they

still can ensure an appropriate level of project performance. This acceptable project performance might improve the degree of collaborative working in future projects if client and contractor can work together again. Grid 4 represents high degrees of CW but low levels of PP, which includes projects 1, 16, 21, 20 and 25. In grid 4, client and contractor might have a good relationship and the high degree of CW is perceived but the effective project performance is not achieved. In this situation, this relationship might be described as 'cosy'. This cosy relationship often occurred in a longer term relationship, for example, contractor 1 has worked with client 1 more than 3 years and especially contractor 20, 21 and 25 have worked with their clients more than 5 years. If the situation of the cosy relationship is not changed, the future collaborative working will definitely be affected negatively

CONCLUSION

Through correlation and regression analysis, the associations between collaborative working and project performance have been explored in a more precise approach. In terms of the results of data analysis, when different indicators of project performance are highlighted the attention are suggested to put on the different aspects of collaborative working. Through correlation and regression analysis (stepwise), the important aspects in the control of project performance are identified and more attention should be paid to them when only limited resource is available. In particular, the attention should be put on those aspects which are most strongly correlated with project performance. Through regression formulas (in particular, those formulas with a high value of R2), the different aspects of project performance can be predicted if they cannot be measured directly. It is noticeable that there are no any attributes strongly correlated with defects performance and the regression formula of defects performance is the weakest one (R2=0.183). In terms of the results from the semi-structured interviews, the potential reason might be that defects performance is mainly undertaken by contractor and it might be far away from the interface between client and contractor.

Correlation and regression (enter) analysis between collaborative working (summed score of its attributes) and project performance (summed score of its indicators) have also been conducted. The result of correlation analysis supports the hypothesis that project performance is strongly and positively correlated with collaborative working because of the high value of r (0.784, p=0.01). The regression formula is also very strong because of the high value of R2 (0.615), which means 61.5% variance of project performance can be explained by collaborative working. This also means when project performance cannot be measured directly the estimation/prediction of project performance by the degree of collaborative working is very reliable.

Although the robust results have been achieved in this research, there are still a few issues needing to be noted. Firstly, in the process of calculating the summed scores of collaborative working and project performance, all attributes or indicators are added together without considering any weights. In future research, it will be more appropriate to assign different weights to those attributes/indicators (variables) in the evaluation of the whole project performance and collaborative working. Secondly, in the phase of data collection, data are collected through non-probability sampling skills because the target population is widely dispersed and sampling frame is not available. However, the stance of this research on sampling is to create a fairly large data pool enabling the statistical analysis (including significance tests) to take place rather than generalise the final results. Moreover, the questionnaire is mainly administered by the

semi-structured interviews, which provides a chance to explore collaborative working, project performance and their attributes/indicators in depth. All of these reflect that the stance of this research is close to the 'intermediate position' described by Fellows and Liu (2003) (they described the research as 'a broad but shallow study at one extreme and a narrow but deep study at the other or an intermediate position'). In future research, if the purpose is to generalise the results, a far larger data pool is necessary. Thirdly, due to time and cost constraints, only one respondent per project has been approached. In the future, in order to achieve a more comprehensive evaluation on collaborative working and project performance more respondents from one project are expected. Finally, regarding the achieved results, more attention should be placed on weak correlations and weak regression formulae in future research (e.g. defects performance and product satisfaction) to find out an appropriate explanation.

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