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Developing a Matrix to Explore the Relationship between Partnering and Total Quality Management in Construction

Wenzhe Tang  Colin F. Duffield  David M. Young

Abstract: Recently, there has been an increasing awareness and implementation of practices associated with Partnering and Total Quality Management (TQM). Partnering and TQM share similar elements, yet most of the studies on Partnering and TQM are conducted separately. There has not been a careful examination of the common and unique practices associated with these techniques. The theoretical analysis in this paper shows that Partnering can facilitate overall implementation of TQM in construction. The study tries to develop a matrix to explore to what extent Partnering can improve TQM implementation in construction. The matrix will create 3 indexes: the Degree of Partnering, the Degree of TQM and the Project Success Index. The matrix will enable the relationship between Partnering and TQM to be analyzed quantitatively, and will also help to understand the trends of Partnering and TQM application in construction and their relationships with project performance. The results of a case study are given by applying this matrix.

Keywords: Partnering, Total Quality Management (TQM), Relationship

1. INTRODUCTION

Based on studies in the USA, Scandinavia and UK, Egan (1998) suggests that up to 30% of construction is rework, labour is used at only 40-60% of potential efficiency, accidents can account for 3-6% of total project costs, and at least 10% of materials are wasted. Egan concludes that there are significant inefficiencies in the construction process and the construction industry needs to improve dramatically. Similarly, Forbes (2002) concludes that new approaches are urgently required to address the USA construction industry’s ills. While other industries have greatly increased their levels of quality and performance, the majority of construction work is based on antiquated techniques, attended by supply-chain deficiencies and high defect rates resulting in wasted labor and materials. Gallo et al. (2002) also indicate that in the Australian construction industry there is a worrying trend of a number of problems and that the overall situation is demonstrably wasteful, inequitable, adversarial, ineffective and inefficient. To improve this situation, it is strongly advised by many researchers that construction industry should learn experience from manufacturing industry. TQM, a proven method in manufacturing industry, has been increasingly introduced and implemented in the construction industry (Egan 1998, European Construction Institute 1996, Kubal 1994 and 1996, Arditii and Gunaydin 1997, Forbes 2002, McGeorge and Palmer 1997).

2. CONCEPT OF TQM

The concept of TQM has firstly developed and applied in manufacturing industry in Japan and resulted in significantly improved efficiency and quality performance in the manufacturing industry.

Carr et al. (1999) summarizes several TQM definitions such as:

- TQM is continuous process improvement;
- TQM is the application of quality improvement tools and techniques to an organization and its aim; and
- TQM is a strategic, integrated management system for achieving customer satisfaction.

Although the definitions of TQM are different, the factors of TQM appeared are similar. The key factors of TQM include: customer focus, measurement and improvement, total involvement, leadership, training, empowerment, teamwork, incentives, systems approach, and culture (Carr et al. 1999, Hoque 2002, Arditii & Gunaydin 1997, Tam & Hui 1996, ECI 1996, and AS-HB35 1992). These factors are applied successfully in the manufacturing industry; however, there are barriers for them to be implemented in the construction industry due to the different nature of the two industries.

3. BARRIERS TO TQM APPLICATION IN CONSTRUCTION

3.1 Unique of a construction project

In manufacturing industry, there is standardizing products and relatively stable and repetitive production method, while each project in construction industry is unique. Each project is a prototype with a different set of conditions (Chase 1998). The construction site, the local conditions – for example, soil, climate, manpower, technology, topography, site plan, materials, equipment, and many other factors vary from one project to another (Bayramoglu 2001). The unique of construction project makes application of continual improvement become difficult.

The first and foremost difference in construction TQM programs is the lack of a typical repeat customer classification for a construction or design organization (Kubal 1994). He indicates that without a typical customer, a company cannot define an overall standard TQM program that is effective for each of its customer. Chinyio et. al. (1998) have evaluated the project needs of UK building clients. Their study has identified 50 aspects of clients' needs showing clients’ individual priorities over these needs are vary, which confirms that it is hard to focus on the specific needs of customer.

3.2 The fragmentation of construction industry

In manufacturing industry, there is much less firms than in construction industry. For example, there are just several main companies such as Nissan, Toyota and Honda in the Japanese car manufacturing industry. Each company has much larger share in car manufacturing industry than a company in the construction industry. This make each automobile company has enough financial support,
historic data, technology and long history company culture to implement TQM. While there are some 163,000 construction companies in the UK construction industry, most employing fewer than eight people (Egan, 1998). The situation in other countries is similar, which means each construction company will get very limited experience to achieve continual improvements.

### 3.3 Project performance depending on all participants

In manufacturing industry the quality of a product is decided solely by the manufacturing company, while the quality of construction project relies on all participants. Construction quality problems may caused by client, designer, contractor, subcontractor, supplier and third party. This makes the implementation of TQM much more difficult in construction industry than in manufacturing industry. Even in a simplistic representation of the site-management hierarchy for a typical construction project, the difficulties in implementing a TQM program best suited for one singular project are daunting (Kubal 1996).

### 3.4 Competitive and high-risk nature of construction industry

Traditionally, construction applies competitive bidding system. Normally the lowest price factor is to win a job for a construction company. As mentioned above, there are large number of companies in the industry, which make it is not surprising that the construction industry has a low and unreliable rate of profitability. Margins are characteristically very low (Egan 1998). On the one hand, the low profitability of the industry makes the ability of a company to resist risks is low, on the other hand, the construction industry is high-risk. Under the pressure of low profit and high risk, traditionally each party tries to transfer the risks as much as possible to the other parties, which leads to an adversarial environment. This makes the key factors of TQM such as teamwork, total involvemer leadership and open culture become very impracticable.

### 4. Partnering's role on the implementation of TQM in construction

Partnering facilitates team working across contractual boundaries. Its fundamental components are formalised mutual objective, agreed problem resolution methods, and identifying or incorporating continuous measurable improvements. Develop and maintaining a strong team is essential for the success of partnering (Chartered Institute of Building, 2002). According to the literature (Cown 1990, Bennett & Jayes 1998, Cox et al. 1999, AC 1999, Black et al. 2000, Scott 2001 and Cheng & Li 2002), the key factors of Partnering are: mutual objective, commitment, equity trust, effective communication, agreed problem resolution method, joint evaluation, and gain/pain sharing mechanism. Partnering enables all participants to share experience of each other. This makes all participants become an integrated organization in operation level, which is similar to a company in manufacturing industry (St fig. 1 and 2). In Partnering the historic project data of each participant are able to be used to analyze the ongoing project. This helps to add value to the project and to obtain continuous improvements.

![Fig. 1] Traditional quality management structure

Partnering and TQM shares many key elements, however they are two different methodologies. Partnering influences inter-organizational activities significantly, while traditionally TQM has been implemented within an organization. Theoretically, Partnering can facilitate overall implementation of TQM in construction, however, to what extent Partnering can improve the implementation of TQM key elements in construction is not clear. Therefore, this study aims at building a matrix to reveal the relationship between Partnering and TQM.

### 5. MATRIX

Thompson & Sanders (1998) also use a concept of Partnering

A matrix is developed to measure the degree of Partnering, the degree of TQM and the performance of a project, which will be Partnering or not. The scores of 8 factors will finally be transferred as an index = DoP, which is an overall compliance to the principles of Partnering, used as data collection instrument to explore the relationships between them. The study will investigate the Degree of Partnering (DoP) of each project by using a Partnering factors rating form (see table 1). The scales of choices means:

1=Strongly disagree, 2=Disagree, 3= Neutral, 4=Agree, 5=Strongly Agree

The concept of DoP is applied in this study because Partnering can be viewed as a matter of degree (Schultze & Unruh, 1996), the concept of DoP enables data of any project being used in th
continuum to describe the DoP. The continuum is divided into four general stages, each of which represents a new level of alignment—competition, cooperation, collaboration and coalescence. Applying analysis without considering whether a project use the name of
Similarly, the implementation of TQM will be measured by Degree of TQM (see table 2).

<table>
<thead>
<tr>
<th>Key factors of Partnering</th>
<th>Objectives</th>
<th>The objective of a factor has been realized</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mutual objectives</td>
<td>The common objectives of all parties have been well understood, which enables all parties to concentrate on the overall success of the project</td>
<td>√</td>
</tr>
<tr>
<td>Commitment</td>
<td>The parties keep commitment</td>
<td>√</td>
</tr>
<tr>
<td>Equity</td>
<td>The parties act fairly, and each party’s interests are best served by utilising win/win thinking</td>
<td>√</td>
</tr>
<tr>
<td>Trust</td>
<td>There is a trust environment encouraging a free flow of information</td>
<td>√</td>
</tr>
<tr>
<td>Effective Communication</td>
<td>Formal and informal communication channels are well established</td>
<td>√</td>
</tr>
<tr>
<td>Problem resolution methods</td>
<td>There are agreed methods for problem resolution supporting joint early problem warning and prompt problem solving</td>
<td>√</td>
</tr>
<tr>
<td>Joint evaluation</td>
<td>Project performance is periodically measured and analyzed to achieve continuous improvement</td>
<td>√</td>
</tr>
<tr>
<td>Gain/pain sharing mechanism</td>
<td>There are agreed gain and pain sharing mechanisms enabling all parties to make reasonable return and to bear appropriate risks</td>
<td>√</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Key factors of TQM</th>
<th>Objectives</th>
<th>The objective of a factor has been realized</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer focus</td>
<td>Understanding both internal and external customers’ needs and striving to exceed customer expectation</td>
<td>√</td>
</tr>
<tr>
<td>Measurement/improvement</td>
<td>Regular measurement against performance indicators and continual improvement obtained</td>
<td>√</td>
</tr>
<tr>
<td>Total involvement</td>
<td>People’s abilities at all levels of parties are able to be used for the project’s good performance</td>
<td>√</td>
</tr>
<tr>
<td>Leadership</td>
<td>Fully committed and actively leading the process</td>
<td>√</td>
</tr>
<tr>
<td>Training</td>
<td>Continual training at all levels to avoid quality deviation due to not familiar with quality systems, lack of technical knowledge and communication skills</td>
<td>√</td>
</tr>
<tr>
<td>Empowerment</td>
<td>Individuals have appropriate responsibility which enables them to contribute their creativity and skills</td>
<td>√</td>
</tr>
<tr>
<td>Teamwork</td>
<td>There are clearly defined problem resolution procedures with free knowledge sharing</td>
<td>√</td>
</tr>
<tr>
<td>Incentive</td>
<td>Monetary and non-monetary rewards being clearly tied with benchmarks assists good performance and continual improvement</td>
<td>√</td>
</tr>
<tr>
<td>Culture</td>
<td>There is an no blame, trust, fair, and open communication environment</td>
<td>√</td>
</tr>
<tr>
<td>Systems approach</td>
<td>Systems/processes are well specified, implemented and monitored in achieving project objectives</td>
<td>√</td>
</tr>
</tbody>
</table>

The scores of 10 factors will finally be transferred as an index—DoTQM, which is an overall compliance to the objectives of the 10 factors.

Degree of Partnering = \( \frac{1}{8} \sum \text{Score of factor } i \times 100\% \)
Where \( i = \text{from 1 to 8} \)

Degree of TQM = \( \frac{1}{10} \sum \text{Score of factor } j \times 100\% \)
Where \( j = \text{from 1 to 10} \)
For simplicity all Partnering factors are set as the same weight because the roles of the key success factors for Partnering have no significant difference. Black et. al (2000) identified 19 key success factors in which the highest score (4.61) compared to the average score (3.99) is 1.16 whereas the lowest score (3.63) compared to the average reaches 0.91.

Similarly, all TQM factors are set as the same weight. Arditi and Guanaydin (1998) surveyed 18 factors that affect quality in construction phase, in which the highest score (9.20) compared to the average score (7.96) is 1.16. The lowest score (5.51) compared to the average is only 0.69, however, the score (7.20) of rank 14 compared to average reaches 0.90. This shows that there is no significant difference among top 10 ranks. Choosing 10 factors and give them same weight when calculate the overall compliance to the objectives is still appropriate.

The two index of DoP and DoTQM enable the relationship between Partnering and TQM in construction to be analysed quantitatively. As the ultimate objective of both Partnering and TQM is to improve the project performance, the achievements of a project should also be considered when the relationship between DoP and DoTQM is analysed. This study will apply a Project Success Index to reflect the performance of a project. Wang & Gibson (2002) have used Project Success Index to demonstrate the relationship between the Project Definition Rating Index and project performance (see formula 3).

\[
\text{Project Success Index} = (0.5x\text{Budget Achievement}) + (0.5x\text{Schedule Achievement}) = \cdots (3)
\]

However, the Project Success Index does not consider the quality performance. Besides the importance of cost, schedule and quality to a project may differ. Therefore, this study will use three indicators of cost, schedule and quality performance with different weights to formulate Project Success index shown as below:

\[
\text{Project Success index} = w_1 \times \text{Cost achievement} + w_2 \times \text{Schedule achievement} + w_3 \times \text{Quality achievement}
\]

Where \( w_i = \) Score of significance \( i/(\Sigma i) \) where \( i = \) from 1 to 3

In this study, the achievement is classified as 5 ranks according to the performance. Besides, the relevant significance of the objectives of cost, schedule and time need to be rated by applying 5 point metric, where 1=not important, 2=sometimes important, 3=important, 4=very important, and 5=most important. The project performance and relevant significance rating form is shown on table 3.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Criteria</th>
<th>Value</th>
<th>Significance of an achievement</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 100%</td>
<td></td>
<td>5</td>
<td>✓</td>
</tr>
<tr>
<td>100% ~ 105%</td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>105% ~ 110%</td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>110% ~ 120%</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>&gt; 120%</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>&lt; 100%</td>
<td></td>
<td>5</td>
<td>✓</td>
</tr>
<tr>
<td>100% ~ 105%</td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>105% ~ 110%</td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>110% ~ 120%</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>&gt; 120%</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>No rework required</td>
<td></td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Minimal rework</td>
<td></td>
<td>4</td>
<td>✓</td>
</tr>
<tr>
<td>Quality</td>
<td>Some rework required</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>achievement</td>
<td>Extensive rework required</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Unacceptable level of quality</td>
<td></td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

6. A CASE STUDY

Based on the matrix in this paper, a case study has been completed. The survey is conducted through the first author’s field trip to a major construction project. Firstly, the matrix is used as a questionnaire, and the key senior staffs of the project are requested to complete it. Then, interviews with them are conducted to discuss further the topics on the questionnaire. Finally, some relevant project documents are reviewed to confirm the former rating. The rating results are shown by the ticks on tables 1, 2 and 3. Then, the DoP, DoTQM and Project Success Index are able to be calculated according to formula (1), (2) and (4).

\[
\text{DoP} = \frac{(4+4+4+4+3+4+4)}{8} \times 100\% = 77.5\%
\]

\[
\text{DoTQM} = \frac{(4+3+4+5+3+4+4+4+4+5)}{10} \times 100\% = 78\%
\]

\[
\text{Project Success Index} = (3/(3+4+5)) \times 5 + (4/(3+4+5)) \times 5 + (5/(3+4+5)) \times 4 = 4.58
\]

The results show that DoP and DoTQM have similar value and the Project Success Index is high. As there is only one project, the conclusion on the relationships between these indexes cannot be obtained. However, analyzing the score of each factor still can help to learn the strength and weakness regarding the compliance to the objective of each factor. In terms of TQM, leadership and systems approach have been implemented best, while total involvement, training and teambuilding need to be improved. Regarding Partnering except problem resolution methods all other factors get 4 points, which means the project need to enhance the aspect of prompt problem solving and other aspects also have potential to achieve improvements. The performance rating indicates that reaching quality objective is the first priority and schedule is the second. The schedule achievement and cost achievement are satisfied, and quality performance needs to be improved.

7. CONCLUSION

The matrix developed in this study can collect project data to calculate the DoP, DoTQM and Project Success Index, and the three indexes enable the relationships between Partnering, TQM and project performance to be analyzed quantitatively. To a specific project, the matrix can help to evaluation the management status and project performance. For the data of a large number of projects collected through this matrix, the relationship between Partnering
and TQM can be revealed by using statistical techniques such as multiple regression analysis. Besides, this matrix will help to understand the trends of Partnering, TQM application in construction and to achieve continual improvement on project performance.

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