External Knowledge Collaboration and Management Program in an EPCM Company

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Abstract
Promoting external knowledge collaboration is a key to successful nurturing a knowledge-based company culture, thus improving quality and productivity of work. This paper examines the external knowledge collaboration and management program in a global, publicly owned company that provides Engineering, Procurement, Construction, and Maintenance (EPCM) services.

The paper describes the identified change of practices and factors that led to the successful implementation of the external knowledge collaboration program, which has reinforced the company’s core value of learning. In this study, the authors examine whether internal collaboration among employees within the company via publishing papers or presentation outside of the company relates to external collaboration behavior with clients. Publication data from the company’s knowledge collaboration database was extracted to examine the hypotheses based on Spearman correlation analysis. Analysis of collected data shows that the impact is significantly and positively associated with number of publications. However, internal collaborations at both intra- and inter-office levels show strong but negative associations with external collaboration impact. This case study offers recommendations to organizations seeking to implement effective external knowledge collaboration programs in the industry.

Keywords
External knowledge collaboration; Motivation; Expertise; Construction; Engineering

1.0 Introduction
While globalization has created many modern trends, companies have to adapt those trends promptly in order to survive in today’s competitive market. Upon realizing the major value of intellectual resources, many companies have begun to manage rationally and improve them [10]. In other words, companies must utilize internal and external knowledge. However, the practical application of this concept among EPCM companies remains relatively general. This paper seeks to investigate the following question with a single case study: Do internal collaborations among employees within a company lead to higher impact on external collaboration?
Using P4 publication information (extracted from P4 database), we measure publications’ external collaboration impact by recording each publication that was authored jointly with clients. After processing the authors’ information for each publication, the number of co-authors from the same or different offices was counted. Then, Spearman correlation coefficient rank test was used to examine how each type of internal collaborations associate with publications’ external collaboration impact.

The paper is structured as follows: Section 2 presents the literature review, while Section 3 provides the background of the case study company and its external knowledge collaboration and management program – Professional Publications & Presentations Program (P4), including barriers and challenges of establishing the program. Section 4 outlines three hypotheses on the interconnections of internal and external knowledge collaborations, as well as the methodology of the data collection and analysis. Section 5 summarizes the analysis results and correlations. Section 6 illustrates a detailed discussion of the case study and data analysis about internal and external knowledge collaborations, and recommendations based on the observations and findings. Finally, Sections 7 and 8 conclude the paper with a discussion of practitioner implications and highlighting future works.

2.0 Literature Review
Knowledge sharing is critical for a company to respond promptly to adapt, innovate and achieve competitive success [1, 5]. Johnson and Filippini [11] concluded that both collaboration that focus on internal integration of departments using cross-functional teams and on external linkages with customers have a beneficial impact on innovation, thus sustaining in the competitive market. While internal and external knowledge sharing has direct implications on performance, the latter is more valuable when individuals in the workgroup are more structurally diverse [12].

The extent of knowing sharing activities depends on one’s desire to share his/her knowledge, social associations and the belief that one’s knowledge can provide contributions to the overall organization are the major reasons of an individual to contribute [2]. The emphasis of personal characteristics or rewards is important to effectively encourage employees to share their knowledge, such as a willingness to share, self-confidence that their knowledge is valuable, trust, shared meanings to understand the knowledge, and personal capability to use a knowledge management system [8, 15].

Similar to other business sectors and industries, companies in the engineering and construction fields recognize the need to share knowledge [4]. Despite many available findings on reasons that drive knowledge sharing motivations, however, many companies find it difficult to implement effective practices on knowledge sharing since the relationships between strategies and knowledge sharing motivations have not been extensively studied [8].

3.0 Case Study Company

3.1 Company Background
The case study company, Fluor Corporation, was chosen as it is a global, publicly owned company providing EPCM, as well as project management services to the oil and gas, power, chemicals, mining, life sciences, and other capital-intensive industries. Fluor Corporation was founded as a construction company in 1912. As of 2013, Fluor has a global workforce of 41,000 employees deployed on projects in 79 countries and global execution centers in 25 countries [6]. Fluor’s core value approach is strongly associated with a learning organization and believes that team learning via collaboration is ultimately important, because the rate at which an organization is learning may become the only sustainable source of competitive advantage [14].

3.2 External Knowledge Collaboration Program – P4
Fluor believes that promoting external knowledge collaboration is a key to a successful knowledge management system. While many would agree with this viewpoint, how can a company encourage an employee to report his/her externally shared knowledge, so that the knowledge can be captured and shared across offices?

- **History of P4**
  In 1995, prior to the official rollout of P4, Fluor had a loosely organized database to capture external papers in the Calgary, Harlem, Houston, and Greenville offices. The oldest entry was published in the 1980s.
It was noted that those externally published papers by Fluor employees would be beneficial to the sales and marketing efforts. It was believed that an organized company-wide program makes a positive impact on proposals and Fluor’s name in the market place. In 1998, Fluor senior management approved the global budget. As the result of a white paper on how to implement P4 as a global initiative, Fluor formally established P4 in 2001 to recognize employees who stay abreast of emerging and current technologies and share their knowledge through the industry’s trade media and professional conferences. P4 provides a unique platform for Fluor to demonstrate its depth of expertise. More important, P4 creates opportunities for employees to collaborate with clients and share success stories from projects. Shortly after P4’s establishment, starting from 2002, positive feedbacks were received from Fluor’s employees and clients that knowledge from P4 publications had provided unique and innovative solutions to clients.

- **P4 Database**
  All P4-qualified papers and presentations can be accessed in the P4 database, which serves as a “knowledge center” for Fluor employees around the world. Figure 1 shows main page of Fluor’s P4 database. It is a Lotus Notes [7] database containing publications from 21 office locations. Each office has at least one administrator to input the information in the database. Version 2.1 was used at the time of publication of this paper.

If a paper or a presentation is published jointly with a client, the client is acknowledged and his/her name can be found in the database. Since 2013, the P4 database has become available to be accessed by Fluor’s clients.

![Figure 1: Fluor’s P4 database main page](image)

### 3.2 Barriers/Challenges of Establishing P4
Initially, P4 did not achieve its success for external knowledge collaboration and the stated purposes until the following main issues were resolved:

- **Complicated Steps to Publish**
The original P4 process had 25 steps to publish and required approvals by three reviewers from the local office P4 implementation committee. The procedures made many employees hesitate to submit the publications for approval. The Global P4 leader examined the problem from system’s perspective. As a result, the submittal procedure was simplified to six steps.
Business Performance Measurement
Linking knowledge management initiatives to profitability has been acknowledged as a complicated problem while many investors expect some measures of success [3]. There is currently no quantifiable business performance measurement to prove that sales of Fluor have been increased due to increased P4 publications. However, qualitative measurements, such as client feedbacks, success stories, and enhanced employee’s social interactions, can reflect the positive impacts on Fluor’s business due to P4’s success.

Diverse Content of P4 Publications
P4 publications range from scholarly journal articles to presentations at business and professional society meetings. The diversity of contents makes it difficult to select “the best publication of the year” and recognize the tremendous effort from the author on one publication.

Through interviews Fluor employees, other barriers that made them fail to recognize the value of P4 were:
- Insufficient knowledge of the benefits of P4,
- Lack of incentives to participate in knowledge sharing via external publications, and
- Insufficient compensation for time and travel expenses when the presentations are held significantly far away from the employee’s work location.

4.0 Data Analysis
A single case study is used for the analysis of the relationships between internal and external collaborations through P4. The study involves a holistic approach with a multitude of detailed observations by examining documents (such as reports, formal studies, and news articles, etc), interview records, and the author’s direct observations.

4.1 Measures
After retrieving the publications list and some modifications, in the P4 database we store publications’ data (e.g., title, publish year, authors’ name, department, office location, whether it was authored by Fluor employees jointly with client). The resulting database contained 6,023 unique publications reflecting the contributions of 2,338 authors from 21 different offices during the period of 1983-2013. In this study, we ignore the author’s department as a parameter of analysis as the author may switch from one department or another one during his/her career at Fluor. We use Spearman correlation rank test to examine the association between the dependent variable and the independent variables as follows:

- **Dependent Variable (Publications Worked Jointly with Client during the Year)**
  The number of publications worked jointly with client during the year reflects how P4 has influenced or encouraged external collaboration.

- **Independent Variables (Total Number of Publications per Year, the Number of Authors per Publication, and the Number of Offices Involved per Publication)**
  We measure collaborations activity using the number co-authors of each publication. To measure intra-office-level collaboration, we count the number of collaborations within the same Fluor office location. As for inter-office-level collaborations, we count number of collaborations among authors from various office locations. Furthermore, we measure the total number of publications during each year from 1983 to 2013.

4.2 Method
Based on the proposed analysis model, we propose following hypotheses:
(H1): External client collaboration correlates to the number of P4 publications per year.
(H2): External client collaboration correlates to a company’s internal collaboration, that is, the number of Fluor authors per P4 publication.
(H3): External client collaboration correlates to inter-office internal collaboration, that is, the number of participated Fluor offices per P4 publication.

5.0 Analysis Results and Correlation
Table 1 provides more information about the distribution of the number of authors and joint office per publication (as an indicator of publication impact). Figure 2 presents the P4 publications statistics from 1983 to 2013.
The average authors per P4 publication is 1.39, which means that majority of the publications are either by one or two authors. Although approximately 74% of the publications are single-authored, but most publications that were jointly with clients are single-authored publications. This indicates that more collaboration will exist between one author and the client if the Fluor author initiates knowledge collaboration through P4. The average office participated per P4 publication is 1.02, which means that a P4 publication is most likely by one Fluor office. The results indicate that external collaboration is highly likely by one office, which may be due to easier communications and coordination when knowledge sharing activities are held within one geographical area.

Table 1: Statistical data of P4 publications

<table>
<thead>
<tr>
<th># of Authors per Paper</th>
<th># of Pubs</th>
<th># of Pubs - Jointly with Client</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4505</td>
<td>115</td>
</tr>
<tr>
<td>2</td>
<td>947</td>
<td>44</td>
</tr>
<tr>
<td>3</td>
<td>376</td>
<td>16</td>
</tr>
<tr>
<td>4</td>
<td>164</td>
<td>11</td>
</tr>
<tr>
<td>5</td>
<td>21</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>6023</strong></td>
<td><strong>189</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th># of Offices per Paper</th>
<th># of Pubs</th>
<th># of Pubs - Jointly with Client</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-Office Paper</td>
<td>4860</td>
<td>175</td>
</tr>
<tr>
<td>2-Office Paper</td>
<td>116</td>
<td>14</td>
</tr>
<tr>
<td>3-Office Paper</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>4-Office Paper</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>4992</strong></td>
<td><strong>189</strong></td>
</tr>
</tbody>
</table>

Ave. Author per Paper 1.39
Ave. Office per Paper 1.02

Figure 2: P4 publications statistics from 1983 to 2013
Spearman correlation analysis was performed to test the proposed hypotheses listed in Section 4.2. The results in Table 2 follows all collaboration measures has relatively significant correlation with the publication impact measure. Total publication count has the largest coefficient value and positive correlation to publication impact. Comparing internal collaboration’s association with publication impact, the result shows that both correlations are negative, and the number of authors within Fluor has lower correlation to publication impact rather than intra- or inter-office-level collaborations. Thus, the publications with more authors from one or two offices will have better impact in external collaboration.

**Table 2: Spearman correlation results**

<table>
<thead>
<tr>
<th>Dependent Variables</th>
<th>Spearman Correlation Coefficient</th>
<th>External Client Collaboration Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td># of P4 Publications per Year</td>
<td>Rho .794 *</td>
<td></td>
</tr>
<tr>
<td># of Fluor Authors per Pub</td>
<td>Rho -.639 **</td>
<td></td>
</tr>
<tr>
<td># of Participated Office per Pub</td>
<td>Rho -.949 **</td>
<td></td>
</tr>
</tbody>
</table>

*. Correlation is significant at the 0.01 level (2-tailed).

**. Correlation is significant at the 0.05 level (2-tailed).

6.0 Observations and Recommendations

6.1 P4 Implementation Strategy – Social Motivations

Motivations were the most frequently mentioned reason for sharing knowledge; and those satisfactions through social motivations are equally important as monetary rewards \[9\]. The following social motivation tactics were used in P4 to encourage employees to share their knowledge:

- **Peer recognition** – P4 authors are given certificates and plaques.
- **Opportunities of mimicking the behavior of leaders** – P4 authors have more chances to work or interact with subject matter experts or company fellows.
- **Honoring knowledge sharing commitments** – P4 authors receive appreciation letters from the operations managers.
- **Perceived value and uniqueness of inter-office knowledge** – The Chief Executive Officer actively promotes and advocates P4 via corporate newsletters.

For an organization wishing to increase knowledge sharing among employees, managers must thoroughly investigate the main motivations behind knowledge sharing behavior in that organization and develop specific strategies.

6.2 Benefits of P4 to Fluor Employees

Considering the team benefits, effective cross-boundary collaboration, either internal or external, helps increase diversity input, support the standardization of processes, increase production quality, and more important, increase creation of innovations. P4 provides a pathway to rapidly leverage the experience of the experts throughout the company. This philosophy allows one employee to represent the employees’ knowledge of Fluor as the whole, but not merely the knowledge of that particular individual.

In addition, P4 provides the benefits of co-authoring. An organization structure may consciously or unconsciously promote silo thinking, where functions, locations or divisions try to maximize their own areas, and reward their people for doing so \[13\]. Co-authoring in P4 with authors from different departments or office locations shifts employees’ focus back to the entire organization and not just one department.

6.3 Effects and Benefits of P4 for Fluor

P4 is related to increase Fluor’s competitiveness in the following areas:

- **Increased Effectiveness of Personnel**
  The speed at which new employees come to understand company policies, procedures and work-processes. This will provide more effective people on the projects while reducing the negative impact on surrounding personnel and experts.
Wong and Shah

- **Increased Accuracy and Competencies of Proposals**
  The capture of historical information, as well as current industry data, allows Fluor’s Marketing and Sales team to make confident and timely bids on future proposals.

- **Improved Worksharing**
  Globalization and worksharing requires experts’ knowledge to be well-documented and accessed globally. Furthermore, implementing the proper knowledge leadership and culture will greatly increase the profitability of the company.

- **Increased Client Confidence**
  Clients are assured that the Fluor has the right expertise to execute their projects.

### 6.4 Measuring P4 Usage

Some specific examples of how P4 usage can be measured are shown below:

- Monitor usage of P4, with feedback from end users on usefulness of information and time/material savings.
- Track estimate and proposal development costs to follow the impact of historical information, which has been captured and organized properly.
- Monitor frequency of publications being accessed, which may result in productivity and quality improvements of company project due to increased knowledge of team members.
- Capture decrease in man-hours spent by employees looking for project data and information in P4.
- Monitor the outcomes of those P4 publications that are authored by Fluor’s employees, jointly with clients, or associations with learning institutions, suppliers, and competitors, etc.
- Estimate how a lack of investment in external organizational knowledge will erode and retard growth through lost revenues to competitors or lowered barriers to entry.

### 6.5 Using P4 Effectively in the Marketing and Sales

In addition, sales and marketing personnel should reference P4 more often in the proposals so that client can understand the company’s capabilities.

### 6.6 New Visions of P4

Through interviews with P4 committee members, the following new visions of P4 have been evolved and will be implemented to help employee better relate P4’s benefits and impacts on an individual:

- P4 participation will become part of the employee’s yearly performance assessment criteria.
- A P4 booklet will be created for the best articles throughout all years.
- Webinars will be created by reusing the materials in the P4 database, so that employees can have opportunities to listen to the external presentations by the Fluor authors and learn from them.

In addition to visions focusing on the benefits of employee, P4 is aiming at working with sales and marketing personnel to reference P4 more often in the proposals so that client can understand the company’s capabilities.

### 7.0 Limitations of the Study

With an in-depth single case study methodology, the results are difficult to generalize to other empirical settings. First, there is a lack of statistical generalizability, which is not a goal of this study. Second, the case study does not include any quantitative analysis and statistics. While the findings of this case study help practitioners and researchers understand the subjects of external collaboration in the knowledge management field, cautions must be taken in applying the findings and recommendations to other organizations.

### 8.0 Implications and Conclusions

This paper examines the external knowledge collaboration and management program of a global EPCM company – Fluor Corporation. The program achieved the established goals and became a global company practice over time. This paper provides the problematic presumptions that hindered the establishment of the program. In addition, this paper illustrates the relationships between internal and external collaborations that eventually sustain Fluor’s competitive advantage in the market over time. Based on the analysis of P4 database, we conclude that external client collaboration correlates to the number of P4 publications per year, and tends to happen when the publication is
authored by less than three Fluor employees, or Fluor employees from one or two different Fluor office locations. The factors contributed to the continuing use of this program are then presented, including the alignment of P4 with the company’s core value, benefits to employees and company, continued technology investment and maintenance, and internal and external social motivations.

The observations, recommendations, as well as conclusions offered in this paper are based on a single-case study findings and results. For managers and practitioners, the implementation of external collaboration strategies relies on the internal and external organizational environments. For researchers, systems dynamics approaches and advanced model simulations will contribute to further understand the relationships between internal and external knowledge management collaboration strategies for globally distributed teams. The authors believe that future researchers will find this subject area of knowledge management global challenges to be extensive and fruitful.

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**References**