

SURVEY OF BENEFITS OF A CONSTRUCTION COLLABORATION TOOL FOR CONTRACT CHANGE MANAGEMENT

Tejas Oza, Ming Sun

Faculty of the Built Environment, University of the West of England, UK

ABSTRACT: This paper presents the results of a user survey on the benefits of an Internet based Contract Change Management (CCM) system for NEC/ ECC project in the UK. The aim is to establish the views of different types of users, such as clients, contractors, or consultants, about the main benefits of using CCM in their projects. The questionnaire was sent to 260 users, and 85 valid replies have been received.

Prior to the survey, a list of 43 benefits was identified under 8 categories: (1) Process improvement; (2) Business improvement; (3) Risk management; (4) Communication; (5) Management information; (6) Efficiency; (7) Collaboration; and (8) Traceability. For each benefit, the respondents were asked to choose one of 4 possible answers - "Strongly Agree", "Agree", "Disagree" or "Strongly Disagree". In addition to rating each benefit, the respondents were also asked to identify 5 most important benefits from the list so that an importance ranking can be established. The survey results have shown that the vast majority of the CCM users agree with the benefits provided by the system. Benefits related to risk management are regarded most important. There are some variations in the answers from different groups of users, i.e., clients, contractors and consultants.

KEYWORDS: information technology (it) benefits, collaboration tools, user survey, questionnaire, change management.

1 INTRODUCTION

The value of Information Technology (IT) in Construction has been debated for many years. There is a consensus in the recognition that the benefit of IT can not always be defined in 'financial' terms (Griffith et al., 2000). Many benefits are intangible and difficult to measure. Measurement and quantification of IT benefits is often a complex process (Geisler & Hoang 1992). IT systems can help in achieving direct cost savings by automating existing manual processes for managing construction projects. IT applications can also improve decision making, effectiveness, communication, responsiveness and resource utilization by allowing rapid access to information (much of which would not be readily available under traditional paper-based systems). Such benefits are often difficult to justify in terms of cost reduction (Bender 1986). Lederer & Mirani (1995) pointed out that among the range of IT benefits, improved business effectiveness through 'better information' was considered to be both the most important and hardest to measure.

The Contract Change Management (CCM) system is an on-line service, purpose designed to support the project management processes of the NEC/ECC form of contract. It is used in practice on many building and engineering projects in the UK. Anecdotal evidence suggests that the system helps projects reduce risks and save costs. There is a shared desire by both the service provider of CCM and its users to ascertain and measure the key benefits of

CCM. To achieve this aim a questionnaire survey has been conducted. This paper reports the results and analyses of this survey.

2 LITERATURE REVIEW

The importance of measuring benefits of IT has been recognised by many researchers, such as Marsh and Flanagan (2000) and Love and Irani (2001). They indicated that the lack of reliable benefit measurement methods is a barrier to the wider uptake of IT and the investment in IT in Construction. However, the appraisal of IT investment is more difficult than that for other forms of investments (Powell, 1992). The traditional evaluation methods, such as Return on Investment (ROI), Net Present Value (NPV) or the Internal Rate of Return (IRR), can not be easily applied to assessing IT benefits (Kumar, 2000). Verhoef (2005) developed a measurement method for investment in IT by using classical financial appraisal technique called risk adjusted discounted cash flow model. The method resulted in a scenario-based approach incorporating two IT specific risks that can substantially influence IT-appraisals (risk of failed IT-projects and overrun risks).

Balanced Scorecard appraisal technique was used by Stewart and Mohamed (2003), and Milis and Mercken (2004) for IT performance evaluation. Their studies dem-

onstrated that the projects need to be evaluated across a range of diverse perspectives, and a variety of indicators spread across these perspectives are imperative to encompass the complete spectrum of value elements. They also suggested that the proposed indicators of the framework should not be considered fixed, e.g. indicators can be individually developed to suit the goals of an organisation. Stewart and Mohamed (2004) emphasised capturing the long-term IT-induced business success. Their study confirms that organisations that score higher in the ‘soft’ technology/ system and user orientation perspectives also experience IT-induced performance improvement in operational, strategic competitiveness and benefits perspectives. Accordingly, project managers are encouraged to closely monitor indicators from the user’s orientation and technology/ system perspectives.

The Construct IT (1998) benefits assessment framework is another development to improve the IT evaluation process within the construction industry. The framework uses business processes to categorise benefits, as many IT investments are not related to specific projects but relate to infrastructure and head office processes. Construct IT approaches IT innovation benefits to businesses in terms of efficiency, effectiveness and performance. The measurement framework suggests that IT innovation can improve various business processes like business planning, marketing, information management, procurement, finance, client management, design, construction, occupation and maintenance, and human resources. Pollalis and Becerik et al (2005) from Harvard Design School published a series of case study reports on Identification and Measurement of Online Collaboration and Project Management (OCPM) technology for measuring IT investments. Similar to the Construct IT approach, IT investments benefits were classified accordingly as Effectiveness (quasi- tangible), Efficiency (tangible) and Performance (intangible). Effectiveness (quasi-tangible benefits) is the ratio of achieved outputs to planned outputs (doing the right things): the ability of a program, project, or work task to produce a specific desired effect or result that can be measured. It is performing the right tasks correctly, consistent with organizational mission, vision, values, and in support of the organization's goals and objectives. Efficiency (tangible benefits), in this context, is defined as the rate at which inputs are converted to outputs (doing things right). Efficiency is financially measurable and is represented by money. Performance (intangible benefits) is not directly measurable in quantifiable terms but is judged qualitatively on the basis of the impact of a successful implementation in influencing long-term business performance and market share.

To gain empirical data on the benefits of IT investment from a large number of construction organisations, Love and et al (2005) adopted a questionnaire survey approach. They revealed that different types of organisation significantly differ in the amount of investment in IT; investment levels in IT were not influenced by organizational size; and the scope of IT evaluation was considered broader than a financial control mechanism. Instead, organisations used ex-post evaluation as an opportunity for learning and thus regenerated knowledge. Based on these findings a pragmatic IT evaluation framework was pro-

posed which can be used by construction organizations to ameliorate their investment decision-making process.

3 QUESTIONNAIRE SURVEY

To evaluate the benefits of the CCM system, the questionnaire survey technique was used for data collection. The questionnaire was sent out to the current users as well as the previous users of the CCM system. The survey was sent by postal mail to approximately 260 users which were randomly selected from the existing CCM user’s database. The sample was selected at random in order to ascertain reliability and chances of equal selection of the population. The samples include a mixed profile of organisational types and roles, including Contractors, Clients, Project Management, Quantity Surveyors, Architect/ Design/ Engineering and Specialist Sub Contractors. This helped to get broader views from all the sections of the business. Prior to the main survey, a pilot study was carried out with 5 selected users. As a result, some minor adjustments were made to some of the questions. However the changes were not very significant. Therefore the 5 responses of the pilot were included with the 80 responses received during the main survey. This makes the total number of valid responses 85, representing a return rate of 33%.

The questionnaire consists of 26 questions in 5 sections:

1. You and your organisation
2. Your experience with the ECC (NEC) and CCM
3. Benefits of the CCM system
4. Evaluation of the CCM system
5. Feedback on the services of the service provider

The “Benefits of the CCM system” is the main focus of this survey. Prior to the survey, a list of 43 potential benefits was identified based on anecdotal evidence. These benefits were included in the questionnaire under 8 categories in section 3 of the questionnaire: (1) Process improvement; (2) Business improvement; (3) Risk management; (4) Communication; (5) Management information; (6) Efficiency; (7) Collaboration/Partnering; and (8) Traceability. The question in the questionnaire reads, “anecdotal evidence indicates CCM offers the following benefits. Do you agree?” For each benefit, the respondents were asked to click one of 4 possible answers - “Strongly agree”, “Agree”, “Disagree” or “Strongly disagree”. Respondents were asked to answer as many questions as they can, if they could not answer all of them. The analysis also focuses on the users’ feedback on the benefits of CCM.

4 RESPONDENTS’ VIEWS ON THE BENEFITS OF THE CCM SYSTEM

Tables 1 and 2 shows the mean score and the Standard Deviation (SD) for all the benefits included in this survey. For the purpose of this analysis, a numeric score is assigned to each answer: Strongly agree – 4, Agree – 3, Disagree – 2, and Strongly disagree – 1. Under this scoring scheme the minimum value is 1, which represents

100% “Strongly disagree” with the existence of that benefit. Maximum value is 4, representing 100% “Strongly agree”. The median value is 2.5. Any mean score greater than 2.5 represents a positive feedback. The result for each benefit is calculated based on the proportion of answer in each answer.

For example, for benefit “1.1 Quality assured change management process” the spread of total 85 is Strongly agree (24%), Agree (65%), Disagree (9%) and Strongly disagree (2%). This gives this benefit a mean score of 3.11 and SD of 0.65. To save space, the percentages are not shown in the tables. In addition to analysis of results for the whole user group (n=85), analysis is also conducted for three separate user groups Clients (n=19), Contractors (n=34) and Consultants (n=32). The results are all shown in tables 1 and 2. For the same benefit 1.1, the mean score for Clients is 3.31, 2.91 for Contractors and 3.19 for Consultants. This indicates that clients are more positive with the benefits of CCM than contractors; although both groups generally agree with the benefits. Consultant is somewhere in between these two. This pattern is quite consistent for virtually all the benefits in this survey.

Table 1. Survey results of CCM benefits (part 1).

Benefits	All (n=85)		Clients (n=19)		Contractors (n=34)		Consultants (n=32)	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Process Improvement								
1.1 Quality assured change management process	3.11	0.65	3.31	0.48	2.91	0.72	3.19	0.59
1.2 Rigorous process support	3.16	0.60	3.35	0.49	3.00	0.71	3.19	0.48
1.3 Support for automated flow of work	2.88	0.64	2.94	0.57	2.74	0.68	3.00	0.64
Business Improvement								
2.1 Reduce cost of implementing ECC	2.61	0.78	2.81	0.75	2.48	0.83	2.58	0.72
2.2 Reduce number and scale of disputes	2.62	0.74	2.81	0.66	2.53	0.82	2.55	0.68
2.3 Quicker closing of final accounts	2.83	0.87	3.29	0.73	2.55	0.89	2.87	0.82
Risk Management								
3.1 Greater visibility of status of all incidents	3.11	0.63	3.25	0.45	3.03	0.70	3.13	0.66
3.2 Provides a complete and documented audit trail	3.41	0.61	3.41	0.51	3.36	0.60	3.47	0.67
3.3 Provides early warning notification of risk	3.21	0.63	3.19	0.66	3.30	0.64	3.13	0.62
3.4 Rapid resolution of disagreements	2.45	0.68	2.63	0.62	2.33	0.84	2.47	0.51
3.5 Quicker agreement of compensation events	2.57	0.67	2.65	0.61	2.40	0.81	2.68	0.54
3.6 Focuses effort on proactive management of early warnings	2.99	0.63	3.00	0.54	2.88	0.71	3.09	0.59
3.7 Improves compliance to ECC procedures and contract management requirements.	3.21	0.61	3.31	0.48	3.03	0.71	3.34	0.56
3.8 Reduces risks of implementing ECC	2.88	0.69	2.88	0.72	2.72	0.84	3.03	0.49
Communication								
4.1 Improves communication between all parties	2.84	0.73	2.94	0.56	2.75	0.88	2.88	0.66
4.2 Documents are not lost or mislaid – leading to a reduction in authentication queries	3.27	0.57	3.18	0.53	3.23	0.62	3.38	0.55
4.3 Provides E-mail notification for important actions	3.09	0.71	3.19	0.54	2.94	0.62	3.19	0.86
4.4 Facilitates monitoring of the project by senior management	3.05	0.55	3.20	0.41	3.09	0.52	2.94	0.62
4.5 Instant availability of latest adjusted contract (target) price	3.00	0.69	3.13	0.50	3.06	0.70	2.88	0.75
4.6 Visibility to the client about changes in the project (usually price)	3.11	0.55	3.25	0.45	3.16	0.52	3.00	0.62
4.7 Records communications through PMI, EW, CE, NCE etc, thus reduces risk of unknown change	3.20	0.58	3.25	0.45	3.09	0.64	3.29	0.59
4.8 Use of CCM database as a Master document for decision making as well as for finding the current project status	2.76	0.68	2.80	0.56	2.69	0.76	2.80	0.66

The result shows that CCM users are clear about the benefits of system in process related aspects, such as Traceability, Communication, and Collaboration/Partnering. However, they are less convinced of the benefits related to direct cost reduction (2.1, 6.4) or reduction in the number of disputes (2.2, 3.4). Overall, there is a strong and clear cut positive feedback on all benefits,

with two exceptions (3.4 and 6.4). These two are the only ones that received mean score below 2.5. There are also differences in the views by different groups of users. Clients are the most positive group. They gave positive feedback on all the benefits, including 3.4 and 6.4.

Table 2. Survey results of CCM benefits (part 2)

Benefits	All (n=85)		Clients (n=19)		Contractors (n=34)		Consultants (n=32)	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Management Information								
5.1 Data gathered can be analysed during and after the contract	3.09	0.60	3.06	0.56	3.10	0.47	3.10	0.75
5.2 Recording of contract progress with date stamps for easy retrieval and analysis	3.09	0.57	2.94	0.44	3.03	0.49	3.24	0.69
5.3 Provides online contract performance information	2.93	0.62	3.00	0.61	3.00	0.61	2.83	0.65
5.4 Provides data export facilities for key performance trend management	2.74	0.56	2.79	0.58	2.71	0.46	2.74	0.66
5.5 Improved predictability of end costs and end dates	2.66	0.70	2.75	0.58	2.65	0.66	2.61	0.83
Efficiency								
6.1 Simple, point and click operation of the entire process	2.97	0.60	3.07	0.59	2.90	0.66	3.00	0.57
6.2 Minimises administrative and secretarial activities	2.86	0.78	3.07	0.59	2.66	0.90	2.97	0.71
6.3 Version and authorisation control of documents, minimises disagreements over facts	2.93	0.68	2.88	0.62	2.82	0.77	3.06	0.63
6.4 Reduces QS time and costs, as CE are agreed quickly	2.47	0.82	2.87	0.74	2.33	0.84	2.43	0.82
6.5 Reduces QS costs due to reduction in unresolved issues post completion	2.62	0.77	2.86	0.66	2.47	0.78	2.69	0.81
6.6 Reduces post project completion issues	2.82	0.78	3.00	0.68	2.68	0.82	2.86	0.79
6.7 Improves quality of quotation, build up information and related audit trail	2.71	0.85	2.71	0.73	2.60	0.81	2.80	0.96
6.8 Saves man hours in document creation, filing and searching	2.96	0.83	3.13	0.50	2.70	0.95	3.17	0.79
6.9 User friendly software – reduces induction timescales	2.83	0.73	3.00	0.37	2.67	0.80	2.90	0.79
Collaboration/ Partnering								
7.1 Provides access to process operation and status information by all parties, any time, any place	3.20	0.46	3.19	0.40	3.16	0.52	3.25	0.44
7.2 Assues document version control through a secure audit trail	3.17	0.52	3.12	0.49	3.06	0.51	3.31	0.54
7.3 Facilitates collaborative decision making	2.82	0.62	2.94	0.57	2.68	0.65	2.90	0.61
7.4 Highlights next action which cannot be ignored or forgotten	3.14	0.57	3.12	0.49	3.06	0.57	3.23	0.62
Traceability								
8.1 Archives of key documents for analysis at any time	3.15	0.60	3.00	0.52	3.13	0.55	3.27	0.69
8.2 Date stamps all key operations	3.33	0.50	3.18	0.39	3.19	0.48	3.52	0.51

Table 3. Perceptions about the CCM system.

Rate	Clients	Contractors	Consultants
Poor	-	3.0%	-
Average	18.8%	21.2%	9.1%
Good	81.3%	66.7%	63.6%
Excellent	-	9.1%	27.3%

Table 3 indicates the perception of the users about the CCM system. It is noted that most of the users have rated CCM system as Good or Excellent thus leading to overall positive scoring. It is also noted that 3% of the Contractors have rated it as ‘Poor’ system to use.

The table 4 shows the ranking of top 10 benefits based on the mean score using statistical analysis. It includes the ranking by all users as well as the rankings by Clients, Contractors and Consultants separately.

The highest mean score achieved is for “3.2 Provides a complete and documented audit trail” is 3.41. It is ranked top by the whole group, as well as the Clients and the Contractors. It is followed by “8.2 Date stamps all key operations”, and “4.2 Documents are not lost or mislaid – leading to a reduction in authentication queries”. Other benefits in the top 10 include (in ranking order) 3.3, 3.7, 7.1, 4.7, 7.2, 1.2 and 8.1. Three out of the top 10 benefits

(3.2, 3.7, & 3.3) are related to ‘Risk Management’. This implies that users perceive CCM as helping them to manage and reduce Risk.

Table 4. Ranking of top 10 benefits based on mean score.

	Ranking by All	Ranking by Clients	Ranking by Contractors	Ranking by Consultants
3.2 Provides a complete and documented audit trail	1	1	1	2
8.2 Date stamps all key operations	2	-	4	1
4.2 Documents are not lost or mislaid – leading to a reduction in authentication queries.	3	-	3	3
3.3 Provides early warning notification of risk	4	10	2	-
3.7 Improves compliance to ECC procedures and contract management requirements.	5	3	-	4
7.1 Provides access to process operation and status information by all parties, any time, any place	6	-	6	8
4.7 Records communications through PMI, EW, CE, NCE etc, thus reduces risk of unknown change	7	6	9	6
7.2 Assures document version control through a secure audit trail	8	-	-	5
1.2 Rigorous process support	9	2	-	-
8.1 Archives of key documents for analysis at any time	10	-	7	7

Clients have five benefits (3.2, 3.3, 3.7, 4.7 & 1.2) in their top ten that are also shown in the overall top 10 ranking. It is interesting to observe that “2.3 Quicker closing of final accounts” (mean= 3.29, SD 0.73) is considered as an important benefit and is ranked 5th by the Clients. However, feedback from the other two groups, especially contractor, is less positive. As a result, this benefit only ranks in 31st position according to mean score for all users. On the other hand, clients did not ranked benefits under the categories of ‘Management Information’, ‘Efficiency’, ‘Collaboration/ Partnering’ and ‘Traceability’ in the top 10. Contractors and consultants gave these benefits higher scores.

The comparison of the whole group against the Contractors illustrates approximately 60% of the top Contractors rankings agree with those of the whole group’s as seen by the occurrence of top 6 benefits (3.2, 3.3, 4.2, 8.2, 7.1, & 4.7). Contractors perceive ‘Communication’ category as most important benefit from CCM ($f= 4$ for, 4.2, 4.6, 4.7 & 4.4). Contractors have also ranked benefit “3.2 Provides a complete and documented audit trail” (mean= 3.36, SD= 0.60) as the top rank benefit which also is in agreement by the whole survey sample. Benefit “4.4 Facilitates monitoring of the project by senior management” (mean= 3.09, SD=0.52) is ranked 10th by the Contractors where as it is considered less important by the whole group and is ranked 18th. Contractors have not ranked any top benefits under the categories of ‘Process Improvement’, ‘Business Improvement’ and ‘Efficiency’.

The comparison of the whole group against the Consultants illustrates approximately 80% of the top Consultants rankings agree with those of the whole group’s ranking as seen by the occurrence of top 8 benefits (8.2, 3.2, 4.2, 3.7, 7.2, 4.7, 8.1 & 7.1) out of 10 ranked by the whole sample. Consultants perceive ‘Collaboration / Partnering’ category as most important benefit from the CCM ($f= 3$ for,

7.2, 7.1 & 7.4). Consultants have also ranked benefit “8.2 Date stamps all key operations” (mean= 3.53, SD= 0.51) as the top benefit compared to ranked 2nd by the whole group. Benefit “5.2 Recording of contract progress with date stamps for easy retrieval and analysis” (mean= 3.24, SD= 0.69) is ranked 9 in importance by the Consultants compared to rank 16 by the whole group. Consultants have not ranked any benefits under the category ‘Process Improvement’, ‘Business Improvement’ and ‘Efficiency’.

In addition to analysis of rankings based on mean scores, CCM users are asked directly in the questionnaire to identify top 5 benefits in an order of importance. During analysis, a weighing factor was assigned to different score, 100 to 1st benefit, 95 to 2nd, 90 to 3rd, 85 to 4th, and 80 to 5th. Then, the accumulative score is calculated for each benefit and a ranking is decided based on the final score. The benefit with the highest score ranks first, next highest score ranks second, and so on. The result, based on ranking from all respondents, is shown in column 2 of Table 5. The same analysis was also carried out for different groups of respondents. The results are shown in columns 3-5 in the Table 5. It is interesting to note the difference in the ranking by different groups. For example, “3.7 Improves compliance to NEC/ECC procedures and contract management requirements” was ranked top by all respondents as a whole group. It was ranked top by Clients and Consultants. However, it was ranked 4th by the Contractors. “1.2 Rigorous process for management of change” was ranked 3rd overall, but did not even make the top 10 in the Contractor’s ranking. It is interesting to note from the mean score tables Clients are more positive towards the CCM system and Contractors are the least.

The ranking according to the mean score in Table 4 shows the extents that CCM is delivering particular benefits. The ranking in Table 5 indicates the degree of important of the benefits. Six benefits (3.2, 3.3, 3.7, 7.1, 4.7, & 1.2) appear in both lists. This implies that the CCM system is providing benefits that are considered important by its users.

Table 5. Ranking of top 10 benefits based on users assessment.

	Ranking by All	Ranking by Contractors	Ranking by Clients	Ranking by Consultants
3.7 Improves compliance to ECC procedures and contract management requirements.	1	4	1	1
3.2 Provides a complete and documented audit trail	2	7	4	2
1.2 Rigorous process for management of change	3	-	3	4
4.7 Records communications through PMI, EW, CE, NCE etc, thus reduces risk of unknown change	4	-	-	6
2.3 Quicker closing of final accounts	5	-	6	10
7.4 Highlights next action which cannot be ignored or forgotten	6	1	-	-
3.6 Focuses effort on proactive management of early warnings	7	-	-	5
7.1 Provides access to process operation and status information by all parties, any time, any place	8	-	-	3
3.3 Provides early warning notification of risk	9	2	-	-
3.1 Greater visibility of status of all incidents	10	3	-	10

5 CONCLUSIONS

IT collaboration tools are important for Construction Industry as they help to improve productivity, performance, efficiency, predictability, reliability as well as help in reducing risk and reducing costs. For certain construction projects, where teams are working far apart from each other, IT tools help the teams to work under a collaborative environment and thus saves the meeting time, costs as well as other important resources. The survey results reported in this paper demonstrate that the CCM system adds value to management of NEC/ECC projects by providing process supports. 41 out of 43 benefits received positive responses as their mean score are above the median value. The standard deviations of the mean scores of the benefits are also low. This indicates that the answers are quite consistent. The survey also revealed some differences in the perception and expectation of CCM by different groups of users.

The overwhelming positive feedback from the users on the CCM system and its benefits provides a good basis for the future expansion of its application. However, the survey and related interviews have also revealed some potential challenges for its implementation in practice. As with any new IT systems, there is often a level of scepticism initially toward adopting CCM by some parties in a project. This study has shown that commitment from the client and leadership from the project manager are usually key to successful adoption of the CCM system in a project. CCM helps to improve the contract change management process and makes the process more transparent. It can be perceived by some parties as a pressure for compliance with contractual requirements as the system generates and archives complete contract data by developing an 'audit trail' which can be used either for organisation post project learning or when the project falls into litigation. Some individual professionals can also be anxious about the fact that their decisions and decision making process are potentially easily monitored by senior managers. Finally, the lack of a measurement method to quantify the extents of CCM benefits is also a barrier for some users to embrace the system fully. These issues will be investigated in the next phase of this study.

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