

USER SURVEY: THE BENEFITS OF AN ONLINE COLLABORATIVE CONTRACT CHANGE MANAGEMENT SYSTEM

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SUMMARY: *The Contract Change Management (CCM) system is an on-line collaboration tool, which supports the contract change management process of NEC (New Engineering Contract) form of contract. It is currently used in practice on a wide range of live civil, power and building projects in the UK. Anecdotal evidences show that the system helps construction projects in saving costs, reducing risk and increasing predictability. The aim of this study is to ascertain these benefits through first-hand feedback from its users. Key questions are: Does CCM help the contract change management process of NEC projects? What are its main benefits? Is there any difference between the views of different types of users, such as clients, contractors, or consultants? To achieve this aim, a questionnaire survey was conducted amongst 260 CCM users with a response rate of 33%, or 85 valid replies. The results have shown that most users are very positive and consistent in their responses. Process supports, such as audit trail and communication records, received the highest positive replies. Answers to benefits related to cost saving and business improvement are more mixed. Amongst the different user groups, clients and consultants are more positive towards the system than contractors.*

KEYWORDS: *IT benefits, Collaboration tools, User survey, Questionnaire, Change management.*

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1. INTRODUCTION

Traditionally, changes and variations often cause disputes, claims, delays and cost overruns in construction projects. The New Engineering Contract (NEC), initially published in 1991, is designed to encourage good management practice and to improve the contract change management process (Mitchell and Trebes, 2005). The essence of NEC is the emphasis on team collaboration when dealing with changes that might affect cost, timescale and quality of product. The key stakeholders of a project, e.g. the contractor and project manager, are required to provide each other early warning of matters which may have an impact on costs, timescale and quality of product. Each early warning usually triggers a sequence of communications between the contractor and the project manager. NEC requires that all communications are done in writing and replies to be given within a time limit specified in the contract. During a typical project, there are often many internal and external factors that may lead to a large number of early warnings. To comply with NEC procedures, a significant amount

of paperwork is often generated for both the contractor and the project manager, which can be difficult to manage using the traditional paper based information and communication systems.

CCM is an internet delivered collaborative system, provided by Management Process Systems Ltd (MPS), which supports the contract change management processes of NEC. It has been used on hundreds of building and engineering projects in the UK. Many users are convinced of the benefits of the system in helping them reduce risks and save costs based on anecdotal evidence. There is a desire by both the CCM service provider and its users to ascertain the benefits of the system through an objective user survey. As part of a two year research project, one such a survey has been conducted. The aim of the survey was to establish: (1) does the system deliver the benefits it promises in practice; (2) what are the most important benefits from the user perspective; and (3) are there any differences between different user groups? This paper presents the main findings of this survey.

2. NEC PROCESSES AND THE CCM SYSTEM

The NEC contract seeks to address the challenge of contract change through encouraging good management process and better collaboration between all parties involved in the decision making process. It requires the principal parties to notify each other as soon as certain conditions become apparent, which may lead to project changes at a later stage. This is called an Early Warning (EW) because it allows the team time to consider their options to deal with the risk, before it impacts on the project's timescales, costs, safety, or quality. Fig 1 shows the NEC processes after an Early Warning is raised. During NEC projects the team is required to hold regular Early Warning, also known as Risk Reduction, meetings to review all known risks and consider action. When a change risk is identified, the Project Manager (PM) usually needs to issue an Instruction (PMI) to the Contractor to deal with the risk or carry out necessary change. If the change has an impact on cost and/or schedule, it will be regarded as a Compensation Event. The Contractor is then required to provide a Quotation for the work, including costs for any time related works caused by any delays. The response period for this is usually 3 weeks, although this may be extended. The PM then has 2 weeks to accept the Quotation, seek resubmission due to incorrect assessment, or carry out a PM Assessment. In most projects, the commercial and programme impact of a change is usually considered and partially agreed at the EW meeting.

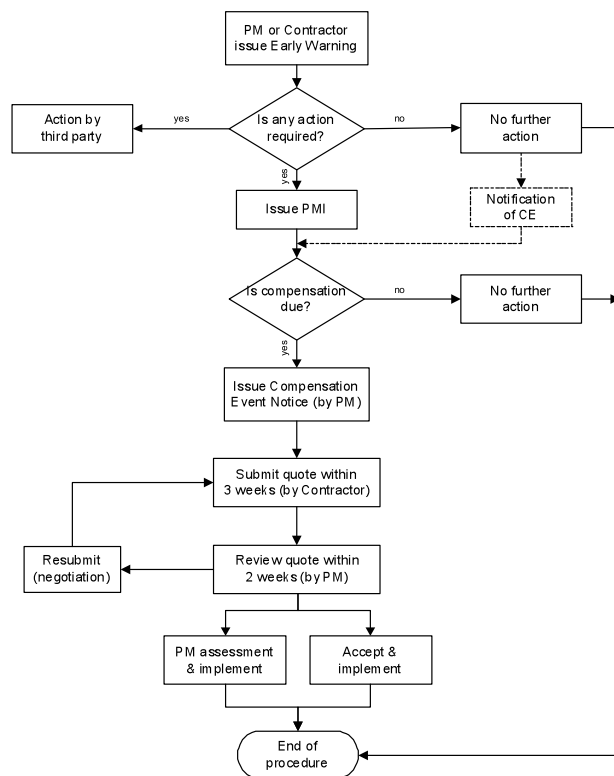


FIG. 1: Contract change management process under NEC contract

Although the process of change management under NEC is well defined, its successful execution in practice relies on good communication and information sharing between the project parties, as well as robust support for the decision making process. These are difficult to be achieved without the support of an appropriate tool. The CCM system is specifically designed to support the NEC change management process (Fig 2). The system manages the life cycles of all notices issued by the NEC contract, in a collaborative environment over the Internet. These include Early Warnings (EWs), Project Manager Instructions (PMIs), Notification of Compensation Events (CEs), Quotations, Project Manager (PM) Assessments, Implementations, and a variety of PM/Contractor Communications. All documents are user and date stamped and held in an audit trail. The impacts of CEs are monitored against the activity schedules for each work package, in order to ensure that the adjusted target price and target completion date are up to date. The key intended business benefits of CCM include: (1) Increased productivity by improving communication efficiency; (2) Improved predictability of outcome (cost & time); (3) Reduced project risk; (4) Better compliance with contract requirement; and (5) Process visibility and auditability. This study seeks to gain feedback from CCM users on these potential benefits of the system.

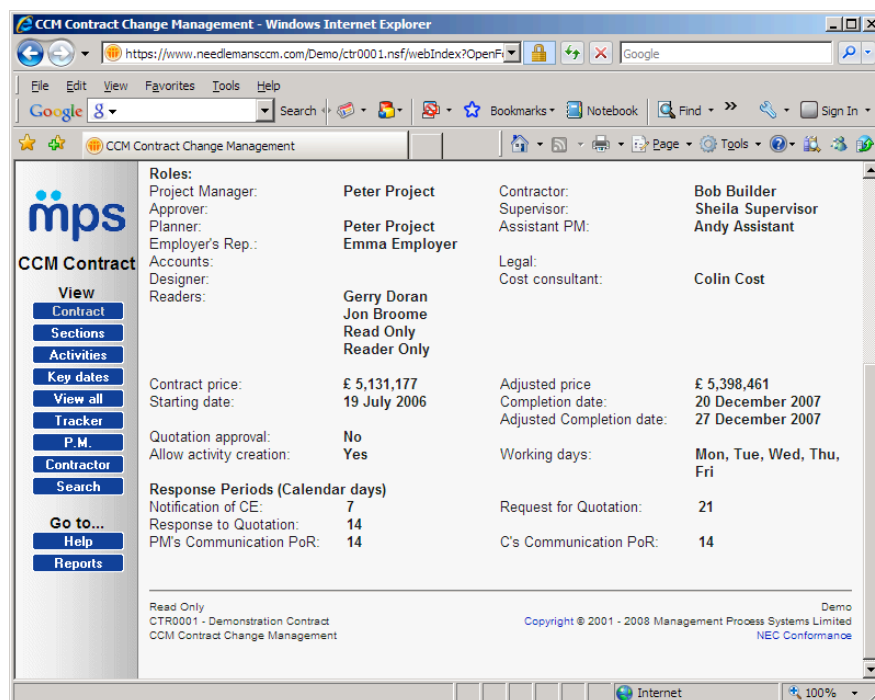


FIG. 2: A Screenshot of the Contract Change Management (CCM) system

3. MEASURING THE BENEFITS OF IT

Since the 1980s with the growing use of computers in business processes, there has been a consistent interest in measuring the benefits of IT. Back in 1984, the UK HM Treasury (1984) published a report outlined a method for evaluating the impact of information technology in government offices. It divided the IT benefits into three categories: (1) those capable of quantification and valuable in monetary term; (2) those generally quantifiable but difficult to value; and (3) those identifiable but not quantifiable. This work influenced many subsequent studies on measurement of IT benefits. In the construction sector, CIRIA (1996) and the Construction Industry Computing Association undertook a study on quantifying the benefits of IT in construction organisations. They carried out seven in-depth case studies. The study highlighted the complexity of conducting cost/benefit analysis for IT investment. It recommended the both tangible and intangible benefits should be considered in any analysis. A subsequent study by the Construct IT Centre (1998) produced a formal framework for measuring the benefits of IT investment. It suggested that IT benefits should be evaluated in three perspectives: *efficiency*; *effectiveness* and *performance*. A benefits matrix was proposed by this study to facilitate the application of this measurement framework. Other studies in this area include Li (1996), Powell (1992), Love and Irani (2001), etc.

In practice, many business managers want to use the traditional investment appraisal methods, such as Net Present Value (NPV), Internal Rate of Return (IRR) or Return on Investment (ROI), to evaluate IT investment.

However, these methods have been proven not appropriate for valuing the extensive intangible benefits often associated with IT investment (Kumar 2000; Ballantine and Stray 1999; Serafeimidis and Smithson 2000). As a result, many IT evaluations only focus on the tangible and quantifiable savings (Anderson et al, 2000). Marsh and Flanagan (2000) proposed an evaluation methodology for tangible benefit. Unfortunately, their method is limited to a specific IT application - the use of high-density bar coding during the maintenance of mechanical and electrical services installation.

Some recent studies focus on establishing empirical evidences of IT benefits through surveys and case studies. Love et al (2005) conducted a questionnaire survey on the benefits of IT investment on a large number of construction organisations in Australia. Their study concentrated on the IT investment decision making by these organisations. Stewart and Mohamed (2003) reported a user survey aimed at evaluating the value of IT adds to the process of project information management in construction. The Network for Construction Collaboration Technology Providers (NCCTP), which includes all the major providers of construction project collaboration tools in the UK, sponsored a survey with 272 users. They aimed at providing a representative, quantifiable measure of the various benefits identified by people with first hand experience of using collaboration technology on live projects (NCCTP, 2006). Pollalis and Becerik (2006) undertook a separate study looking at similar issues using case study method. Nine case studies were carried out, during which questionnaire was used to obtain respondent feedback on the benefits of online collaboration and project management tool.

4. RESEARCH METHODOLOGY - QUESTIONNAIRE SURVEY

In order to gather feedback from a large number of CCM users, questionnaire survey was chosen as the main research method. Unlike other information sharing oriented collaboration tools, the CCM system does not need to be used by every member of a project team. Instead, for each project the usual number of users is 3-5. In addition, because the system is relatively new its total user base is fair small. Therefore, it was decided to include all the CCM users in the survey. A list of users and their contact details were obtained from the service provider. After removing the names whose contact details were no longer up-to-date, a total of 260 users were identified as the target audience of this survey. A questionnaire was then developed, which contains 26 questions in the following 5 sections:

- *You and your organisation:* This section includes questions about the “type of organisation”; “role/job title of respondent”; “attitude towards using computer”; “IT skills and competence” and “types of Internet access”.
- *Your experience with the NEC and CCM:* This section includes questions on “the number of year of working in construction”; “the number of NEC projects undertaken”; “attitude towards NEC form of contract”; “number of projects where CCM was used”; and “various aspects related to the usage of CCM”.
- *Benefits of the CCM system:* This is the main section of the questionnaire. A list of 43 potential benefits was identified based on anecdotal evidence. These benefits were listed under 8 categories: (1) Process improvement; (2) Business improvement; (3) Risk management; (4) Communication; (5) Management information; (6) Efficiency; (7) Collaboration/Partnering; and (8) Traceability. For each benefit, the respondents were asked to choose one from 4 possible answers - “Strongly agree”, “Agree”, “Disagree” or “Strongly disagree”. In addition, respondents were also asked to list top five benefits from their perspective.
- *Evaluation of the CCM system:* In this section, the respondents were asked to rate their levels of satisfaction for various aspects of the CCM system, including “functionality”, “user interface”, “usability”, “reliability” and “on-line help”. They were also asked to provide an overall rating for the CCM system.
- *Feedback on MPS services:* In this section, the respondents were asked to rate their level of satisfaction for various aspects of the services provided by the service provider, including “configuration and database set up”, “initial training”, user support” and “customer relationship management”.

The questionnaire is designed to contain a mixture of different types of questions. Classification questions are asked for personal and organisational details. These are used to establish the profiles of respondents. Individual identity is not asked to ensure anonymity of replies and minimise potential biases in the answers. Factual questions are asked on respondents’ experience of NEC projects and the CCM system. Opinion questions are used for respondents’ view of the benefits of the CCM system, and their overall evaluation of the system as well

as the quality of service they received. Multiple choice style answers are used for most of the questions to facilitate reply and subsequent data analysis. Several open questions are included for respondents' suggestion on the CCM system features and comments on the quality of service.

Prior to the main survey, a pilot was carried out with 5 selected CCM users. As a result, some minor adjustments were made to some of the questions. Once the questionnaire is finalised, it is printed and sent to the 260 CCM users through post with a cover letter and a return envelope. They were asked to reply within two weeks. A reminder was sent out through email a few days before the deadline. All these efforts were aimed to encourage replies from as many users as possible. In the end, 85 valid responses were received, which represent a return rate of 32.7%. All replies were coded and entered into the SPSS software package for subsequent analyses.

5. SURVEY RESULTS AND ANALYSIS

5.1 Profiles of respondents

- The respondents to the survey included Contractors (40%), Client Organisations (22%), and Consultants (38%). The Consultants category includes Quantity Surveyors, Project Management Consultants, and Architect/Design/Engineering specialists.
- According to roles, the respondents included Project/Contract Managers (41%), Quantity Surveyors (19%), Directors/ Senior Managers (15%), Commercial Managers (11%), Supervisors/ Clerk of Works (4%), Architect/ Design/ Engineering (1%) and 'Others' category (9%).
- 98% of the respondents are "comfortable working with computers". A similar number "welcomes the opportunity to utilise computer systems for better business management". However, 33% would be "resistant to using computer systems if they require extensive training".
- 96% rated themselves as "Intermediate" or "Expert" IT users; only 4% self rated as "Basic" user.
- Almost all respondents have broadband Internet access.
- 92% of respondents have Internet access at work; 46% can access using laptop on the move; 62% have home Internet access, and 27% use Internet from other business offices.

5.2 Respondents' experiences with NEC and CCM

- Approximately 31% of respondents have over 25 years of experience in the construction industry, another 31% have 16-25 years and 32% have 6-15 years. A small number (under 7%) have 0-5 years of experience. (or 94% of respondents have more than 6 years experience in the industry)
- Most of the respondents have used the NEC form of contract. Amongst them, 24% have used NEC on over 6 projects; 29% have used it on 4-6 projects and 44% have used NEC on 1-3 projects.
- Most of the respondents have a positive view of NEC as a standard form of contract (Table 1). Of all respondents, 88% consider NEC as either "Excellent" (29%) or "Good" (59%). The Client group is particularly in favour of NEC; 94% regard it as "Excellent" or "Good". No client considers NEC contract as "Poor". For Contractors, the proportion that rated NEC as "Excellent" or "Good" is 81%. It is smaller than that of the Clients, but still a clear majority.

TABLE 1: Rating of NEC as standard form of contract.

Rating	Excellent	Good	Average	Poor
Clients	22.2%	72.2%	5.6%	0.0%
Contractors	22.6%	58.1%	16.1%	3.2%
Consultants	33.3%	56.7%	6.7%	3.3%
All	28.9%	59.0%	9.6%	2.4%

- Implementing NEC contract requires a good collaboration between different members of a project team. The questionnaire included questions on a list of specific requirements. Table 2 summarises users' answers. It can be seen that there is a general agreement on most of these requirements. This underlies the need for a collaboration support tool to assist the project management processes.

TABLE 2: Answers to the NEC implementation requirements.

Do you agree that implementing NEC requires?	Yes	No

Requires quick management response to queries	98.8%	1.2%
Frequent review on outstanding actions compared to other forms of contract	96.3%	3.7%
An increase in the number of formal notifications compared to other forms of contract	82.9%	17.1%
Rigorous contract management process	92.6%	7.4%
Greater amount of management resources compared to other forms of contract	64.2%	35.8%
Greater visibility of risk and change at all levels in the organisation	86.6%	13.4%
Formal training in the operation of the process	85.4%	14.6%

- CCM supports two types of users - Active User (who can enter information into the system) and Read Only User (who can only read and download information from the system). 74% of the CCM users surveyed were Active Users (they might also be Read Only users on different projects), and 26% are Read Only users.
- 30% of all respondents use CCM up to an hour per week; 35% use it for 1-3 hours; 25% use for 3-5 hours; 5% use 5-8 hours and 5% use it for more than 8 hours per week. However, the usage varies between client, contractor and consultant users, as well as between different project stages. Details are shown in Table 3.

TABLE 3: Distribution of levels of CCM usage (hours per week)

Hours per week	<1	1-3	3-5	5-8	>8
Clients	55.6%	38.9%	5.6%	0.0%	0.0%
Contractors	21.9%	34.4%	28.1%	6.3%	9.4%
Consultants	24.1%	37.9%	37.9%	0.0%	0.0%
At initial stage	50.0%	20.0%	30.0%	0.0%	0.0%
At mid stage	10.0%	46.7%	30.0%	10.0%	3.3%
At end/closure	28.0%	36.0%	24.0%	4.0%	8.0%
Average	30.1%	34.9%	25.3%	4.8%	4.8%

- CCM provides a 24 hour / 7 day service. 30% of the CCM users take advantage of this provision by accessing the system during evenings and weekends. Their 'out of office' hour access counts, on average, for 10-25% of their use of the system.

5.3 Overview of CCM benefits survey results

As stated earlier, a list of 43 benefits in 8 categories was identified prior to the survey. The question in the questionnaire reads: "anecdotal evidence indicates CCM offers the following benefits. Do you agree?" For each benefit, the users were asked to choose from 4 possible answers - "Strongly agree", "Agree", "Disagree" or "Strongly disagree". For the purpose of data 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. Table 4 shows the survey results with regard to CCM benefits.

In order to fit in the width of the table, some of the benefit descriptions have been paraphrased. In these three tables, the percentage of responses for each answer is shown in columns under (1), (2), (3) and (4). Other columns show the Mean scores and Standard Deviations (SD) for All Users, as well as a breakdown of three different groups: Clients, Contractors and Consultants. For example, for the benefit "1.1 Quality assured change management process", 2% of the respondents answered "Strongly disagree", 9% of them answered "Disagree", 65% answered "Agree" and 24% answered "Strongly agree". This gives this benefit a mean score of 3.11 and standard deviation of 0.65 for the whole group of all 85 users. For the same benefit, the mean score for 19 clients is 3.31 with a standard deviation of 0.48. The mean score and standard deviation for the 34 contractors are 2.91 and 0.72; for the 32 consultants they are 3.19 and 0.59.

TABLE 4: Survey results of CCM benefits

Benefit description	(1)	(2)	(3)	(4)	All (n=85)		Clients (n=19)		Contractors (n=34)		Consultants (n=32)	
					Mean	SD	Mean	SD	Mean	SD	Mean	SD
Process Improvement												
1.1 Quality assured change management process	2%	9%	65%	24%	3.11	0.65	3.31	0.48	2.91	0.72	3.19	0.59
1.2 Rigorous process support	1%	7%	66%	26%	3.16	0.60	3.35	0.49	3.00	0.71	3.19	0.48
1.3 Support for automated flow of work	3%	19%	65%	13%	2.88	0.64	2.94	0.57	2.74	0.68	3.00	0.64
Business Improvement												
2.1 Reduce cost of implementing NEC	6%	38%	44%	12%	2.61	0.78	2.81	0.75	2.48	0.83	2.58	0.72
2.2 Reduce number and scale of disputes	6%	35%	50%	9%	2.62	0.74	2.81	0.66	2.53	0.82	2.55	0.68
2.3 Quicker closing of final accounts	8%	24%	46%	22%	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	1%	11%	63%	25%	3.11	0.63	3.25	0.45	3.03	0.70	3.13	0.66
3.2 Provides a documented audit trail	1%	2%	51%	46%	3.41	0.61	3.41	0.51	3.36	0.60	3.47	0.67
3.3 Provides early warning notification of risk	0%	11%	57%	32%	3.21	0.63	3.19	0.66	3.30	0.64	3.13	0.62
3.4 Rapid resolution of disagreements	6%	45%	44%	5%	2.45	0.68	2.63	0.62	2.33	0.84	2.47	0.51
3.5 Quicker agreement of compensation events	8%	30%	59%	3%	2.57	0.67	2.65	0.61	2.40	0.81	2.68	0.54
3.6 Proactive management of early warnings	1%	16%	65%	18%	2.99	0.63	3.00	0.54	2.88	0.71	3.09	0.59
3.7 Improves compliance to NEC procedures.	1%	6%	63%	30%	3.21	0.61	3.31	0.48	3.03	0.71	3.34	0.56
3.8 Reduces risks of implementing NEC	4%	18%	63%	14%	2.88	0.69	2.88	0.72	2.72	0.84	3.03	0.49
Communication												
4.1 Improves communication between all parties	5%	21%	60%	14%	2.84	0.73	2.94	0.56	2.75	0.88	2.88	0.66
4.2 Documents are not lost or mislaid	0%	7%	60%	33%	3.27	0.57	3.18	0.53	3.23	0.62	3.38	0.55
4.3 E-mail notification for important actions	4%	10%	60%	26%	3.09	0.71	3.19	0.54	2.94	0.62	3.19	0.86
4.4 Facilitates monitoring by senior management	1%	9%	74%	16%	3.05	0.55	3.20	0.41	3.09	0.52	2.94	0.62
4.5 Instant availability of latest contract prices	4%	12%	64%	20%	3.00	0.69	3.13	0.50	3.06	0.70	2.88	0.75
4.6 Visibility to the client about changes	1%	6%	73%	2%	3.11	0.55	3.25	0.45	3.16	0.52	3.00	0.62
4.7 Records communications: PMI, EW, CE, NCE	0%	9%	62%	29%	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	3%	29%	57%	11%	2.76	0.68	2.80	0.56	2.69	0.76	2.80	0.66
Management Information												
5.1 Data can be analysed during/after the contract	3%	6%	71%	20%	3.09	0.60	3.06	0.56	3.10	0.47	3.10	0.75
5.2 Contract progress with date stamps	1%	8%	71%	20%	3.09	0.57	2.94	0.44	3.03	0.49	3.24	0.69
5.3 Online contract performance information	1%	18%	66%	14%	2.93	0.62	3.00	0.61	3.00	0.61	2.83	0.65
5.4 Data export for performance trend management	3%	23%	71%	3%	2.74	0.56	2.79	0.58	2.71	0.46	2.74	0.66
5.5 Improved predictability of end costs/end dates	4%	36%	51%	9%	2.66	0.70	2.75	0.58	2.65	0.66	2.61	0.83
Efficiency												
6.1 Simple, point and click operation process	1%	16%	68%	15%	2.97	0.60	3.07	0.59	2.90	0.66	3.00	0.57
6.2 Minimises administrative/secretarial activities	5%	23%	53%	19%	2.86	0.78	3.07	0.59	2.66	0.90	2.97	0.71
6.3 Minimises disagreements over facts	1%	23%	58%	18%	2.93	0.68	2.88	0.62	2.82	0.77	3.06	0.63
6.4 Reduces QS time/costs, as CE agreed quickly	9%	46%	33%	12%	2.47	0.82	2.87	0.74	2.33	0.84	2.43	0.82
6.5 Reduction in unresolved issues post completion	8%	32%	51%	9%	2.62	0.77	2.86	0.66	2.47	0.78	2.69	0.81
6.6 Reduces post project completion issues	6%	24%	54%	17%	2.82	0.78	3.00	0.68	2.68	0.82	2.86	0.79
6.7 Improves quality of quotation by audit trail	9%	27%	48%	16%	2.71	0.85	2.71	0.73	2.60	0.81	2.80	0.96
6.8 Saves man hours in document management	6%	17%	51%	26%	2.96	0.83	3.13	0.50	2.70	0.95	3.17	0.79
6.9 User friendly software; reduces induction	8%	12%	68%	12%	2.83	0.73	3.00	0.37	2.67	0.80	2.90	0.79
Collaboration/Partnering												
7.1 Access to process operation/status by the team	0%	3%	75%	23%	3.20	0.46	3.19	0.40	3.16	0.52	3.25	0.44
7.2 Assures document version control	0%	6%	70%	23%	3.17	0.52	3.12	0.49	3.06	0.51	3.31	0.54
7.3 Facilitates collaborative decision making	1%	26%	63%	10%	2.82	0.62	2.94	0.57	2.68	0.65	2.90	0.61
7.4 Highlights next action not be ignored/forgotten	0%	10%	66%	24%	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	1%	8%	66%	25%	3.15	0.60	3.00	0.52	3.13	0.55	3.27	0.69
8.2 Date stamps all key operations	0%	1%	65%	34%	3.33	0.50	3.18	0.39	3.19	0.48	3.52	0.51

5.4 Analysis and discussions of CCM benefit survey results

Based on analysis of the CCM benefits survey results (Table 4), the following tentative conclusions can be drawn:

- The vast majority of the CCM users agree that the system offers key benefits in helping the contract change management process of NEC projects. Out of the potential 43 benefits, 41 benefits received positive feedback with mean scores greater than the median value. The two benefits with negative feedback are “3.4 Rapid resolution of disagreements” and “6.4 Reduces QS time and costs, as CE agreed quickly”. This result implies that CCM is a tool that can assist dispute resolution between the project partners. It is not a solution itself. A range of other benefits should suggest that the system can help to reduce time and costs for all professionals involved. However over half of the respondents were not convinced such a benefit for Quantity Surveyors. This could mean that they do not believe that CCM helps to reduce time and costs for QS; or it might mean that they do not see solid evidence due to the lack of appropriate measurement method.
- Evidence of benefits in helping with the process of contract change management is more overwhelming. Amongst the 8 categories of potential benefits, Traceability received the highest percentage positive reply (“Agree” or “Strong agree”) from 95% of users. It is followed by Collaboration/Partnering (89%), Process Improvement (86%), Communication (84%), Management Information (79%). In comparison, the benefits related to the outcomes of the change management process received more mixed responses. The positive reply for Efficiency related benefits is 70%; and for Business Improvement benefits the figure is 61%.
- Table 5 shows the top ten benefits of CCM in a ranking order according to value of mean score. For NEC projects change management process is extremely important. When a compensation event occurs, the requirement of notification and acceptance by all the principal parties is clearly defined in the contract. The party who fails to take appropriate action in time will risk losing money or time. It is therefore not surprising that most of the top benefits are related to functions that help project team to comply with contract process requirement, such as “3.2 Provides a documented audit trail”, “8.2 Date stamps all key operations”, “4.2 Documents are not lost or mislaid”, and so on.

TABLE 5: Top ten benefits by mean score

Benefit description	Mean Score Ranking	Importance Ranking
3.2 Provides a documented audit trail	1	2
8.2 Date stamps all key operations	2	-
4.2 Documents are not lost or mislaid	3	-
3.3 Provides early warning notification of risk	4	9
3.7 Improves compliance to NEC procedures	5	1
7.1 Access to process operation/status by the team	6	8
4.7 Records communications: PMI, EW, CE, NCE	7	4
7.2 Assures document version control	8	-
1.2 Rigorous process support	9	3
8.1 Archives of key documents for analysis	10	-

- CCM users were asked explicitly in the questionnaire to identify top 5 benefits in an order of importance. During analysis, a weighing factor was assigned to different score, 100 for the top benefit, 95 to the 2nd benefit, 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 scores. The ranking according to mean score in Table 5 shows the extents that CCM is delivering particular benefits. The ranking according to importance indicates how important those benefits are. Six benefits appear in both lists; they are: “3.2 Provides a documented audit trail”, “3.3 Provides early warning notification of risk”, “3.7 Improves compliance to NEC procedures”, “7.1 Access to process operation/status by the team”, “4.7 Records communications: PMI, EW, CE, NCE”, and “1.2 Rigorous process support”. This implies that the CCM system is providing benefits that are considered important by its users. The other benefits in the top 10 according to importance are “2.3 Quicker closing of final account” at 5; “7.4 Highlights next action no be ignored/forgotten” at 6;

“3.6 Proactive management of early warning” at 7; and “3.1 Greater visibility of status of all incidents” at 10.

- The survey result breakdowns in Tables 4 show some interesting comparisons between the three main user groups- Clients, Contractors and Consultants. The mean scores indicate a good consistency between the groups. They all scored high for benefits related to Traceability, Collaboration/Partnering, Communication, and Process Improvement. On the other hand, they all score low for benefits related to Business Improvement and Efficiency. Clients are the most positive group. This group gave positive replies to all 43 potential benefits. This may be explained by the fact that CCM makes the contract change management process more transparent from the client’s perspective. It gives the client more control over the decision making process.
- In comparison, Contractors are the least positive group. They gave negative replied to five benefits (“2.1 Reduce cost of implementing NEC”, “3.4 Rapid resolution of disagreements”, “3.5 Quicker agreement of compensation events”, “6.4 Reduces QS time/costs, as CE agreed quickly”, and “6.5 Reduction in unresolved issues post completion”). In addition, the standard deviations for their mean scores are higher on a consistent basis for the Contractors. It implies more diverse views within this group.
- The general approval of the CCM system is also illustrated by the fact that 84% of the users during this survey regarded the system as “Good” or “Excellent”. Similarly, 89% of the users are happy with the quality of services of the system provider.
- The survey did not ask explicitly what the reasons are when a user does not like the CCM system. However, the analysis of the answers to the benefits related questions will shed some light to this issue. Respondents who rated CCM as “Average” or “Poor” (n=13) are identified. Their answers to benefits related questions are analysed. Table 6 lists the bottom 10 benefits according to mean scores by this group of users. All the mean scores in the table are below the median value of 2.50, which means this group of users do not believe CCM offer these benefits. These least convincing benefits are mainly related to reduction in cost (“6.4 Reduces QS time/costs, as CE agreed quickly”, “2.1 Reduce cost of implementing NEC”), reduction in the number of disputes (“6.5 Reduction in unresolved issues post completion”, “6.6 Reduces post project completion issues”, “2.2 Reduce number and scale of disputes”), increase in the speed of dispute resolution (“3.4 Rapid resolution of disagreements”, “3.5 Quicker agreement of compensation events”, “2.3 Quicker closing of final accounts”), or reduction in uncertainty (“5.5 Improved predictability of end costs/end dates”, “6.7 Improves quality of quotation by audit trail”). These results once again illustrate that an IT tool would not replace good management when solving business problems.

TABLE 6: Bottom 10 benefits by users who rated CCM as Average or Poor (n=13)

Benefits	Mean
6.5 Reduction in unresolved issues post completion	1.67
6.4 Reduces QS time/costs, as CE agreed quickly	1.73
3.4 Rapid resolution of disagreements	1.82
3.5 Quicker agreement of compensation events	1.83
6.6 Reduces post project completion issues	1.90
2.2 Reduce number and scale of disputes	1.91
2.3 Quicker closing of final accounts	2.00
5.5 Improved predictability of end costs/end dates	2.00
6.7 Improves quality of quotation by audit trail	2.00
2.1 Reduce cost of implementing NEC	2.08

6. CONCLUSIONS

This paper reported the results of a survey involving 85 users of the online Contract Change Management (CCM) system. The vast majority of the users believe the system delivers benefits in key aspects of managing NEC projects. 41 out of 43 benefits received positive scores. Process support related benefits, such as audit trail and communication records, received the highest percentage of positive replies. Benefits in the Risk Management category are regarded most important. Five of the top ten benefits according to user rated importance are related to Risk Management. Six of the top ten benefits by importance are in the top ten

according to mean scores. This correlation proves that CCM is delivering in areas regarded as important by its users.

Benefits in the Business Improvement and Efficiency categories received mixed responses. An analysis of the low scoring benefits, especially from the least positive group of users, showed that CCM does not automatically lead to direct cost savings or reduction in disputes. It is a tool that needs to be used together with good management in order to achieve business benefits.

Clients are most positive towards CCM. They provided positive scores for all 43 benefits. This may be because CCM enables them to monitor their projects more effectively. In contrast, Contractors are the least positive group even though they score higher than the median value in 38 of the 43 benefits. Consultants fall between these two groups.

The findings of this study show that the majority of the construction professionals have a positive attitude toward using IT tools, such as the CCM system, during the contract change management process of NEC projects. Amongst of the identified benefits of CCM, some are tangible and can be quantified in term of time and cost savings. Others are intangible and cannot be easily measured in financial terms, such as reducing risks and improving process quality. However, they are just as important as tangible benefits. In many cases, intangible benefits are more important because greater certainty and predictability and less risk can potentially lead to bigger savings. The survey only established the existence of these benefits from a user perspective. It does not provide any indication of the degree of the impact of CCM or ways of measuring the benefits of the system. The focus of the next phase of this study will be on developing appropriate methods to quantify both tangible and intangible benefits of the CCM system.

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