Proceedings of International Structural Engineering and Construction, 7(2), 2020
Emerging Technologies and Sustainability Principles
*Edited by* Askarinejad, H., Yazdani, S., and Singh, A.

ISSN: 2644-108X
www.doi.org/10.14455/ISEC.2020.7(2).CON-06

# USING KPI FOR INCENTIVIZATION

SAI ON CHEUNG, NAN CAO, and WING SUM ALFRED MA

*Construction Dispute Resolution Research Unit, Dept of Architecture and Civil Engineering, City University of Hong Kong, Hong Kong*

Construction projects are getting bigger and more complex. The services of multi-disciplinary teams of professionals are needed. To complete the projects on time, within budget and of required standards, concerted efforts of all team members are paramount. In Hong Kong, the HKSAR government has been promoting the use of the New Engineering Contract (NEC) for use in public projects on the belief that NEC can foster cooperation among the team members. Furthermore, incentives have been used to galvanize team effort in order to meet the project goals. This study posits to study the use of incentives under the NEC, in particular, how the Key Performance Index (KPI) can be used to monitor the attainment of the goals set under the incentive arrangement. Accordingly, Option X20 of the NEC was selected as the focus of this study. A questionnaire survey was used to collect views of practitioners as to what kinds of KPIs are suitable the operation of Option X20. The results of the survey indicated that cost- and time-related; objective and quantitative KPIs should be used as these are indicative of the achievement of collaboration. It is concluded that when suitable KPIs are selected with realistic and attainable targets, incentivizing effects can be materialized.

*Keywords*: Performance evaluation, NEC, Construction, Project management.

## 1 INTRODUCTION

Construction projects usually require specialized technical input from professionals of various disciplines. There has been a trend in the industry, calling for a change in the traditional adversarial culture by adopting a more collaborative project delivery approach. In this regard, the Hong Kong government has been searching for a suitable contract that would enable co-operative contracting. New Engineering Contract (NEC hereafter) has been advocated by a number of studies that would offer this effect (ICE 2013, Chan 2017, Kan and Le 2014, Manu *et al*. 2015, Kumaraswamy *et al*. 2005). In fact, NEC has also used quite often in infrastructure and building projects in Europe. As a result, NEC was selected and used in several pilots. Inspired by the success of these pilots, the HKSAR government has decided to extend the use of NEC in the procurement of public works project as of 2016. In particular, the target cost Options have been used in different mega projects (Development Bureau 2017).

With growing popularity, it is of interest to study in what ways NEC can be further utilized (Halliday 1995). For example, a study on the differences between the NEC and the traditional construction contracts (Broome and Hayes 1997), as well as the benefits of using the NEC (Wright and Fergusson 2009, Jackson 2012, O'Neil 2018, Lau *et al*. 2019). Very few studies have investigated the incentive arrangement under the NEC conditions of the contract. As Meng and Gallagher (2012) remarked that the use of contractual incentives in the construction is on the

rise, an effective incentivizing arrangement is gaining importance. This study aims to bridge the existing research gap by investigating the incentivization under the NEC conditions of contract and focuses on the use of Option X20 "Key Performance Indicators". This Option rewards the contractor if a specified target is met and has been adopted in the pilot projects in Hong Kong. As the outcome has proved satisfactory, the use of X20 in other public work projects can be expected (Development Bureau 2017). Toor and Ogunlana (2009) observed that performance measurement could be done by establishing KPIs that provide objective criteria to evaluate the success of a project. This study examines the prospect of X20 KPIs in enhancing the performance of the NEC contracting parties.

## 2 SUITABLE KPIS TO THE ACHIEVEMENT OF COLLABORATION

### 2.1 The Generalization of KPIs for the NEC3

The KPI Working Group (2000) has summarized a list of 38 indicators organized in six major groups, namely time, cost, quality, client satisfaction, business performance, and health & safety. In fact, KPIs have been utilized in many previous research in construction (Cheung *et al*. 2004, Lam *et al*. 2007, Luu *et al*. 2008) for benchmarking performance. While ICE (2005) pointed out the NEC3 does not include a set of possible KPIs itself, and the parties can introduce different KPIs based on their own objectives. Given the ethos of collaboration is one of the key features of NEC3, there is a good course to consider certain relevant KPIs are more suitable to be used with NEC3 better foster collaboration among the contracting parties. Barratt (2004) demonstrated that collaboration has four major manifestations: trust, mutuality, information exchange, openness, and communication. These four manifestations could provide a good basis for evaluating which KPIs are suitable for NEC projects in fostering collaboration. The thirteen KPIs shown in Table 1 were chosen from the UK KPI Report (KPI Working Group 2000). The significance of each of the chosen KPI to the promotion of collaboration was also evaluated.

### 2.2 Data Collection

An online questionnaire was designed to collect general opinions on the suitable KPIs for the NEC3. To this end, the questionnaire has two main questions. The first question was to identify and classify the background of the respondents by requesting them to indicate whether they had been involved in any NEC3 projects; while the second question seeks to find out the significance of each KPI to the achievement of collaboration (and hence its suitability for NEC3) by asking the respondents to rate each KPI against the four collaborative criteria on the aforementioned 1-5 scale (where 1 denotes "no", 2 denotes "marginal", 3 denotes "useful", 4 denotes "important", and 5 denotes "absolutely"). A collaborative score that is the mean score would be calculated for each KPI.

By snowballing effect, a total of eighteen NEC3-experienced practitioners completed the questionnaire, and twenty-seven practitioners without NEC experience were also provided data.

In addition, two NEC-experienced respondents, from the employer (Water Supplies Department) and the consultant currently being involved in an NEC3 public project, were invited to conduct a follow-up interview and provide expert advice. The interviewees were asked to share their insights into the subject and provide possible explanations for the general opinions gathered from the questionnaire survey. They were also welcomed to put forth extra information that was important to the subject matters. The descriptive statistics of the questionnaire results were illustrated in Table 1 – where the KPIs were listed in Table 2 in descending order of their collaborative scores (mean scores). Given the p-values obtained from the t-test were greater than

0.05 (Table 2), the null hypothesis could not be rejected. In other words, the mean values for the two respondent groups were not statistically significantly different from each other. This implied that respondents with or without NEC-related experience held a similar view on the KPIs selection. Table 2 shows that eight out of the thirteen KPIs received a collaborative score above three and that they were believed to be useful to promote collaboration. Among them, the five top-ranked KPIs a cost predictability – design and construction (a.), occurrence and magnitude of dispute (b.), time for construction (c.), time predictability – design and construction (d.), and contractor's involvement in project's design (k). To delve deeper into the significance of taking different KPIs to promote the achievement of collaboration among contracting parties under the NEC3, the collaborative elements that were given a score greater than "3" by at least 80% of respondents were denoted with a ligature to related KPIs in Figure 1.

Table 1. KPIs selected from the UK KPI Working Group (2000).

| Group | Indicators | Measure |
|---|---|---|
| Cost | Cost Predictability – Design and Construction | Difference between the actual design and construction cost and the estimated design and construction cost |
| | Occurrence and Magnitude of Disputes | Average cost involved in dispute settlement |
| Time | Time for Construction | Percentage of work completed on time |
| | Time Predictability – Design and Construction | Difference between actual design and construction time and estimated design and construction time |
| | Time to Rectify Defects | Time taken by the Contractor to rectify all defects in weeks |
| Quality | Defects | Impacts, at time of handover, caused by the condition of the facility, with respect to defects using 1-10 scale |
| | Quality Issues at the End of Defect Rectification Period | No. of outstanding quality issues at the end of defect rectification period |
| Satisfaction | Client's Satisfaction | How satisfied the client is with the finished product using the score against 1 to 10 scale |
| Change Orders | Change Orders | Turnaround time for response to change orders in weeks |
| Business Performance | Time Taken to Reach Final Account | Time taken to reach final account after practical completion in weeks |
| | Contractor's involvement in Project Design | Change in cost or time due to the alternative design proposed by the Contractor |
| Health and Safety | Reportable Accidents | Reportable accidents per 10,000 hours worked |
| | Lost Time Accidents | Lost time accidents per 10,000 hours worked |

Table 2. Descriptive statistics for the collaborative scores of the KPIs.

| Rank | Ref. | KPIs | Collaborative score | Standard deviation | T-test | |
|---|---|---|---|---|---|---|
| | | | | | F-ratio | p-value |
| 1 | a | Cost Predictability – Design and Construction | 4.400 | 0.474 | 0.800 | 0.397 |
| 2 | b | Occurrence and Magnitude of Disputes | 4.250 | 0.391 | 4.115 | 0.077 |
| 3 | c | Time for Construction | 3.975 | 0.299 | 0.007 | 0.937 |
| 4 | d | Time Predictability – Design and Construction | 3.925 | 0.237 | 0.914 | 0.367 |
| 5 | k | Contractor's Involvement in Project's Design | 3.900 | 0.474 | 1.956 | 0.200 |
| 6 | e | Time to Rectify Defects | 3.775 | 0.640 | 3.222 | 0.110 |
| 7 | g | Quality Issues at the End of Defect Rectification Period | 3.475 | 0.343 | 0.060 | 0.813 |
| 8 | i | Change Orders | 3.425 | 0.602 | 1.936 | 0.202 |
| 9 | f | Defects | 2.975 | 0.299 | 0.585 | 0.466 |
| 10 | j | Time Taken to Reach Final Account | 2.825 | 0.501 | 4.504 | 0.067 |
| 11 | h | Client's Satisfaction | 2.750 | 0.236 | 2.224 | 0.174 |
| 12 | l | Reportable Accidents | 1.600 | 0.269 | 0.351 | 0.570 |
| 13 | m | Lost Time Accidents | 1.500 | 0.236 | 0.870 | 0.378 |

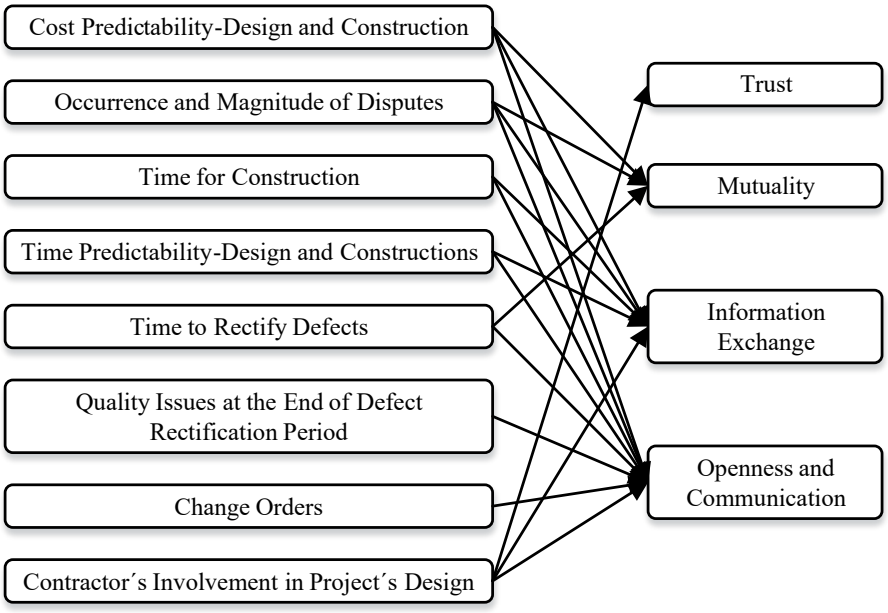


Figure 1. Significance of the KPIs with respect to Each Collaborative Element.

## 3 RESULT

Among those KPIs, cost predictability – design and construction (a), occurrence and magnitude of dispute (b), and contractor's involvement in project's design (k) were considered the most relevant KPIs in fostering collaboration. Besides, time for construction (c) and time predictability – design and construction (d), and time to rectify defects (e) were found instrumental in two collaborative elements, namely information exchange (E3) and openness and communication (E4). These were in line with the collaborative scores rankings that are presented in Table 2. The findings were subsequently shown to two NEC- experienced interviews, and they regarded them justifiable. They opined that despite the ideal of the NEC contract to require working in the spirit of mutual trust and cooperation, after all, what was of the utmost concern to the contractor, in reality, was still money and time. Previous literature also showed that the contractor holds project cost and duration in high regard (Bryde and Robinson 2005). On the other hand, Table 2 revealed that objective KPIs, which are quantitative, were generally better than subjective KPIs in promoting collaboration. Cox *et al*. (2003) indicated quantitative KPIs are usually preferred. The two interviewees share the same view that KPIs were more instrumental in information exchange (E3) and openness and communication (E4).

The results of the mean traits and frequency analysis suggested that cost predictability – design and construction (a), occurrence and magnitude of dispute (b), time for construction (c) and time predictability – design and construction (d), and contractor's involvement in project's design (k) were the best five KPIs to be taken to promote the achievement of collaboration under the NEC3.

## 4 DISCUSSION

Despite the government's commitment to using the NEC3 for major capital projects put out to tender from 2015/2016 onwards, the use of the NEC3 has yet been popularized in Hong Kong, mainly confined to the public sector. Option X20 has been adopted by the HK government for the "Pay for Safety Performance Merit Scheme" to incentivize the contractor for a better safety performance so far. The information that was available in this regard was very limited when this study was conducted. Therefore, the study was mainly based on previous literature data as well as personal views of respondents and interviewees. The number of respondents is not large; as such, findings may not be able to fully reflect the real situation of use of KPIs under Option X20.

For future research into the use of KPIs under the Option X20 of the NEC3, in-depth case studies of the application of the KPIs under Option X20 are suggested. Other than upholding the ethos of collaboration, the NEC3 other innovations, like taking a proactive risk management approach, are other research topics on NEC.

## 5 CONCLUSION

This study examines incentivization under the NEC conditions of contract by looking into the use of Option X20. Based on the collaborative feature of the NEC3, a research framework is established by linking selected KPIs to the four collaborative elements views of the industry. The results of the questionnaire survey were solicited by suggest that cost and time related KPIs are generally more relevant to promote collaboration among the contracting parties. Furthermore, Cost predictability – design and construction (a), occurrence and magnitude of dispute (b), time for construction (c) and time predictability – design and construction (d), and contractor's involvement in project's design (k) are identified as the most suitable KPIs to be used with Option X20 according to the mean traits and frequency analysis of the data received.

## References


Barratt, M*., Understanding The Meaning of Collaboration in The Supply Chain,* Supply Chain Management: An International Journal, 9(1), 30–42, 2004.

Broome, J. C., and Hayes, R. W., A Comparison of the Clarity of Traditional Construction Contracts and of The New Engineering Contract, International Journal of Project Management, 15(4), 255-261, 1997.

Bryde, D. J., and Robinson, L., Client Versus Contractor Perspectives On Project Success Criteria, International Journal of Project Management, 23(8), 622-629, 2005.

Chan, T. W. C*., Mitigation of Construction Disputes through Relational Contracting in Public Projects in Hong Kong,* in Hall, K., (ed.), Construction Projects: Improvement Strategies, Quality Management and Potential Challenges, Nova Science Publishers, Inc., USA, 137-171, 2017.

Cheung, S. O., Suen, H. C. H., and Cheung, K. K. W., *PPMS: A Web-Based Construction Project Performance Monitoring System,* Automation in Construction, 13(3), 361–376, 2004.

Cox, R. F., Issa, R. R., and Ahrens, D., Management's Perception of Key Performance Indicators for Construction, Journal of Construction Engineering and Management, 129(2), 142-151, 2003.

Development Bureau, Practice Notes for New Engineering Contract (NEC) – Engineering and Construction Contract (ECC) for Public Works Projects in Hong Kong, Hong Kong Special Administrative Region, Development Bureau. Retrieved from https://www.devb.gov.hk/filemanager/en/content_1002/01_NEC_ECC_PN_V1.1_201703.pdf, 2017.

Halliday, J., Use of the New Engineering Contract in Hong Kong, Engineering, Construction and Architectural Management, 2(4), 307–315, 1995.

ICE, *NEC3 Procurement and Contract Strategies,* Institution of Civil Engineers, Bell and Bain Limited, Glasgow, 2005.

ICE, *U.K., Guidance Notes -NEC3 Engineering and Construction Contract (ECC), 3rd Edition,* Reprinted with amendments 2013, Institution of Civil Engineers, Thomas Telford, UK, 2013.

Jackson, S., *The NEC Contract - A New Approach: It May Not Be Suitable for Every Project but It Is Worth Considering Whether Other Contracts Would Benefit from Using Similar Principles to the NEC*, suggests Jackson, S., Senior Associate at Pinsent Masons (Law and Contract), Construction Europe, 23(2), 18, 2012.

Kan, H., and Le, Y., *Research On Contract Governance in The Field of Project Management,* The 2014 International Conference on Construction and Real Estate Management (ICCREM 2014), American Society of Civil Engineers. September 27-28, 2014, Kunming, China, 733–74, 2014.

KPI Working Group, *KPI Report for the Minister for Construction, Department of Environment, Transport and the Region,* London, 2000.

Kumaraswamy, M. M., Rahman, M. M., Yean, F. Y. Y., and Siew, T. P., *Reconstructing Cultures for Relational Contracting,* Journal of Construction Engineering and Management, 131(10), 1065–1075.

Lam, E. W. M., Chan, A. P. C., and Chan, D. W. M., *Benchmarking The Performance of Design-Build Projects,* Benchmarking: An International Journal, 14(5), 624–638, 2007.

Lau, C., Mesthrige, J., Lam, P., and Javed, A., *The Challenges of Adopting New Engineering Contract: A Hong Kong Study,* Engineering, Construction and Architectural Management, 26(10), 2389-2409, 2019.

Luu, V. T., Kim, S. Y., and Huynh, T. A., *Improving Project Management Performance of Large Contractors Using Benchmarking Approach,* International Journal of Project Management, 26(7), 758–769, 2008.

Manu, E., Akrah, N., Chinyio, E., and Proverbs, D., *Trust Influencing Factors in Main Contractor and Subcontractor Relationships During Projects,* International Journal of Project Management, 33(7), 1495–1508, 2015.

Meng, X., and Gallagher, B., *The Impact of Incentive Mechanisms on Project Performance,* International Journal of Project Management, 30(3), 352–362, 2012.

O'Neil, C., *The New Engineering Contract (NEC) Interface with Early Warning Systems and Collaboration*, In Global Construction Success, 129-132, Chichester, UK, John Wiley and Sons, 2018.

Toor, S. U. R., and Ogunlana, S. O., *Construction Professionals' Perception of Critical Success Factors for* Large-Scale Construction Projects, Construction Innovation, 9(2), 149–167, 2018.

Wright, J. N., and Fergusson, W., Benefits of the NEC ECC form of Contract: A New Zealand Case Study, International Journal of Project Management, 27(3), 243-249, 2009.