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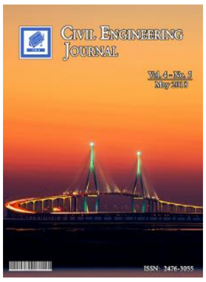

Evaluation of Legislation Adequacy in Managing Time and Quality Performance in Iraqi Construction Projects- a Bayesian Decision Tree Approach

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Abstract

Delay and quality defects are significant problems in Iraqi construction projects. During the period from 2003-2014, legislation has been changed to enhance the performance of construction project. This change is done by modifying some clauses of legislation and adding or deleting the others. The aim of this study is to evaluate the adequacy of these changes by using questionnaire and Bayesian decision tree model. 30 projects were taken for the period from 2003-2014. Performance of construction project was assessed on one hand by conducting a questionnaire which depend on the impact of legislation clauses on the time and quality performance, while on the other hand Bayesian decision tree model was developed in which qualitative estimate of time and quality performance by using KNIME program. The results of questionnaire estimate the delay from very low to very high and quality from very low to high in Iraqi construction industry. The results of Bayesian decision tree model reveal that the high percentage of construction projects were implemented with very high delay and high level of quality. The model gives good accuracy in prediction time and quality performance about 86.7%. These results show the enhancement in the quality performance is greater than the time performance under the legislative change. The model can assist the Iraqi legislator in evaluation the impact of legislation on time and quality performance of construction project.

Keywords: Time Overrun; Quality; Legislation; Naive Bayes; Gradient Boosting Decision Tree.

1. Introduction

The construction sector has a strategic role in improving economic sector of developed countries. In Iraq, constriction projects are suffered from many problems in performance such as time, quality and cost [20]. The causes of delay in construction projects are: awarding of project to the lowest bidder price [11-14], delay of payments by owner [16], variation order during construction, politic environment of country [13, 14]. Quality are affected by several factors such as: provisions that related to selection of contractor [26, 27], experience of contractor [28, 29], skills of management leadership [28-30]. Deficiency in safety system [32, 27]. One of the policies to get the desired outcomes is modifying laws and regulation [14]. Legislations are important in Iraqi construction industry.it has important role in regulating the works, rights, and duties between parties of construction project [33]. These legislations in sometimes conflict with each other or with previous legislations and affect the performance of construction project [18]. One of the most practical approach for solving learning problem is Bayesian algorithm. Bayesian theory is a probabilistic approach for making decision under uncertain condition. In Bayes theory the frequency of events is used to determine the probability of their future [1]. One of the most Bayesian learning method is the Naive Bayes Classifier is consider one of the best learning method that is based on Bayesian theory. Decision tree one of the most common techniques in data mining. It's a

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graphical representation of rules which lead to a class. This study aims to investigate the impact of legislation on the time and quality performance in the Iraqi construction industry by using the questionnaire and Bayesian decision tree model.

2. Literature Review

Nemours studies have been done to determine delay and quality factors in construction projects. Assaf and Al-Hejji (2006) classified causes of delay of construction projects in into nine categories and they concluded that the top important factors causing delay in construction project are variation orders during construction, delay in progress payment, defective planning and scheduling, Shortage of manpower and difficulties in finance on the part of the contractor [16].

Ewadh and Aswed (2007) divided the causes of delay of construction project into four categories: Contractor, Owner, Government regulation and External causes. They concluded that the top important causes of delay are Delay in laboratory tests, awarding contracts to the lowest bidder price, difficulties in finance the project by the contractor, sudden rise in the materials prices and incorrect estimation of contractor for contract duration [13]. Mahamid et al. (2012) concluded that the top five severe delay causes of road construction projects in the West Bank in Palestine are Political situation, separation of the West Bank, limited movement between areas, award project to lowest bidder price, payment delay by owner and lack of equipment [14]. According to Elawi et al. (2015) the factors of delay that contributed for the majority of time overrun were; acquisition of land, expertise lack of contractor, re-designing, and line services (haphazard underground utilities) [17]. One of the practices that required to reduce delay in construction projects is modifying laws and regulation that related to construction projects [14]. Callistus et al. (2014) concluded that the most critically factors influencing quality performance in Ghana are: practices of fraudulent and kickbacks, lack of coordination between contractors and designers, poor monitoring and feedback, lack of quality training for staff, deficiency of management leadership and lack of experience of contractor [28]. Abas et al. (2015) stated that contractor procurement unit, ISO certification, availability of technical person, problem communication, joint working and continuous improvement are the main that have direct impact on the quality performance of construction projects in Pakistan [31]. The study carried out by Raphael and Phillip (2016) revealed that the critical factors that influence the quality performance of government financed construction projects are: processes of project financing, contractors experience in construction industry, technology of project, availability of equipment and plant, procurement processes and system and the project manager skills and knowledge [29].

In order to enhance the performance of construction industry, legislations have been changed many times during the period from 2003 to 2014 [19]. The change covered many acts including; the General Term of the Civil Engineering Contracts [22], Governmental contracts implementation Instructions no.1 [21], federal budget act [34], Cabinet resolution no 395 [24], and the Registry Instructions of Iraqi Contractors [23], and the regulation of insertion of delayed bidder in implementation their contractual obligation in the delayed company list [25]. The effect of these changes could best be measured by Bayesian decision tree which is considered one of the most practical approach for solving learning problem. Bayesian theory is a probabilistic approach for making decision under uncertain condition [1]. The mathematical formula for this theory is as in Equation 1.

$$P(h\backslash D) = \frac{P(D\backslash h)p(h))}{p(D)} \tag{1}$$

P (h): represent the probability of hypothesis

P (D): the evidence, represent the probability of observation D

P (D\h): represent the likelihood of D that given h

P (h\D): represent the probability of h that given D

Naive Bayesian is statistical classifier based on Bayes' theorem. This classifier depended on simplify of assumption that the value of attribute is independent of other attributes values [36]. In mathematic that is mean.

$$P(D\backslash h_i) \approx \prod_{k=1}^{n} p(D_k\backslash h_i) \qquad (2)\ [2]$$

Decision tree one of the most common techniques in data mining. It's a graphical representation of rules which lead to a value or class [3]. One of the widely-used in machine learning is gradient boosting decision tree (GBDT) that is used because of its accuracy, efficiency and interpretability [4]. GBDT used to achieve performances in many tasks of machine learning like prediction [5] and multi-class classification [6]. GBDT is an ensemble of decision tree models. In GBDT algorithm, learning process of decision tree is done by fitting the residual error in each iteration [4].

3. Methodology of Research

Research methodology involves of two parts, questionnaire and using techniques of data mining. 30 projects were taken and the questionnaire was distributed to different populations that includes the managers of these projects and engineers and the main stakeholders, about 15 people. This questionnaire included two parts, the part one was dedicated to the qualitative assessment of the change in time and quality level depending on the data that collected from the construction projects, while the second part of the questionnaire investigates the impact of legislation clauses on the performance of construction projects, the clauses of each legislation change are shown in Table 1.

Table 1. Clauses of legislation

Clauses of contract that related to time and quality performance	Legislation change
Engineer power to issue variation order	Leg.1, Leg.2, Leg.3, Leg.4
Preparation of location	Leg.2, Leg.3, Leg.4
authorization of the head of contracting department to accept and analyze bid	Leg.2, Leg.3, Leg.4
regulation that required to get the best tender	Leg.2, Leg.3, Leg.4
Awarding of bid	Leg .1
list of similar work and equipment that attached with tender	Leg.1
scores that given for evaluation of tender	Leg.2, Leg.3, Leg.4
Extension of time	Leg.1, Leg.2, Leg.3, Leg.4
Payment	Leg.1, Leg.2, Leg.3, Leg.4
Initial payment	Leg.1, Leg.2, Leg.3, Leg.4
duration to authorize change order	Leg.2, Leg.3, Leg.4
delay penalties	Leg.1, Leg.2, Leg.3, Leg.4
condition of contractor experience	Leg.1, Leg.2, Leg.3, Leg.4
condition of technical and accounting staff of contractor	Leg.1, Leg.2, Leg.3, Leg.4
capital of the company of contractor	Leg.1, Leg.2, Leg.3, Leg.4
declaration of estimated cost	Leg.4
insertion of bidder	Leg.4
Available of modern study on estimated cost	Leg.2, Leg.3, Leg.4
Worker injury	Leg.1, Leg.2, Leg.3, Leg.4
testing	Leg.1, Leg.2, Leg.3, Leg.4
List of equipment	Leg. 1
source certification	Leg.3, Leg.4
Condition of equipment	Leg.3, Leg.4
Safety of work method	Leg.1, Leg.2, Leg.3, Leg.4

For analysis of legislation impact on time and quality performance, the researcher used KNIME analytics platform. KNIME (Konstanz Information Miner,) data analytics platform and an open source data its used for processing, analysis and integration [7].

4. Results and Discussions

Clauses of legislation were identified and assessed through questionnaire to evaluate the impact of these clauses on the time and quality performance of construction project. The acquired data was initially analyzed through statistical techniques by obtaining the mean for each clause with respect to impact on the time and quality performance. The scores provided by each respondent for all the listed clauses were treated using Statistical Package for Social Sciences (SPSS).the impact of each clauses was calculated by using below equation.

$$\text{Mean } (\bar{X}) = \sum_{i}^{N} fx_i / N \quad (3)\ [35]$$

Where:

($\bar{X}$): The Mean

(X_i): The number of values of the variable X one for each observation

(f): frequency of class

(i): first number of observations

(N): number of observations

The outcomes of questionnaire reflect the improvement in the time and quality performance under changing in legislation. Time overrun estimates between very low and very high under the legislation from 2003-2014. Quality estimates between very low and high under legislation during the period 2003-2014. The data was obtained from questionnaire has been entered to the KNIME program to begin classification process. The process beginning with open the program and select Naive Bayes node and Gradient Booted trees node to determine qualitative analysis of legislation.

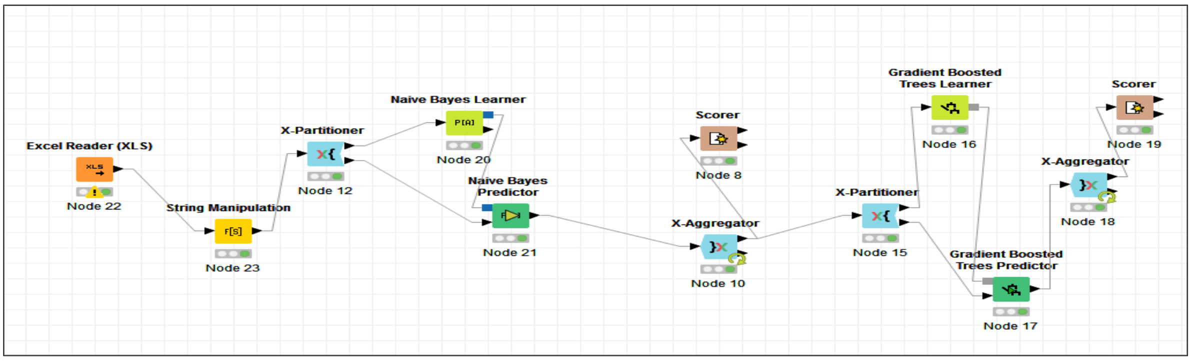

Figure 1. Work flow of Bayesian decision tree

The parameter that used to measure the performance of algorithm is [8]:

TP: represent the number of observations that actually positive and classified positive.

FP: represent the number of observations that actually positive and classified negative.

TN: represent the number of observations that actually negative and classified negative.

FN: represent the number of observations that actually negative and classified positive.

Recall =TP/TP+FN (4)

Precision = TP/TP+FP (5)

Accuracy = TP+TN/TP+FP+TN+FN (6)

F-measure represent the integration of recall and precision [9]. Cohen's kappa coefficient used to measure the qualitative item in statistic in term of inter-rater agreement [10]. From the analysis process the results were obtained from Bayesian algorithm and Bayesian decision tree algorithm. These results showed the enhancement in the time and quality performance under the change in legislation.

Table 2. Gaussian distribution for change in project time

	high	low	medium	very high	very low
Count:	6	3	4	12	2
Mean:	80.965	38.67	60.3075	227.6142	13.555
Std. Deviation:	4.40813	10.95315	7.4131	124.5631	3.45775
Rate:	22%	11%	15%	44%	7%

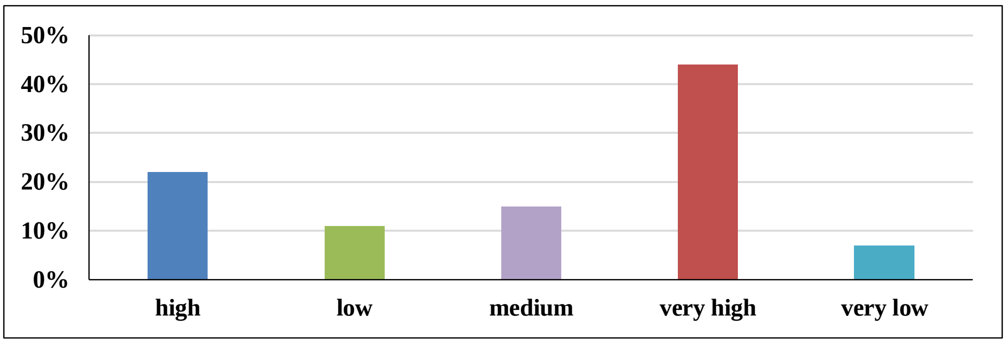

Figure 2. Distribution rate of the change in the project time

Results of classification model in Table 2 and Figure 2 show the range of the change in project time is between very low to very high and the highest percentage of project lie under very high and high level.

Table 3. Results of Naive Bayes classifier for the change in project time under legislation

Row	True pos.	False pos.	True neg.	False neg.	Recall	Precision	Sensitivity	Septicity	F - means	Accuracy	Cohen
high	5	0	22	3	0.625	1	0.625	1	0.769	?	?
Very high	12	7	11	0	1	0.632	1	0.611	0.774	?	?
low	3	0	26	1	0.75	1	0.75	1	0.857	?	?
medium	3	0	26	1	0.75	1	0.75	1	0.857	?	?
Very low	0	0	28	2	0	?	0	1	?	?	?
overall	?	?	?	?	?	?	?	?	?	0.767	0.655

Table 4. Results of Bayesian decision tree for the change in project time under legislation

Row	True pos.	False pos.	True neg.	False neg.	Recall	Precision	Sensitivity	Septicity	F - means	Accuracy	Cohen
low	3	2	25	0	0.625	1	1	0.926	0.75	?	?
high	4	1	24	1	1	0.8	0.8	0.96	0.8	?	?
Very high	16	1	10	3	0.75	0.842	0.842	0.842	0.889	?	?
medium	3	0	27	0	0.75	1	1	1	1	?	?
overall	?	?	?	?	?	?	?	?	?	0.867	0.773

Table 3 shows the results of naive Bayes model which indicate accuracy with 76%, the results of Bayesian decision tree model illustrate in Figure 4 that the accuracy of the model is 86.7%. This finding gives good accuracy in prediction the time performance depending on the questionnaire and Bayesian decision tree model.

Table 5. Gaussian distribution for quality of construction project

	high	low	medium	very low
Count:	15	3	8	1
Mean:	21.6	9.66667	12.125	8
Std. Deviation:	8.36489	13.31666	11.49456	0
Rate:	56%	11%	30%	4%

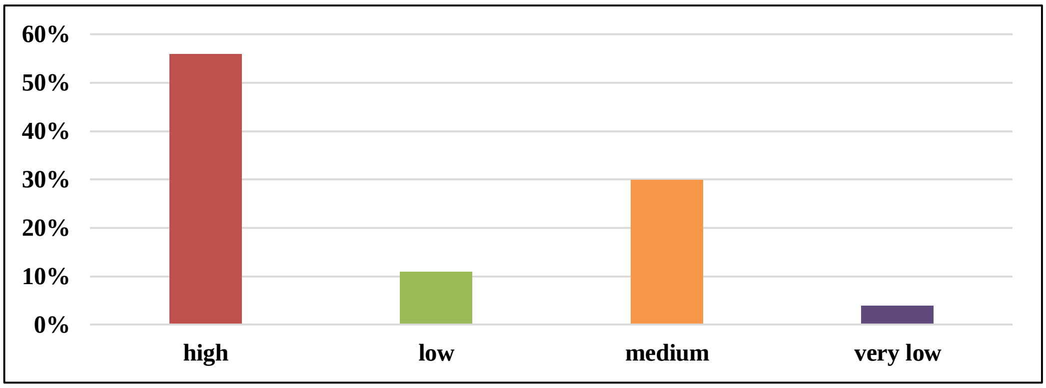

Figure 3. Distribution rate of the project quality performance

Results in Table 5 and Figure 3 that obtained from classification model show the range of quality is between very low and high and the highest percentage of project lie under high level.

Table 6. Results of Naive Bayes classifier for the project quality under legislation

Row	True pos.	False pos.	True neg.	False neg.	Recall	Precision	Sensitivity	Septicity	F - means	Accuracy	Cohen
medium	10	1	19	0	1	0.909	1	0.95	0.952	?	?
high	3	7	11	0	1	0.842	1	0.786	0.914	?	?
low	0	0	27	3	0	?	0	1	?	?	?
Very low	0	0	29	1	0	?	0	1	?	?	?
overall	?	?	?	?	?	?	?	?	?	0.867	0.753

Table 7. Results of Bayesian decision tree for the project quality under legislation

Row	True pos.	False pos.	True neg.	False neg.	Recall	Precision	Sensitivity	Septicity	F - means	Accuracy	Cohen
medium	10	1	19	0	1	0.909	1	0.95	0.952	?	?
high	16	3	11	0	1	0.842	1	0.914	0.914	?	?
low	0	0	27	3	0	?	0	1	?	?	?
Very low	0	0	29	1	0	?	0	1	?	?	?
overall	?	?	?	?	?	?	?	?	?	0.867	0.73

Table 6 and 7 show the results of Bayesian decision tree model in prediction quality performance in construction project. The results show the accuracy of the model is about 86.7%. These results indicate good accuracy in prediction the quality performance by using questionnaire and Bayesian decision tree model. These outcomes of the questionnaire and classification model reflects the gradual enhancement in the time and quality performance due to the change in the legislation in the studied period. The results show that the enhancement in quality performance is greater than in time performance. The difference between enhancement in quality performance and time performance can interpret by the nature of law in Iraqi construction industry.

5. Conclusion

Time overrun and quality defects are major problems in construction project. Legislation is applied to reduce this problem in Iraqi construction industry. Questionnaire and Bayesian decision tree model were developed for this purpose. 30 construction projects implemented during the period from 2003-2014 were taken and the questionnaire was distributed for 15 persons who work in the project. The questionnaire depended on the impact of legislation clauses on the time and quality performance of construction project. The results show that the delay between very low and very high the quality very low and high in Iraqi construction industry. These results reflect the impact of legislation on the project performance for the period 2003-2014. The Bayesian decision tree model, on the other hand, was developed by using KNIME program for qualitative analysis of legislation. The results of Bayesian decision tree model reveal that the high percentage of construction projects were implemented with very high delay and high level of quality .The model gives good accuracy for classification process that is about 86.7% for time and quality performance of construction project. The model can help the Iraqi legislator to assess the impact of legislation on time and quality performance of construction projects.

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7. Appendix

Results of questionnaire:

Table 1. Qualitative analysis of the change in time performance

Year	Project	Qualitative analysis
2005	1	high
2005	2	very high
2005	3	very high
2005	4	high
2008	5	low
2008	6	high
2008	7	very high
2008	8	very high
2009	9	very high
2010	10	low
2010	11	low
2010	12	medium
2010	13	very high
2010	14	very high
2010	15	high
2010	16	low
2010	17	medium
2010	18	very high
2010	19	medium
2011	20	high
2011	21	very low
2011	22	very high
2011	23	high
2011	24	very high
2011	25	very high
2012	26	high
2012	27	medium
2013	28	very high
2013	29	very low
2013	30	high

Table 2. Impact of legislation clauses on time performance

Projects	Clauses											
Project 1	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
Quantitative	3.8889	4.1389	3.4167	3.8333	3.25	3.75	3.2222	3.3611	4.0278	3.8611	3.4444	3.1667
Qualitative	high	high	high	high	medium	high	medium	medium	high	high	high	medium
2	4.1111	4.278	3.5556	4.3056	3.6667	4.3056	3.4167	3.6111	4.25	4.0833	3.8889	4.3333
	high	Very high	high	Very high	high	Very high	high	high	Very high	high	high	Very high
Project 3	4.1111	4.2778	3.5556	4.3056	3.6667	4.3056	3.4167	3.6111	4.25	4.0833	3.8889	4.3333
	high	Very high	high	Very high	high	Very high	high	high	Very high	high	high	Very high
4	3.8889	4.1389	3.4167	3.8333	3.25	3.75	3.2222	3.3611	4.0278	3.8611	3.4444	4.1111
	high	high	high	high	medium	high	medium	medium	high	high	high	high

For period 2007-2008

Projects	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15
5	3.7778	3.4167	4	3.4444	3.5556	3.0833	4	3.4167	3.6944	4.0556	4.0278	4.0833	3.5556	3.5278	4.1111
	high	high	high	high	high	medium	high	high	high	high	high	high	high	high	high
6	3.7778	3.4167	4	3.4444	3.5556	3.0833	4	3.4167	3.6944	4.0556	4.0278	4.0833	3.5556	3.5278	4.1111
	high	high	high	high	high	medium	high	high	high	high	high	high	high	high	high
7	3.9444	3.75	3.7222	3.8333	3.8889	3.8611	3.8056	3.75	4.0833	4.4167	4.2222	4.3889	3.8889	3.4167	4.2222
	high	high	high	high	high	high	high	high	high	very high	vey high	very high	high	high	very high
8	4.5278	4.2778	3.9444	4.2222	4.25	4.3611	4.5278	4.2778	4.3056	4.5556	4.4444	4.3889	3.8889	3.4167	4.4444
	Very high	Very high	high	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high	high	high	Very high

For period 2009-2011

Projects	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15
9	4.5833	3.8333	2.8056	4.5833	4.4722	4.3611	4.3889	4.3611	4.4722	4.5278	4.5278	4.7222	4.4722	4.5278	4.4722
	Very high	high	medium	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high
10	2.3611	2.2778	2.1944	2.3889	2.4167	2.4722	2.3333	2.5278	2.4722	2.4444	2.4267	2.25	1.5833	1.6111	1.8333
	low	low	low	low	low	low	low	low	low	low	low	low	Very low	Very low	low
11	2.3611	2.2778	2.1944	2.3889	2.4167	2.4722	2.3333	2.5278	2.4722	2.4444	2.4267	2.25	1.5833	1.6111	1.8333
	low	low	low	low	low	low	low	low	low	low	low	low	Very low	Very low	low
12	3.1994	2.8889	2.8056	3.1389	2.7222	3.1389	2.8056	3.2778	3.1111	3.1111	3.1111	2.9444	2.5833	2.6111	2.6944
	medium	medium	medium	medium	medium	medium	medium	medium	medium	medium	medium	medium	low	medium	medium
13	4.5833	3.8333	2.8056	4.5833	4.4722	4.3611	4.3889	4.3611	4.4722	4.5278	4.5278	4.7222	4.4722	4.5278	4.4722
	Very high	high	medium	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high
14	4.5833	3.8333	2.8056	4.5833	4.4722	4.3611	4.3889	4.3611	4.4722	4.5278	4.5278	4.7222	4.4722	4.5278	4.4722
	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high
15	4.3333	4.0278	3.9444	3.7778	3.8056	3.6944	3.8611	4.0556	3.9722	4	4	4.0556	3.8889	3.4167	3.7222
	Very high	high	high	high	high	high	high	high	high	high	high	high	medium	high	high
16	2.3611	2.2778	2.1944	2.3889	2.4167	2.4722	2.3333	2.5278	2.4722	2.4444	2.4267	2.25	1.5833	1.6111	1.8333
	low	low	low	low	low	low	low	low	low	low	low	low	Very low	Very low	low
17	3.1994	2.8889	2.8056	3.1389	2.7222	3.1389	2.8056	3.2778	3.1111	3.1111	3.1111	2.9444	2.5833	2.6111	2.6944
	medium	medium	medium	medium	medium	medium	medium	medium	medium	medium	medium	medium	low	medium	medium
18	4.5833	3.8333	2.8056	4.5833	4.4722	4.3611	4.3889	4.3611	4.4722	4.5278	4.5278	4.7222	4.4722	4.5278	4.4722
	Very high	high	medium	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high
19	3.1999	2.8889	2.8056	3.1389	2.7222	3.1389	2.8056	3.2778	3.1111	3.1111	3.1111	2.9444	2.5833	2.6111	2.6944

	medium	medium	medium	medium	medium	medium	medium	medium	medium	medium	medium	medium	low	medium	medium
20	4.3333	4.0278	3.9444	3.7778	3.8056	3.6944	3.8611	4.0556	3.9722	4	4	4.0556	3.8889	3.4167	3.7222
	Very high	high	high	high	high	high	high	high	high	high	high	high	high	high	high
21	2.3611	2.2778	2.1944	2.3889	2.4167	2.4722	2.3333	2.5278	2.4722	2.4444	2.4267	2.25	1.5833	1.6111	1.8333
	low	low	low	low	low	low	low	low	low	low	low	low	Very low	Very low	low
22	4.5833	3.8333	2.8056	4.5833	4.4722	4.3611	4.3889	4.3611	4.4722	4.5278	4.5278	4.7222	4.4722	4.5278	4.4722
	Very high	high	medium	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high
23	4.3333	4.0278	3.9444	3.7778	3.8056	3.6944	3.8611	4.0556	3.9722	4	4	4.0556	3.8889	3.4167	3.7222
	Very high	high	high	high	high	high	high	high	high	high	high	high	high	high	high
24	4.5833	3.8333	2.8056	4.5833	4.4722	4.3611	4.3889	4.3611	4.4722	4.5278	4.5278	4.7222	4.4722	4.5278	4.4722
	Very high	high	medium	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high
25	4.5833	3.8333	2.8056	4.5833	4.4722	4.3611	4.3889	4.3611	4.4722	4.5278	4.5278	4.7222	4.4722	4.5278	4.4722
	Very high	high	medium	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high	Very high

For period 2012-2014

Projects	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17
26	3.7778	3.4167	4	3.4444	3.5556	3.0833	4	3.4167	3.6944	4.0556	4.0278	4.0833	3.5556	3.5278	4.1111	3.5556	3.75
	high	high	high	high	high	high	high	high	high	high	high	high	high	high	high	high	high
27	2.6111	2.8889	2.6111	2.7222	3.2222	3.0833	2.9444	3.1111	3.0556	2.5278	2.7778	3.1111	3.0833	3.0278	3.25	3.1944	3.2778
	medium	medium	medium	medium	medium	medium	medium	medium	medium	low	medium	medium	medium	medium	medium	medium	medium
28	4.3889	4.3611	4.4722	4.3778	4.1111	3.0833	4.3333	4.2778	3.9167	4.3611	4.1944	4.4444	4.1389	3.9722	4.25	4.3056	4.0278
	Very high	Very high	Very high	Very high	high	medium	Very high	Very high	high	Very high	high	Very high	high	high	Very high	Very high	high
29	1.6111	1.5	1.5556	1.5556	1.5	1.5	1.75	1.75	1.5833	1.9444	1.805	1.4444	1.4444	2.0278	1.8056	1.6111	2.3333
	Very low	Very low	Very low	Very low	Very low	Very low	Very low	Very low	Very low	low	Very low	low	low	low	low	low	low
30	3.7778	3.4167	4	3.4444	3.5556	3.0833	4	3.4167	3.6944	4.0556	4.0278	4.0833	3.5556	3.5278	4.1111	3.5556	3.75
	high	high	high	high	high	high	high	high	high	high	high	high	high	high	high	high	high

Table 3. Qualitative analysis of the quality performance in different legislation period

Year	Project	Qualitative analysis
2005	1	low
2005	2	medium
2005	3	low
2005	4	medium
2008	5	medium
2008	6	medium
2008	7	medium
2008	8	very low

2009	9	high
2010	10	high
2010	11	high
2010	12	medium
2010	13	high
2010	14	medium
2010	15	high
2010	16	high
2010	17	high
2010	18	high
2010	19	high
2011	20	low
2011	21	high
2011	22	high
2011	23	high
2011	24	medium
2011	25	high
2012	26	medium
2012	27	high
2013	28	medium
2013	29	high
2013	30	high

Table 4. Impact of legislation clauses on the quality performance

For period 2003-2006

Projects	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
1	2.0278	1.8333	1.4444	2.0278	1.8056	1.9722	1.7222	1.5833	2.4444	1.9444	2.0278
	low	low	Very low	low	low	low	Very low	Very low	low	low	low
2	2.6667	2.1944	2.1944	3.1389	2.9167	3.389	2.6389	2.2222	2.6667	3.3056	3.3056
	medium	low	low	medium	medium	medium	medium	low	medium	medium	medium
3	2.0278	1.8333	1.4444	2.0278	1.8056	1.9722	1.7222	1.5833	2.4444	1.9444	2.0278
	low	low	low	low	low	low	low	low	low	low	low
4	2.6667	2.1944	2.1944	3.1389	2.9167	3.389	2.6389	2.2222	2.6667	3.3056	3.3056
	medium	low	low	medium	medium	medium	medium	low	medium	medium	medium

For period 2007-2008

Projects	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
5	2.9167	3.3056	3.3889	3.3056	2.7778	2.6667	2.5278	2.1944	3.1389	2.9167	3.1111
	medium	medium	medium	medium	medium	medium	low	low	medium	medium	medium
6	2.9167	3.3056	3.3889	3.3056	2.7778	2.6667	2.5278	2.1944	3.1389	2.9167	3.1111
	medium	medium	medium	medium	medium	medium	low	low	medium	medium	medium
7	2.9167	3.3056	3.3889	3.3056	2.7778	2.6667	2.5278	2.1944	3.1389	2.9167	3.1111
	medium	medium	medium	medium	medium	medium	low	low	medium	medium	medium
8	2.4167	1.9167	2.1944	2.0278	1.9444	1.9722	2.5278	2.1111	2	2.0556	1.8056
	low	low	low	low	low	low	low	low	low	low	low

For period 2009-2011

Projects	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13
9	3.944	2.8611	3.8333	4.0833	3.8889	3.4444	3.6944	4.1111	4.0833	3.4722	2.8056	3.5	3.5556
	high	medium	high	high	high	high	high	high	high	high	medium	high	high
10	3.944	2.8611	3.8333	4.0833	3.8889	3.4444	3.6944	4.1111	4.0833	3.4722	2.8056	3.5	3.5556
	high	medium	high	high	high	high	high	high	high	high	medium	high	high
11	3.944	2.8611	3.8333	4.0833	3.8889	3.4444	3.6944	4.1111	4.0833	3.4722	2.8056	3.5	3.5556
	high	medium	high	high	high	high	high	high	high	high	medium	high	high
12	2.9167	3.305	3.3889	3.3056	2.7778	2.6667	2.9444	3.0278	3.1389	2.9167	3.1111	2.6944	3.0278
	medium	medium	medium	medium	medium	medium	medium	medium	medium	medium	medium	medium	medium
13	3.944	2.8611	3.8333	4.0833	3.8889	3.4444	3.6944	4.1111	4.0833	3.4722	2.8056	3.5	3.5556
	high	medium	high	high	high	high	high	high	high	high	medium	high	high
14	2.9167	3.305	3.3889	3.3056	2.7778	2.6667	2.9444	3.0278	3.1389	2.9167	3.1111	2.6944	3.0278
	medium	medium	medium	medium	medium	medium	medium	medium	medium	medium	medium	medium	medium
15	3.944	2.8611	3.8333	4.0833	3.8889	3.4444	3.6944	4.1111	4.0833	3.4722	2.8056	3.5	3.5556
	high	medium	high	high	high	high	high	high	high	high	medium	high	high
16	3.944	2.8611	3.8333	4.0833	3.8889	3.4444	3.6944	4.1111	4.0833	3.4722	2.8056	3.5	3.5556
	high	medium	high	high	high	high	high	high	high	high	high	high	high
17	3.944	2.8611	3.8333	4.0833	3.8889	3.4444	3.6944	4.1111	4.0833	3.4722	2.8056	3.5	3.5556
	high	medium	high	high	high	high	high	high	high	high	medium	high	high
18	3.944	2.8611	3.8333	4.0833	3.8889	3.4444	3.6944	4.1111	4.0833	3.4722	2.8056	3.5	3.5556
	high	medium	high	high	high	high	high	high	high	high	medium	high	high
19	3.944	2.8611	3.8333	4.0833	3.8889	3.4444	3.6944	4.1111	4.0833	3.4722	2.8056	3.5	3.5556
	high	medium	high	high	high	high	high	high	high	high	medium	high	high
20	2.9167	3.305	3.3889	3.3056	2.7778	2.6667	2.9444	3.0278	3.1389	2.9167	3.1111	2.6944	3.0278
	medium	medium	medium	medium	medium	medium	medium	medium	medium	medium	medium	medium	medium
21	3.944	2.8611	3.8333	4.0833	3.8889	3.4444	3.6944	4.1111	4.0833	3.4722	2.8056	3.5	3.5556
	high	medium	high	high	high	high	high	high	high	high	medium	high	high
22	3.944	2.8611	3.8333	4.0833	3.8889	3.4444	3.6944	4.1111	4.0833	3.4722	2.8056	3.5	3.5556
	high	medium	high	high	high	high	high	high	high	high	medium	high	high
23	3.944	2.8611	3.8222	4.0833	3.8889	3.4444	3.6944	4.1111	4.0833	3.4722	2.8056	3.5	3.5556
	high	medium	high	high	high	high	high	high	high	high	medium	high	high
24	2.9167	3.305	3.3889	3.3056	2.7778	2.6667	2.9444	3.0278	3.1389	2.9167	3.1111	2.6944	3.0278

	medium	medium	medium	medium	medium	medium	medium	medium	medium	medium	medium	medium	medium
25	3.944	2.8611	3.8222	4.0833	3.8889	3.4444	3.6944	4.1111	4.0833	3.4722	2.8056	3.5	3.5556
	high	medium	high	high	high	high	high	high	high	high	medium	high	high
26	3.944	2.8611	3.8333	4.0833	3.8889	3.4444	3.6944	4.1111	4.0833	3.4722	2.8056	3.5	3.5556
	high	medium	high	high	high	high	high	high	high	high	high	high	high
27	3.944	2.8611	3.8333	4.0833	3.8889	3.4444	3.6944	4.1111	4.0833	3.4722	2.8056	3.5	3.5556
	high	high	high	high	high	high	high	high	high	high	high	high	high
28	3.944	2.8611	3.8333	4.0833	3.8889	3.4444	3.6944	4.1111	4.0833	3.4722	2.8056	3.5	3.5556
	high	medium	high	high	high	high	high	high	high	high	high	high	high
29	2.9167	3.305	3.3889	3.3056	2.7778	2.6667	2.9444	3.0278	3.1389	2.9167	3.1111	2.6944	3.0278
	medium	medium	medium	medium	medium	medium	medium	medium	medium	medium	medium	medium	medium
30	3.944	2.8611	3.8333	4.0833	3.8889	3.4444	3.6944	4.1111	4.0833	3.4722	2.8056	3.5	3.5556
	high	medium	high	high	high	high	high	high	high	high	high	high	high