Is it faster and is that Measurable

A Quantitative Research Into the Time Effects of Integrated Contract Forms in Development Processes

Akbarian, Bahar; Prins, Matthijs; van Oel, Clarine

Publication date
2016

Document Version
Final published version

Published in
Proceedings of the CIB World Building Congress 2016

CIB World Building Congress 2016

Proceedings of the CIB World Building Congress 2016

Volume II

Environmental Opportunities and challenges

Constructing commitment and acknowledging human experiences

Edited by
Matthijs Prins, Hans Wamelink, Bob Giddings, Kihong Ku and Manon Feenstra

TAMPERE UNIVERSITY OF TECHNOLOGY

Tampereen teknillinen yliopisto. Rakennustekniikan laitos.
Rakennustuotanto ja -talous. Raportti 18
Tampere University of Technology. Department of Civil Engineering.
Construction Management and Economics. Report 18

Matthijs Prins, Hans Wamelink, Bob Giddings, Kihong Ku and Manon Feenstra (eds.).

WBC16 Proceedings : Volume II

Environmental Opportunities and challenges

Constructing Commitment and Acknowledging Human Experiences

Tampere University of Technology. Department of Civil Engineering
Tampere 2016

Published by: TUT – Tampere University of Technology

ISBN 978-952-15-3740-0 (set)
ISBN 978-952-15-3741-7 (vol. I)
ISBN 978-952-15-3742-4 (vol. II)
ISBN 978-952-15-3743-1 (vol. III)
ISBN 978-952-15-3744-8 (vol. IV)
ISBN 978-952-15-3745-5 (vol. V)
ISSN 1797-8904

Is it faster and is that measurable?
A Quantitative Research Into The Time Effects Of Integrated Contract Forms In Development Processes

Bahar Akbarian
ICSadviseurs
baharakbarian@gmail.com
Matthijs Prins
Faculty of Architecture and the Built Environment, Delft University of Technology
m.prins@tudelft.nl
Clarine van Oel
Faculty of Architecture and the Built Environment, Delft University of Technology
c.j.vanoel@tudelft.nl

Abstract

Integrated contract forms are seen as a solution to various problems in the construction industry. Some studies found that building projects delivered with integrated contract forms show better performances on time, cost and quality. Other studies state that projects developed with integrated contract forms do not perform better on time, cost or quality when compared to projects developed with traditional contract forms. Conclusions from the studies analyzed vary and these studies have their shortcomings. This study reflects critically on these previous studies in order to promote better research and to reveal a small piece of the puzzle called 'integrated contract forms'. Empirical findings from a case control study of thirty secondary schools indicate that the use of integrated contract forms do not provide the expected benefits to time performance when compared to traditional contract forms. The data was collected from project managers via online questionnaires. However, when there is above average time pressure during the development process, parties tend to choose for integrated contracts because they assume that projects developed in this way have faster processes than projects developed with traditional contracts.

Keywords: integrated contract forms, time effects, empirical study, case control study, statistical analysis.

1. Introduction

Cost- and time overruns are unfortunately very common in the construction industry (Flyvbjerg, 2011). As a result there is high pressure from society to better control budgets and time schedules. At the same time, governments and the construction industry strongly steer on cost and time savings, as well as higher quality for buildings (Meng, 2012; Visscher, 2011). Other than traditional contract forms are thought to better enable control of budgets and schedules and therefore enhance quality. In the traditional contract form, which is still commonly used, the design phase and execution phase are procured to different parties (Masterman, 2002). The most common integrated contract form is the Design & Build contract form wherein the design phase

and construction phase are procured in one procurement to one party or to a consortium. Over the last years Design, Build & Maintenance and Design, Build, Maintenance & Operate contract forms are emerging. In these contract forms maintenance and operation actions are also included in the contract which makes the contracting party also responsible for the exploitation of the building and the reward is a performance- related pay (Masterman, 2002).

Many studies have analyzed the effects of integrated contract forms in construction, all with different outcomes. Some of these studies found that the use of integrated contract forms leads to lower cost buildings, a faster development process and higher quality results (Bennett, Pothecary, & Robinson, 1996; Hale, Shrestha, Gibson, & Migliaccio, 2009; Konchar & Sanvido, 1998). While another study found that projects delivered with integrated contract forms have faster processes, but were not always cheaper (Vasters et al., 2010). In contrast, Ibbs found that projects developed with integrated contract forms do not perform significantly better on time and cost aspects compared to projects delivered with traditional contract forms (Ibbs, Kwak, Ng, & Odabasi, 2003). Conclusions from these studies vary, which may be partly due to their methodological weaknesses. Even in studies where the methodology is strong, results cannot be compared with each other because of the different definitions of measures used. As a result, the effects of integrated contract forms are unclear. Different definitions for time and cost are used in different studies, hence studies have different conclusions and outcomes of studies cannot be compared with each other. Weak methodology of studies is caused by different factors. First, the used samples are often too small or too heterogeneous and there was selection bias present in the sample. Secondly, studies are often based on expert judgements, resulting in socially desirable answers. Last, it can be mentioned the description of the methodology used often is weak.

According to Nyström (2007) studies comparing different contract forms must meet three requirements. First, the study must be based on project data and not on expert judgments. Secondly, the study must be based on comparative analyses. Finally, the study must address project variables other than contract form, potentially influencing the outcome. Since one of the flaws in previous studies concerns the too large heterogeneity of the data, this study focusses on secondary schools in the Netherlands. These schools are assumed a homogenous building type due to their similar appearance, purpose and funding. In the Netherlands, the (re)construction of secondary schools is publicly funded. This homogeneity makes them the better research sample for this study. The aim of this paper is to gain better insights into the effect of the process contract form, on the build outcome, in terms of time, by reducing weaknesses of previous studies. Specifically, the study elaborates on the research question: *"Do projects with integrated contract forms perform better on time aspects than projects with traditional contract forms?"*

The study's focus is on time aspects as the other outcomes, appearance, purpose and funding, are similar for secondary schools. To answer the research question a literature review was conducted followed by a case control study. Data was collected by online questionnaires completed by thirty project managers who were involved in the development of thirty secondary schools in the Netherlands. In the questionnaire project managers were asked to share project data only, the questionnaire did not elaborate on their expert opinion. The literature review

provided input for the questionnaire that was developed as part of this study. The data was analyzed statistically to answer the research question. After that, findings were discussed in relation to prior literature, followed by conclusions and discussion of theoretical contributions.

2. Literature Review

Construction projects use a variety of contract forms to control project outcomes, some of which evolved over the last few decades. Research methods have varied across studies from project specific case studies, through opinion surveys, to empirical studies. Results of the most important empirical studies, which analyzed the relation between process and product, are reviewed here.

Bennett studied 332 projects and found that the construction speed (m^2 built per month) of D&B projects is 12% higher compared to traditional projects. The total project time, including design and construction, is 30% shorter for D&B projects than for projects with a traditional contract form. He found that 75% of D&B projects were delivered with a maximum budget overrun of 5%. While 63% of the traditional projects were delivered with a maximum budget overrun of 5%. D&B projects were at least 13% cheaper than traditional projects (Bennett et al., 1996).

Vasters partly disagreed with Bennett. He studied cost and time efficiency of six projects. He found that projects with a D&C contract show better time efficiency but not better cost efficiency (Vasters et al., 2010).

Hale is partly contrasting with Vasters. Hale's focus was on 77 military barracks of the US Navy. His conclusion was that projects with D&B contracts have shorter project times compared to projects with traditional contracts. He also concluded that projects with D&B contracts have less cost and time overruns than projects with traditional contracts (Hale et al., 2009).

Ibbs findings were partly inconsistent with Hale's. From his research Ibbs concluded that projects delivered with D&B contracts did not perform significantly better than projects delivered with traditional contracts. D&B projects have slightly less time overruns, not significant less, compared to projects with a traditional contract. And no cost savings were measured for D&B (Ibbs et al., 2003).

Konchar and Sanvido studied 351 building projects and concluded that projects delivered with D&B contracts performed better than projects with traditional contracts (Konchar & Sanvido, 1998).

By evaluating previous studies it became clear that different definitions for the variable 'time' were used. As summarized in table 1, the studies measured 'time' as building speed, total project time, delivery speed, time efficiency and schedule growth (Bennett et al., 1996; Hale et al., 2009; Ibbs et al., 2003; Konchar & Sanvido, 1998; Vasters et al., 2010). The studies also defined some variables differently.

Definition of the variable time (Time performance).	Explanation	Conclusion
Speed (m^2/time) (Bennett et al., 1996; Konchar & Sanvido, 1998).	**Construction speed**= [(net floor space/end date construction phase – start date construction phase)/30] in (m^2/month) **Delivery speed**= net floor space / (total actual project time/30) in (m^2/month)	The construction speed of D&B projects is 12% less than traditional projects (Bennett et al., 1996). The construction speed of D&B projects is at least 12% less compared to traditional projects (Konchar & Sanvido, 1998).
Time efficiency (Vasters et al., 2009).	**Time efficiency**= standard project time / total actual project time	D&C projects demonstrate a 52% higher time efficiency than traditional projects (Vasters et al., 2010).
Project time (Bennett et al., 1996; Hale et al., 2009; Konchar & Sanvido, 1998).	**Total actual project time**= date of project completion – date of the first contract action	D&B projects have shorter project times than traditional projects (Hale et al., 2009). The total project time of a project, design and construction time included, is 30% faster by D&B projects compared to traditional projects (Bennett et al., 1996). D&B projects are at least 33,5% faster delivered than traditional projects (Konchar & Sanvido, 1998).
Time schedule versus real project time (Bennett et al., 1996; Hale et al., 2009; Ibbs et al., 2003; Konchar & Sanvido, 1998).	**Change in total schedule (%)** = [(total actual project time – total as- planned project time) / total as- planned project time] * 100 **Change in design schedule** (%) = [(total design time – total as- planned design time) / total as- planned design time] * 100 **Change in construction schedule (%)** = [(total construction time – total as- planned construction time) / total as- planned construction time] * 100	It is 50% more likely that D&B projects are delivered on time compared to traditional projects (Bennett et al., 1996). D&B projects have less schedule growth than traditional projects (Hale et al., 2009). In absolute terms, D&B projects have 7,7% schedule growth compared to the planned schedule. Traditional projects have 8,4% schedule growth compared to the planned schedule. In relative terms, D&B projects have 4,1% schedule growth compared to the planned schedule. Traditional projects have 6,5% schedule growth compared to the planned schedule. These are no significant results. (Ibbs et al., 2003). D&B projects have at least 11,37% less schedule growth compared to traditional projects (Konchar & Sanvido, 1998)

Table 1: Used definitions of variables and conclusions of previous studies

In this paragraph some critical remarks on the used methodology of previous studies as listed in table 1, are identified and it is described how these issues are addressed.

In Bennett et al, (1996) report it is not clear how the sample is composed. A very big heterogeneous sample is used, but the report does not describe if smaller homogenous samples are used for the analysis. It is not possible to perform the same study, which makes this study less reliable. Also, the sample is composed with projects from the database of the Glenigan Group. From the report it is not possible to determine whether there was a selection bias. These two shortcomings are diminished in this study by composing a homogenous sample, also the way data is collected is described very precise and in a way that could be repeated. The sample used in Vasters study (Vasters et al., 2010) is too small (N=6). A bigger sample is composed in

this study which makes statistical analyses more meaningful. The variable 'time efficiency' as used by Vasters is time consuming to calculate, therefore in this study the variable 'time efficiency' is not used. Ibbs's et al. (2003) sample exists of different building types from different countries, as a result the sample is very heterogeneous. The focus of this study is on the variable 'as planned project time versus real project time' which makes it not absolutely necessary to have a homogenous sample. But different countries have different views on schedules and contract forms, which makes the differences between countries too big. Therefore, projects in this study's sample were built in one country and over a short time span.
Konchar and Sanvido's study (Konchar and Sanvido, 1998) consists of 351 projects and more than 100 variables are used to compare project performances. Due to the large number of variables (+100) there might be the danger of data dredging. The process of data dredging is the use of a single sample by exhaustively searching for combinations of variables that might show correlation (Field, 2009). In this study fewer variables were used to minimize the chance of data dredging.
Last, Hale's study (Hale et al., 2009) is evaluated, no shortcomings were identified in this study.

3. Research Methods

When collecting and analyzing data from development processes, a case control study is especially appropriate to measure the performance of processes. In the study two types of contract forms are compared with each other, on the one hand projects with traditional contracts on the other hand projects with integrated contracts. By identifying gaps and modifying prior work, this study aims to extend and elaborate on existing literature for performance measurement of different contract forms.

Forty six secondary school projects were selected through random sampling. The purpose of random sampling is to select projects completely randomly. Constraints for these projects are the eligibility criteria. Schools included in the sample must meet eligibility criteria to give greater confidence that results are caused by the intervention between process and outcome and not by other factors. Three eligibility criteria were specified; one building houses one school; the buildings were delivered between January 2008 and January 2015; the buildings are newly constructed buildings, renovation or transformation projects or an expansion of the existing building. If the building was a renovation, transformation or expansion project then the renovated, transformed or expanded floor space has to be 50% or more of the existing total floor space.

Data was collected through online questionnaires filled in by project managers hired by the client. Furthermore, the outcomes of processes in project management are measured in terms of cost, time and quality, these three control aspects form a triangle (Winch, 2010). The idea behind the triangle is that change in one of the control aspects has influence on the other control aspects. If, for example a project has to be completed in a shorter period of time, the costs are higher. Or, if the costs are lower, the quality is also lower. For clarity, cost, time and quality are interdependent. When the theory behind the triangle is applied to this study, the focus is limited to time aspects. This limitation is the reason secondary schools are chosen as the study subjects.

As mentioned earlier, secondary schools in the Netherlands receive the same funding for buildings; as a result the control aspects of 'cost' and 'quality' are more or less constant among this building type, which makes it possible to measure performance by time aspects. Therefore this study focused on the 'time' variable.

As mentioned, the outcome variables are the time performances. In the literature review four time performances are identified, namely 'Speed' (m^2/time), 'Time Efficiency', 'Project Time' and 'Time Schedule versus Real Project Time' (Bennett et al., 1996; Hale et al., 2009; Ibbs et al., 2003; Konchar & Sanvido, 1998; Vasters et al., 2010). 'Time efficiency' as used by Vasters is ignored in this study due to the time and effort needed to calculate this variable. 'Speed' and 'Project Time', as used by Bennett, Konchar and Hale, are not very reliable variables to measure project performance. These variables are project dependent; their outcome depends strongly on the construction type and circumstances of the project. As a result, the most appropriate variable to measure process performance is by comparing the planned schedule with the real project time. To calculate this variable a range of questions were asked to determine what the planned schedule for different phases was, and what the real project time for the same phases was. Nevertheless 'Speed' and 'Project Time' are also measured to have a complete picture.
The comprehensive online questionnaire included questions about a large number of subjects, namely:

- General questions about the project (m^2, project type, construction type, lay out of the plan and involved parties).
- Procurement method and contract form - Which procurement method and contract form were used and why? On the basis of which specifications was the project procured?
- Time schedule - What was the planned schedule for the different phases within the development process?
- Actual time spent - What was the actual time spent on the different phases of the development process?
- Additional information about the budget, delays, causes of delays, unforeseen circumstances, the role of the architect after the procurement, etc.

In addition to the process parameters and outcome variables, explanatory variables were set up. It is assumed that the contract form has an effect on the explanatory variables. Many explanatory variables were included in this study. The most important explanatory variables are:

- The presence or absence of above average time pressure on the development process.
- The number of parties involved during the preparation, design and execution phase.
- Reasons for choosing the contract form.
- If there is a presumption by the respondent about the kind of contract form and the speed of the development process, then the following question was asked: Was the choice for the contract form partly determined by the desired speed for the development process?

- Is the respondent willing to use the contract form also in the future for projects like the questioned project?
- Questions about the planned schedule, namely; the phase wherein the schedule was set up, how many times the schedule was changed during the development process, the aim of the schedule and commitment to the schedule.

Projectmanagers involved in the development process filled in the questionnaires with only project data (how long, how much, when, what, why etc.). Therefore expert opinions and measuring client/ projectmanager satisfaction were avoided.
To ensure the questionnaire focused on the correct variables, process parameters and outcome variables were set up. These parameters and variables were translated into questions in the questionnaires. Process parameters are the mechanisms which may influence the process performance of projects. This study focused on the influence of the contract form on the process performance of the project: the process parameter is the contract form and the outcome variables are the process performances on time.

For the contract form nine options are distinguished, namely the traditional contract form, the building team, the Design & Build or Design & Construct contract form (these are equivalents in the Netherlands), the Engineer & Build or Engineer & Construct contract form, the Design, Build & Maintain contract form, the Design, Build, Finance & Maintain contract form, the Design, Build, Maintain & Operate contract form and the Design, Build, Finance, Maintain & Operate contract form.
For analysis of the results the contract form is reclassified into two options: integrated contract form and not integrated contract form (which is the traditional contract form). This classification is based on whether the design and execution phase are procured within one contract to one party or to a consortium or are procured with two contracts, one for design and one for execution, to two different parties. The new classification categorizes 'the traditional contract form' and 'the building team' as 'traditional contract form/ not integrated contract form', the other contract forms form the category 'integrated contract form'.

Collected data was analyzed by statistical models with SPSS version 22. Exploratory univariate analyses were followed by multivariate linear regression models with bootstrapping. Univariate analysis of variables gave a global insight into the relationship between variables (Field, 2009). This analysis tested if the relationship found between variables is significant or based on coincidence.

This study applied a significance level of 95% ($p \leq 0.05$), which means that the probability that the observed values would be found without a relationship between the variables is smaller than 5% (Field, 2009). For logistic regression modelling the selection of potential variables occurred using the approach recommended by Hosmer and Lemeshow. Their approach is a purposeful selection process which begins by univariate analyses of each variable. Any variable having a significant univariate test at some arbitrary level is selected as a candidate for the logistic

regression model, any variable with a p-value lower than 0,3 is eligible for inclusion in the model (Hosmer, Lemeshow, & Sturdivant, 2013). Logistic regression models were developed to explain multivariate comparisons between contract forms. The logistic regression model predicts the outcome of the process parameter based on one or more outcome variables. These outcome variables are the variables from the 'significant group' and the 'hopeful group'. Bootstrapping is an efficient way to ensure that logistic regression models are reliable and will produce accurate results.
By resampling with replacements from the original data sample thousands of alternative versions of the data set were created. This made the results more reliable and accurate, also the impact of outliers was reduced which helps to ensure the stability and reliability of models (Field, 2009). In this study bootstrapping was applied because of the small sample size (N=30). The sample size was small but large enough for univariate logistic regression analysis. By applying the bootstrap method for the logistic regression model the results from this study became more reliable and accurate compared to not using the bootstrap method.

4. Results

Forty six questionnaires were sent to project managers. Thirty questionnaires were filled in and returned, which is a net response rate of 65%. Prior to sending out the questionnaires the respondents were asked if they would agree to collaborate, hence the high response rate.

Of the thirty projects surveyed, 53.3% were developed using traditional contract forms and 46.7% were developed using integrated contract forms (Design & Build, Design & Construct, Engineer & Build, Engineer & Construct and Design, Build & Maintain). The projects have a good spread across the Netherlands. 86.7% of the projects were completely new constructed buildings, while 13.3% of the surveyed projects were renovation, expansion or transformation projects. The majority of the projects (82%) were delivered between 2010 and 2013. Projects ranged in size from 1.518 m^2 to 26.500 m^2 . The mean of the project size is 9.130 m^2 with a standard deviation of 5.535 m^2. Unit costs (€/m^2) ranged from € 874 /m^2 to € 2153 /m^2. The mean of the unit cost is € 1447/m^2 with a standard deviation of € 367/m^2.
As mentioned earlier, the logistic regression model explains the contract form from differences in outcome variables.
Final modelling turned out to be difficult, as many of the questions are to be considered as describing the type of contract used. Any attempts to explain differences in time related outcomes were not distinguishing;

- Projects with integrated contract forms do not have significantly faster construction and delivery speed compared to projects delivered with traditional contract forms.
- Projects with integrated contract forms do not have significantly shorter project times.
- Projects with integrated contract forms do not meet planned schedules significantly more often compared to projects with traditional contract forms.

As a result, it can be concluded that projects with integrated contract forms do not perform better on time aspects compared to projects with traditional contract forms.

Thereafter a model was fitted using the presence of above average time pressure in the development process as an outcome. It then turned out that time pressure differs between processes covered by traditional and integrated contracts. More particularly, the presence of above average time pressure was found to be differing according to:

Variable	**P-value**
The choice for the contract form is influenced by the desired speed for the development process.	0.00
The presence of the contractor during the initiative, definition and design phase.	0.00
The kind of specification documents.	0.00
The contract form.	0.00
Procured on the basis of Lowest Price or MEAT (Most Economically Advantageous Tender).	0.03
The number of involved parties during the initiative and definition phase.	0.09
Control the capacity of the involved parties and commit to the schedule.	0.10
The phase in which the schedule is drawn up.	0.10
The number of involved parties during the design phase.	0.20
The kind of procurement procedure.	0.25
Adjusting the time schedule during the process.	0.26
The number of involved parties during the construction phase.	0.27

Table 2: Univariate analysis which were used as input in the logistic regression model with 'the presence of above average tim pressure in the development process'.

The final model was shaped by stepwise omitting variables that were not related to time pressure in addition to variables which were more significant related to time pressure, and starting with the one with the highest p- value (the number of parties involved during the construction phase, p- value: 0.27). Table 3 summarizes the final model, whereas table 4 shows the most eligible variables for inclusion in the final model. Since the question addresses the whole development process, time pressure concerns the initiative, design and construction phase.

Output of the bootstrapped logistic regression model for the variable 'the presence of above average time pressure on the development process'.						
Variable	**B**	**Odds ratio**	**S.E.**	**Sig.**	**Lower**	**Upper**
The choice for the contract form is influenced by the desired speed for the development process.	2.972	19.531	18.154	0.007	-18.777	56.127
The presence of the contractor during the initiative, definition and design phase.	1.966	7.142	16.040	0.014	-19.411	38.560
The kind of procurement procedure.	-1.852	0.157	16.631	0.017	-52.136	17.579
Constant	0.890	2.435	8.384	0.068	-8.503	26.349

Table 3: Final logistic regression model with process parameter: the presence of above average time pressure on the development process.

Univariate analyses	P-value
The choice for integrated contract forms is also influenced by the desired speed for the development process.	0,003
There is more often above average time pressure during the development process when projects are delivered with integrated contract forms.	0,035

Table 4. Outcome of the most relevant univariate analyses in addition to the final model.

5. Discussion and Conclusions

The purpose of this study was to get more precise insights into the effects of the contract form on the outcome in terms of cost, time and quality. By narrowing down the scope of this study on time aspects the research question became: *"Do projects with integrated contract forms perform better on time aspects than projects with traditional contract forms?"*

This study has shown that projects delivered with integrated contract forms do not perform significantly better on time aspects compared to projects delivered with traditional contract forms. This means that projects with integrated contract forms:
(i) were not developed significantly faster than projects with traditional contract forms.
(ii) did not meet planned schedules significantly more often than projects developed with traditional contract forms.
However, the study has shown that when there is above average time pressure on development processes, parties choose for integrated contract forms significantly more often (p- value: 0.035) because involved parties assume that projects developed with integrated contract forms are faster developed than projects developed with traditional contract forms (p- value: 0.007). But based on this study, the assumption that integrated projects are faster developed or enable greater control over time schedules is not supported.

There was the assumption that the results may be biased by renovation, expansion and transformation projects (13.3% of the data sample). To exclude doubts about the results, all analyses were also conducted for only the newly constructed projects, without the renovation, expansion and transformation projects, but these results did not differ significantly compared to the results from the original data sample.
Nevertheless, the results should be discussed in relation to the different penalty clauses on time overruns for traditional and integrated contract forms, because this may provide new insights.
In the Netherlands the UAC- 2012 (Uniform Administrative Conditions for the Execution of Works and Technical Installation Works 2012) regulates the contractual relationship between the client and contractor in a building process for traditional contract forms. Normally the client and contractor include project specific fines for time overruns in the contract documents. In absence of such project specific fines the UAC- 2012 describes a fine for time overruns which is € 60,- for each day overrun. The UAC- IC- 2005 (Uniform Administrative Conditions for Integrated Contracts 2005) is the same kind of regulation as the UAC- 2012, but for integrated contract forms. But the UAC-IC-2005 does not include any prescribed fines for time overruns. The client and the contractor have to include fines for time overruns in the contract documents.

Scope creep, i.e. extra works added, does not occur significantly more often by projects with traditional contract forms. Therefore it is not expected that projects with traditional contract forms do not meet planned time schedules compared to projects with integrated contract forms.
Almost always project specific fines in contract documents for both, integrated and traditional, contract forms are much more than the described € 60,- per day because the losses for the client are almost always more than € 60,- per day. Fines in the range of € 1000,- per day are not uncommon. But fines have to be proportionate with the actual damage suffered by the client and the reasonable ability of the contractor to pay.

To sum up, the size of fines is highly project specific, but as found in this study, parties choose significantly more often for integrated contract forms when there is above average time pressure on the development process and they assume that integrated processes have time savings. As a result it's more likely that integrated projects have higher fines when time overruns occur. This is an important issue as it shows the possibility of bias being present in studies using contract form as a sampling criterion: when time overruns are stricter penalized in integrated contract forms it makes sense that they will occur less when compared to using traditional contract forms, because contractors will make more effort to ensure that no time overruns occur.
However this study did not find less time overruns when using integrated contract forms. In contrast, almost all previous studies found that time overruns occur less frequently when using integrated contract forms. This argue may lie in the presence of penalty clauses rather than in the characteristics of the process of integrated contract forms. The topic of penalty clauses is not related to time overruns and contract forms in other studies. Further research is needed to get better insights about penalty clauses within different contract forms and time overruns.

Almost all studies discussed in the literature review did show better performances on time for integrated contract forms compared to traditional contract forms. The results of this study align with Ibbs' (2013) findings; projects developed with integrated contract forms do not perform significantly better on time aspects compared to projects developed with traditional contract forms. One argument for this great difference between findings is that previous studies are conducted between 1996 and 2009. Construction processes of buildings became more and more complex over the past decade due to the presence of more stakeholders, more and stricter building requirements and more and stricter regulations for procurement procedures. As a result construction processes from the '90 and early 00's vary a lot compared to processes nowadays and it is not so plausible to compare these studies with recent studies. In this line of reasoning it is legitimate that time savings found in 'older' studies cannot be found in recent construction processes, due to the more complex circumstances involved when developing buildings. This complexity makes that time savings became negligible and therefore are not measured.

This paper offered a performance-based, empirical study of two groups of contract forms. The study achieved several milestones in the field of research methodology and added state of the art findings to the body of knowledge of integrated contract forms.
This study was able to diminish shortcomings of previous research, which resulted in a more reliable study when compared to previous studies.
First, a homogenous data sample with objective data that was not biased by the selection of the

projects and expert opinions was composed. Second, transparency regarding the research methodology and the data collection process increases the reliability of this study. Last, this study's reliability is also enhanced by using the bootstrap method for the logistic regression model, which generates more reliable results.

Nevertheless, this study also has its shortcomings. There was the assumption that due to the similiar public funding for secondary schools, the sample is homogenous on the aspect of cost per m2. But analyses show a wide spread in costs per m2, this is caused due to extra funding available for schools by municipalities and school boards. Therefore the sample is less homogenous on the aspect of cost per m2 , but still homogenous due to similar appearance and purpose. Furthermore, this study's purpose was to study time aspects of development processes from the start of the initiative phase up to the end of the construction phase, but this was not possible due to the limited involvement of respondents during the initiative and definition phase (together the preparation phase) of projects.
Almost all respondents were only involved during the design and construction phase and not during the preparation phase. As a result no data is collected about the preparation phase. But when studying time aspects, and therefore time savings, it is essential to collect data about the preparation phase, because there is the widely shared presumption that integrated projects have a significant longer preparation phase and a significant shorter design and construction phase compared to traditional projects. This study was not able to study this presumption comprehensive, though a part of this presumption was subject of this study.

To conclude, this study measured performance as only being time aspects and found no significant better performances for integrated contract forms. This contradicts with many assumptions and statements.

References

Bennett, J., Pothecary, E., & Robinson, G. (1996). Designing and Building a World- Class Industry. Reading: Centre for Strategic Studies in Construction, University of Reading.

Field, A. (2009). *Discovering Statistics Using SPSS* (Vol. 3). London: Sage.

Flyvbjerg, B. (2011). Over budget, over time, over and over again. In P. Morris, Pinto, J., Söderland, J. (Ed.), *THe Oxford handbook of project management*. Oxford: Oxford University Press.

Hale, D. R., Shrestha, P. P., Gibson, E., & Migliaccio, G. (2009). Empirical comparision of Design/Build and Design/Bid/Build project delivery methods. *Journal of Construction Engineering and Management*.

Hosmer, D. W., Lemeshow, S., & Sturdivant, R. X. (2013). *Applied Logistic Regression* (Third edition ed.). Hoboken, New Jersey: John Wiley & Sons Inc.

Ibbs, C. W., Kwak, Y. H., Ng, T., & Odabasi, A. M. (2003). Project Delivery Systems and Project Change: Quantitative Analysis. *Journal of Construction Engineering and Management, 129*.

Konchar, M., & Sanvido, V. (1998). Comparison of U.S. Project Delivery Systems. *Journal of Construction Engineering and Management*(124), 435- 444.

Masterman, J. (2002). *An introduction to building procurement systems*: Routledge.

Meng, X. (2012). The effect of relationship management on project performance in construction. *International Journal of Project Management.. 30*, 188-198.

Nyström, J. (2007). *Partnering: definition, theory and evaluation.* PhD Thesis, Johan Royal Institute of Technology (KTH) School of Architecture, Built Environment and Real Estate Economics, Stockholm.

Vasters, R., Prins, M., & Koppels, P. W. (2010). *Does Integrated Procurement Reduce Building Cost and Project Time?* Paper presented at the CIB World Conference Salford.

Visscher, R. (2011). Vertraging Spoorzone Delft past in lange traditie Retrieved 19-02-2015, 2015, from http://www.delta.tudelft.nl/artikel/vertraging-spoorzone-delft-past-in-lange-traditie/23646

Winch, G. M. (2010). *Managing construction projects*. Chichester: Wiley- Blackwell.