IS IT FASTER AND IS THAT MEASURABLE?

A quantitative research into the time effects of integrated contract forms in the development process.

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

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.

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1. INTRODUCTION

Cost- and time overruns are unfortunately very common in the construction industry (Flyvbjerg, 2011; van Lieshout, 2009). 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). Integrated contract forms are characterized by the elimination of the separation between different procurements in one project to different parties (Cushman & Loulakis, 2001). 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). Figure 1 shows the different contract forms with the division of responsibilities during the development and operation phase of buildings.

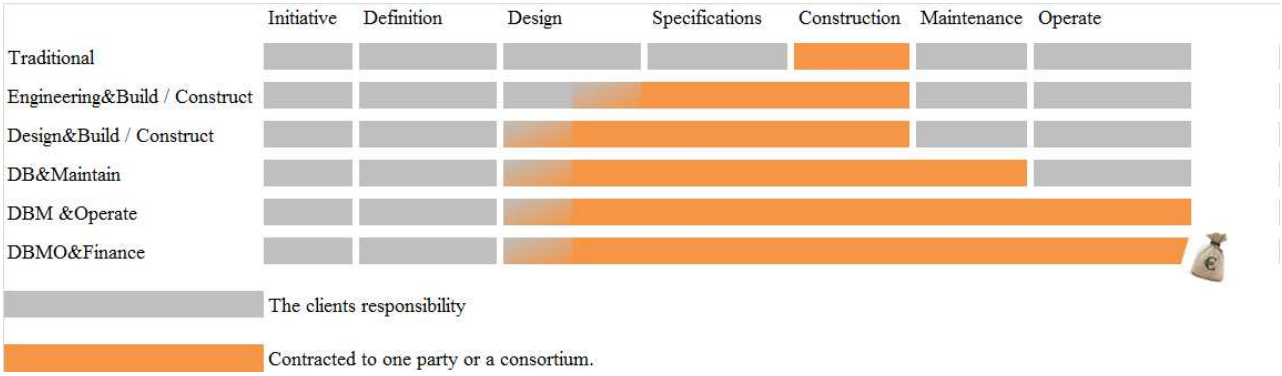

Figure 1: The contract forms with the division of tasks (Huiden, 2013).

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; Vasters, Prins, & Koppels, 2010). While another study found that projects delivered with integrated contract forms have faster processes, but were not 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). The conclusions from these studies vary, which may be partly due to their methodological weaknesses (Nyström, 2007).

Nyström states that weaknesses in previous studies are caused by using different definitions of measures and weak methodology of some studies. Even in studies where the methodology is strong, results cannot be compared with each other because of the different definitions of measures. As a result, the effects of integrated contract forms are unclear. Figure 2 distinguishes between those two lines of reasoning.

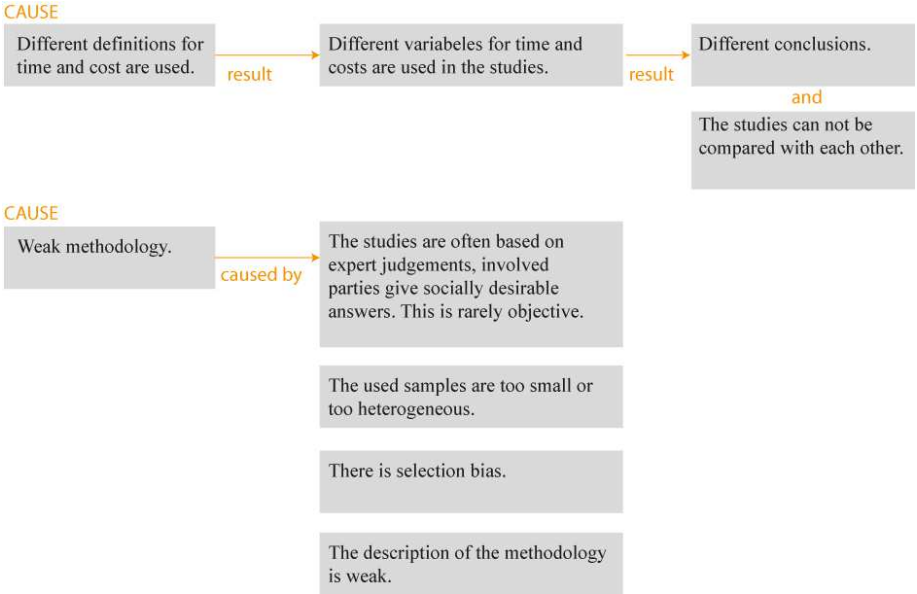

Figure 2: Clarification of the two causes of weak studies (own illustration).

According to Nyström 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 (Nyström, 2007).

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 a homogenous building type due to their similar appearance, purpose and funding. In the Netherlands, the (re)construction of secondary schools are 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 cost and time during the development process and the quality of the resulted building, 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?"

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 focused on the methodologies and findings of the most important empirical studies conducted over the past years in the field of integrated contract forms and 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 the conclusions and discussion of theoretical contributions.

As mentioned earlier, the purpose of this study is to get more precise insights into the effects of the building process on the product. It is widely assumed that there is a relationship between process (the contract form) and the outcome (the cost and time of the development process as well as the quality of the building) as seen is figure 3.

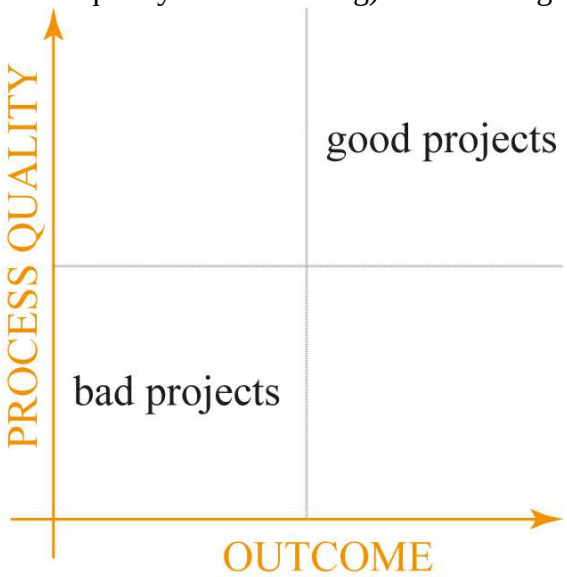

Figure 3: The assumed relationship between process and product (own illustration).

Although many have suggested that process quality gives rise to good outcomes in construction industry, most of the studies focused either on process or outcome. Only few focused on the effects of the process on the outcome, but conclusions of these studies vary greatly. Some studies stated that integration in the contract form (process) results in faster and cheaper development processes (outcome) (Bennett et al., 1996; Hale et al., 2009; Konchar & Sanvido, 1998). While others stated that integration in the contract form results in only faster processes (Vasters et al.,

2010). In contrast, another study did not find a relation between process and product: integrated contract forms did not result in cheaper and faster processes or better quality of the building (Ibbs et al., 2003). *Section 2. Literature Review* elaborated more in depth on these findings and the used methodologies.

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 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.

Performances in Previous Research

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 partly disagreed 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).

Time Variables in Previous Research

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 the 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	The construction speed of D&B projects is 12% less than traditional projects (Bennett et al.,

	construction phase)/30] in (m^2/month) **Delivery speed**= net floor space / (total actual project time/30) in (m^2/month)	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.

Reliability of previous studies

This empirical study focused on the effects of time performance during the development process when integrated contract forms are used. Shortcomings of previous studies are identified in table 2; this table also describes how these shortcomings are diminished in this study.

Study	Evaluation	Steps to reduce these shortcomings in this study.
Bennett et al., 1996	Reliability: 1. From the 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. 2. 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.	1. Composed a homogenous sample. 2. The way data was collected is described very precise and in a way that could be repeated.
Vasters et al., 2010	Reliability: 3. The sample is too small (N=6). Due to the small sample the used statistical analyses, ANOVA and MANOVA, are meaningless. Practical objection: 4.It is time consuming to calculate the variable 'time efficiency', as done in this study.	3. A bigger sample is composed which makes statistical analyses more meaningful. 4. In this study the variable 'time efficiency' is not used.
Hale et al., 2009	Reliability: Good.	-
Ibbs et al., 2003	Reliability: 5. The 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.	5. Projects in the sample are built in one country and over a short time span.
Konchar and Sanvido, 1998	Reliability: 6. The sample 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	6. Fewer variables were used in this study to minimize the chance of data dredging.

	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).

Table 2: Evaluation of the previous studies.

3. RESEARCH METHOD

Case Control Study

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.

Composing a Homogeneous Sample and Data Collection

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 minimally involved in the design and execution phase. These project managers were hired by the Board of Education of the schools, which is the client of the project.

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.

Questionnaire

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 questionnaires 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.

Data Processing

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.
- 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.
- 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 new 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. This classification is based on the focus of this research; the process performance during the development phase.

The new classification is as follows:

Contract form	New classification
the traditional contract form.	Traditional contract form.
the building team.	Traditional contract form.
the Design & Build or Design & Construct contract form.	Integrated contract form.
the Engineer & Build or Engineer & Construct contract form.	Integrated contract form.
the Design, Build & Maintain contract form.	Integrated contract form.
the Design, Build, Finance & Maintain contract form.	Integrated contract form.
the Design, Build, Maintain & Operate contract form.	Integrated contract form.
the Design, Build, Finance, Maintain & Operate contract form.	Integrated contract form.

Table 3: New classification of the contract form.

Multivariate Linear Regression Model with Bootstrap

Collected data was analyzed by statistical models with SPSS version 22, a software package for statistical analysis. 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 probabilty that the observed values would be found without a relationship between the variables is smaller than 5% (Field, 2009). For logistic regression modeling 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 included in the model (Hosmer, Lemeshow, & Sturdivant, 2013).

Three groups of univariate analyses were classified. The first group was the ‘significant group’, p- values of these analyses were ≤ 0.1. A p-value of ≤ 0.1 rather than a p- value of ≤ 0.05 was chosen for the univariate analysis because some not significant univariate outcomes can become significant under influence of other variables in the multivariate linear regression model.
The variables in this ‘significant group’ were included in the multivariate linear regression model and removed from the final model if significance felled below $p < 0.05$.

The second group was ‘the hopeful group’; the p- value of these analyses was between 0.1 and 0.3. These univariate outcomes were also included in the multivariate linear regression model because they can become significant under influence of other variables and removed

from the final model if significance felled below p <0.05.

The third group was ‘the hopeless group’; p- values of these analyses were ≥ 0.3. These outcomes were not included in the logistic regression model.

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

Descriptive characteristics

Forty six questionnaires were sent to project managers. Thirty questionnaires were filled in and returned, which is a 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 country (figure 4).

Figure 4: The spread of the surveyed projects across the country (own illustration).

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.

Modeling
As mentioned earlier, the logistic regression model explains the contract form from differences in outcome variables.

Final model 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.

Therefore 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 4:Univariate analysis which were used as input in the logistic regression model with ‘the presence of above average time 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 5 summarizes the final model, whereas table 6 shows the most relevant univariate analyses in addition to 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 5: 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 6: Outcome of the most relevant univariate analyses in addition to the final model.

5. CONCLUSION AND DISCUSSION

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 (Chao- Duivis, 2013).
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 ("Boeteclausules,").
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. And here lies the crux: when time overruns are stricter penalized in integrated contract forms it is logical 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.
But 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. But this may lie in the penalty clauses and not 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.

As mentioned earlier, this study's results are for a great part not supported by results from previous studies. 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' 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. The line of reasoning that secondary schools in the Netherlands are a homogenous building type due to almost the same budgets for construction contradicts with the results from the data sample. The surveyed projects ranged in costs from € 874 /m^2 to € 2153 /m^2 with a mean of € 1447/m^2 and a standard deviation of € 367/m^2. This resulted in a less homogenous data sample as expected.
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.

Follow up research regarding the operation phase of buildings is recommended. This study’s focus was on the effects of process integration on performance measured in terms of time aspects. Follow up research should focus on the same data sample but respondents will be the Board of Education of the schools and will be questioned about efficiency of the building during the operation phase. In this context efficiency is the exploitation of the building and user quality. This is particularly interesting because changes in de development phase (integration between design and construction) will be linked to performance during the operation phase. This follow up study’s goal is to study whether changes in the process (integrated contract forms) influence the quality of the building during the operation phase. Table 7 elaborates on this recommendation.

This study	Follow up study
Study subject: Secondary schools in the Netherlands delivered between January 2008 and January 2015.	**Study subject:** The same buildings as in this study.
Respondents: Project managers involved in the development process.	**Respondents:** Board of Education of the school, is involved in the operation phase of the building.
Which phases of the life cycle of the buildings is studied? ○ Design phase. ○ Construction phase.	**Which phases of the life cycle of the buildings is studied?** ○ Operation phase.
Research question: Do projects with integrated contract forms perform better on time aspects than projects with traditional contract forms?	**Research question:** Does integration in the contract form deliver more efficient buildings, in terms of exploitation of the building and user quality? Do projects which performed better (on time aspects) in this study also perform better during the operation phase, in terms of exploitation of the building and user quality?

Table 7: The follow up 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. It is time to continue revealing the puzzle called ‘integrated contract forms’ by conducting reliable research into the other performances; costs and quality.

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