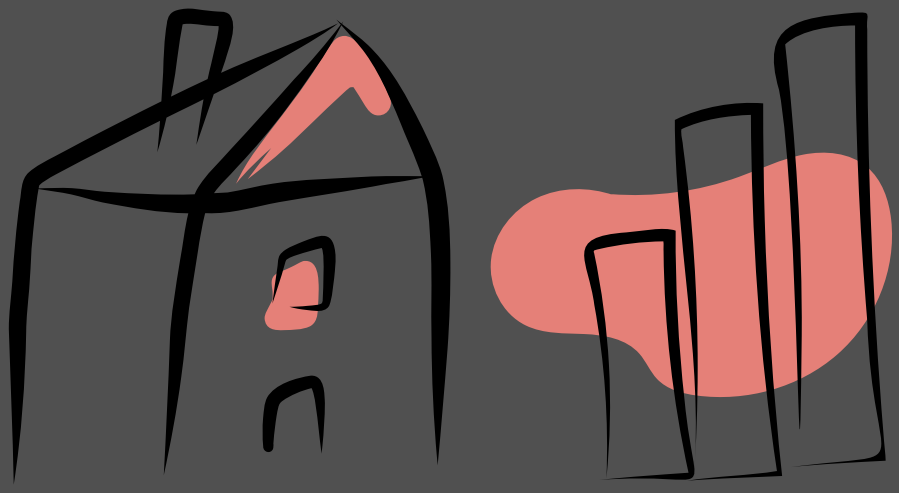
Quantifying investment risks

Forecasting Delivery Time of New-Build Projects of Dutch Housing Associations



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Preface

The following dissertation “Quantifying investment risks: Forecasting Delivery Time of New-Build Projects of Dutch Housing Associations” is based on two parts. The first is a qualitative study including a survey on housing associations (HA's) and in-depth interviews with supervisory bodies and the second, a statistical analysis to create a decision model that predicts time to deliver new build projects for Dutch HA's. The thesis satisfies the graduation requirements of the MSc Architecture, Urbanism and Building Sciences in the track Management in the Built Environment at the Delft University of Technology. I was engaged in researching and writing this dissertation from August 2021 to June 2022.

The project was undertaken at the request of Ortec Finance, where I undertook a graduation internship targeted at Dutch HA's and supervisory bodies. My research question was formulated together with my company mentor Maarten van ‘t Hek who approached me with the interesting problem and has been pivotal for industry guidance and relevance of this thesis. The research was difficult but conducting extensive investigation has allowed me to answer the questions that we identified. I would also like to thank my mentors from TU Delft, Ellen Geurts and Vincent Gruis who have consistently guided and provided expert academic rigor to this research. They have also always been available and willing to answer my queries and provide constructive critique. I am very grateful for the excellent guidance and support during this process. I would also like to personally thank Ivo de Lijster who offered invaluable insights into the management of HA's and went above and beyond to provide me with insights, data, and guidance.

I also wish to thank all the respondents from AW, WSW, BZK and HA's without whose cooperation I would not have been able to conduct this research. I would like to thank everyone who provided technical or content opinion including Peter de Jong, Gert Wim Bos, Peter van Os, Arjen Wolters, Marc Francke, Sylvia Janssen, Marlous van Berkum, David Kroon, Farley Ishaak, Bianca Meij, Bert Bredewold, Robert Hendriks, Martijn van der Linden, Margit Jokovi, Reynt Sluis and Ivar Kramer. Your help, insights and expertise are greatly appreciated.

To my manager at Ortec Finance’s Real estate management team, Annique Verkoeijen, I would like to thank you for your wonderful cooperation and understanding during this research. It was always helpful to bat ideas about my research with you and your leadership, expertise and passion for real estate management inspires me.

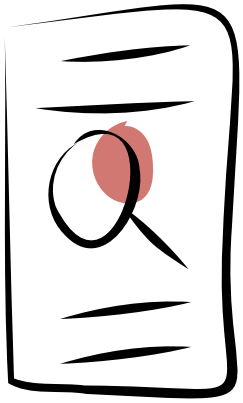
I also benefited from debating issues with my lovely wife Alinda Vos Seda to whom I am incredible grateful for the impeccable scientific rigour with which you looked at this research for the past 12 months and the shoulder to lean on through this entire research. If I ever lost interest in my masters, you kept me motivated.

I hope you enjoy reading.

Edwin Seda

Delft, The Netherlands
10th June 2022

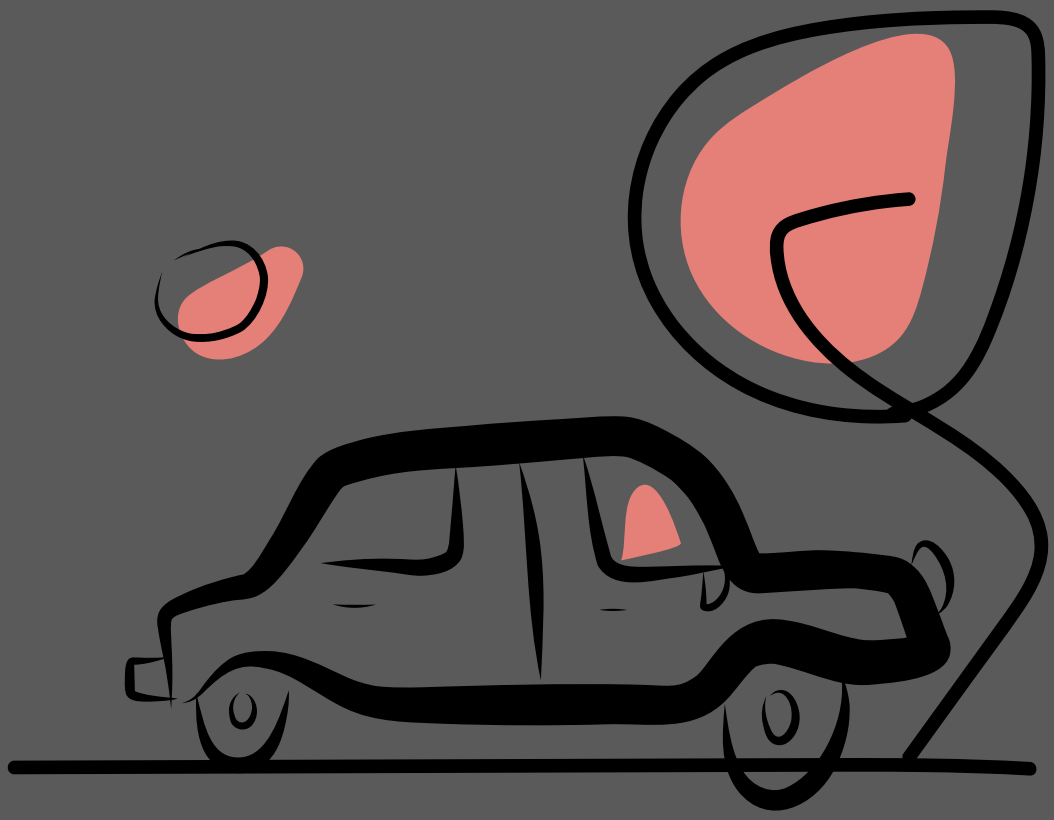
Abstract



Dutch Housing associations (HA's) are responsible for producing, maintaining, and managing about 30% of all Dutch housing stock. HA's draw up their investment forecasts yearly for the next 5 years to construct, improve or maintain homes and other real estate investments. Since 2013, the realization rate of new construction plans by HA's, which is the comparison of forecasts (dPi) against realized plans (dVi) decreased due to HA's not realizing new build homes within the time they propose to realize them in their forecast plans. HA's currently use valuation methods which assist them to mitigate emerging risks that affect new build plans of HA's. However, valuation methods have been found to focus on indexable risks and capture financial loss while excluding time effect of risks. This means that new build investment forecast as currently conducted yields inaccurate results and are considered too optimistic. Forecasts that are too optimistic lead to disappointments from tenant organizations and municipalities, reduced financial guarantees from lenders, long waiting times for tenants and affects financial feasibilities which rely on accurate prediction of time to completion of projects.

The aim of the research is to explore how new build plans can be made more realistic by accurately predicting the delivery time of investment forecasts. The study results in the identification of risks that lead to delay of new build investment plans and their subsequent indicators. The risks include long permit procedures, long land acquisition processes or lack of land positions to build, long tendering procedures, contractor related delays, rise in construction costs and lack of capacity at municipal level in dealing with development projects. The indicators of risks which statistically significantly predicted project time are construction costs, change in input price index of material and labour costs as of date when decision was made to tender, municipal location, and type of construction i.e., on empty ground or existing site that needs demolition. The project indicators can be used by HA's to accurately predict project time via stochastic decision tree models (SDTA) that rely on multiple linear regression (MLR) and Monte Carlo simulations (MCS). Supervisory bodies can also use these to gauge realism of new build investment forecast.

Keywords: Housing associations, new build investment forecast, Stochastic Decision Tree Analysis (SDTA), Multiple linear regression (MLR), Monte Carlo Simulation (MCS), delivery time, systematic risks, unsystematic risks



Executive Summary

A Introduction

Dutch Housing associations (HA's) are responsible for producing, maintaining, and managing about 30% of all Dutch housing stock[1]. HA's draw up their investment forecasts yearly for the next 5 years to construct, improve or maintain home and other real estate investments[2]. Since 2013, the realization rate of new construction plans by HA's, which is the comparison of forecasts (dPi) against realized plans (dVi), decreased due to HA's not realizing new build homes within the time they predict to be able to realize them[3]. HA's currently use valuation methods which assist them to mitigate emerging risks that affect new build plans of HA's[4].

However, valuation methods have been found to focus on indexable risks and capture financial loss while excluding time effect of risks[5]. New build investment forecast as currently forecast are inaccurate as evidenced by the declining rate of realization and is considered too optimistic[3]. Forecasts that are too optimistic lead to disappointments from tenant organizations and municipalities[3], reduced financial guarantees from lenders[6], long waiting times for tenants and affects financial feasibilities which rely on accurate prediction of time to completion of projects[7].

The purpose of this research is to explore how new build plans can be made more realistic by accurately predicting the delivery time of investment forecasts. The research explores the risks that affect delivery time and how they can be modelled to determine total new build project time. Against the explained background, the following research question is explored and answered: "How can time to deliver new build investments of Dutch housing associations be accurately forecast?". 3 sub-questions were subsequently set up: [1] What are the main risks that affect the accuracy of new build investment forecasting for Dutch housing associations? [2] What are the current gaps in how such risks are integrated in predicting the delivery times of new build investment forecasts? And [3] How can the current gaps be resolved to improve the accuracy of new build investment forecasting?

The goal of the research is to provide HA's managers with a model to quantify risks that affect the time to deliver projects. The model creates a way to model risks into project time, thereby accurately predicting new build plans in the dPi.

B Methodology

This research followed an empirical research methodology and was conducted in two main ways i.e., qualitative, and quantitatively. Qualitatively, literature review, in depth interviews, surveys and expert opinions were conducted. Literature review explored the history and regulatory context of Dutch social housing in the Netherlands, risks affecting HA's realization of new build projects and techniques used to model the risks. An in-depth interview was conducted with 5 data and policy managers from supervisory bodies (AW, WSW, AEDES and BZK).

Surveys were conducted with 29 Dutch HA's with more than 10,000 rental units and expert opinion interviews were conducted among 3 experts (portfolio manager, project development manager and project controller from Portaal, a housing association from the Netherlands with homes in Amersfoort, Arnhem, Leiden, Nijmegen, Soest and Utrecht.

The risks identified in the qualitative section were converted from abstract concepts into numeric project indicators for the qualitative study. Three methods (Multi Linear Regression, Decision Tree Analysis and Monte Carlo simulations) were used to build a decision model using IBM SPSS and Microsoft Excel (including Palisade Precision Tree and @ Risk plugins). Using a dataset of 57 projects from Portaal, the dependent variable (Total project time) and independent indicator variables (number of homes, input price index at decision to tender, construction budget, property type i.e., multi apartment (MGW) or single-family homes (EGW), municipal location of project and construction type i.e., demolish build or new build on vacant land) were used in the linear regression model with the following formula:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + ... \beta_n X_n$$

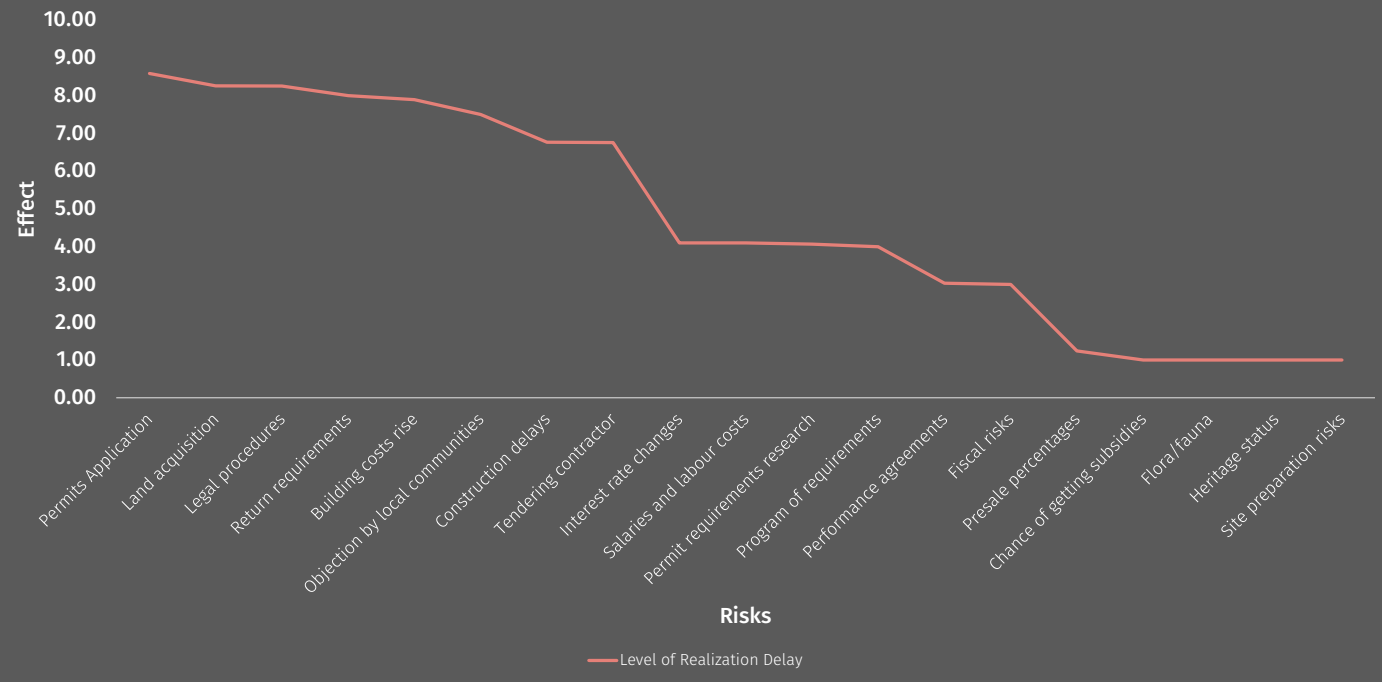
The resulting linear model was then converted into a stochastic decision tree model. The results were then presented back to the expert panel for review and discussion.

C Findings

Risks and techniques in investment forecasts

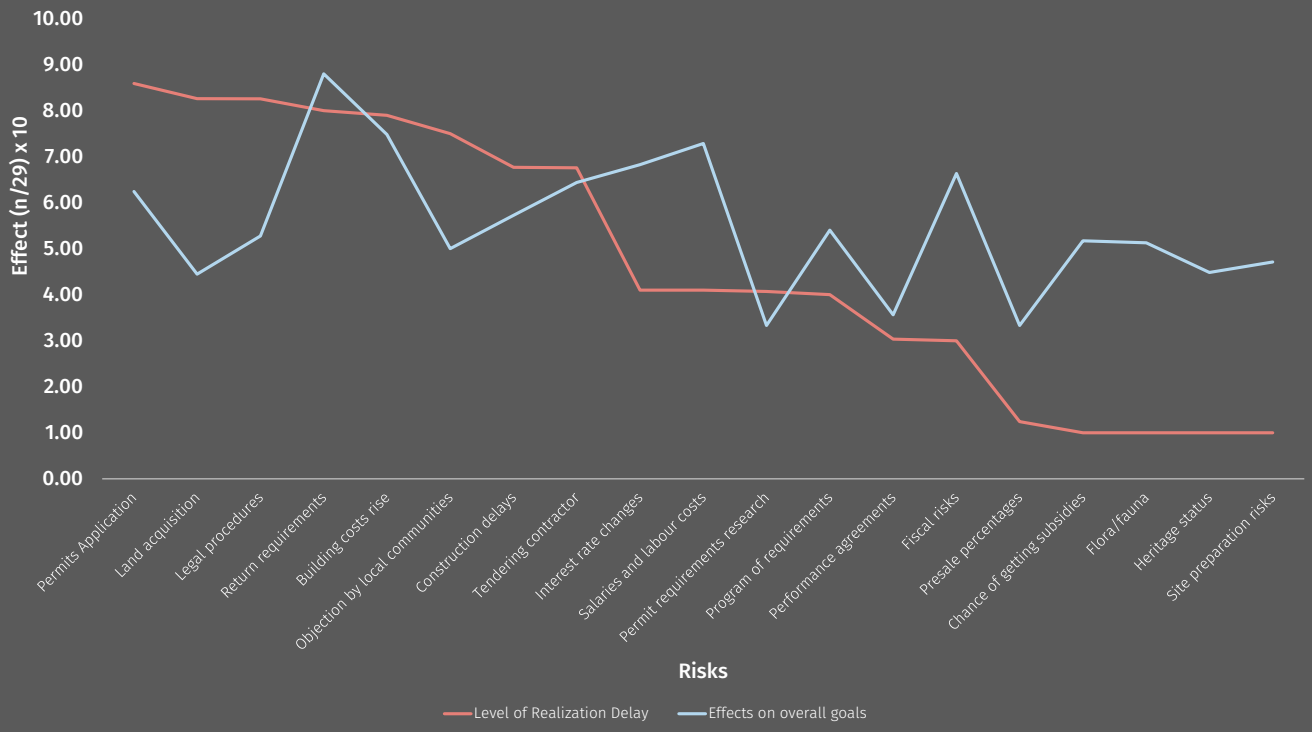
The top risks that cause delay were found to be permit procedures (including permit applications, legal procedures and objections by local residents), elongated land acquisition procedures, delays from return requirements, rise in construction costs, contractor on site delays and complexities when tendering and appointing a contractor.

Figure 1: Order of risks that cause delay of new build projects for Dutch HA's.



Municipalities delayed projects with underdeveloped agreements made at strategic level. Agreed on plans later suffered from long durations to approve permits and underdeveloped resources like land and development teams capable of fast-tracking processes. It was also found that return requirements, building costs rise, salaries and labour costs, interest rate changes and fiscal risks topped the list of risks that affected social and financial goals of HA's forecast plans.

Figure 2: Order of risks that cause delay versus effects on overall goals.



Financial risks (return requirements, fiscal risks, interest rate changes and salaries/labour costs) and performance agreements risks are the most prioritized for resolution in the dPi. Permit procedure, land acquisition, contractor delays and tendering are prioritized as medium to low for resolution.

Figure 3: Order of risks that cause delay versus priority of resolution for dPi.

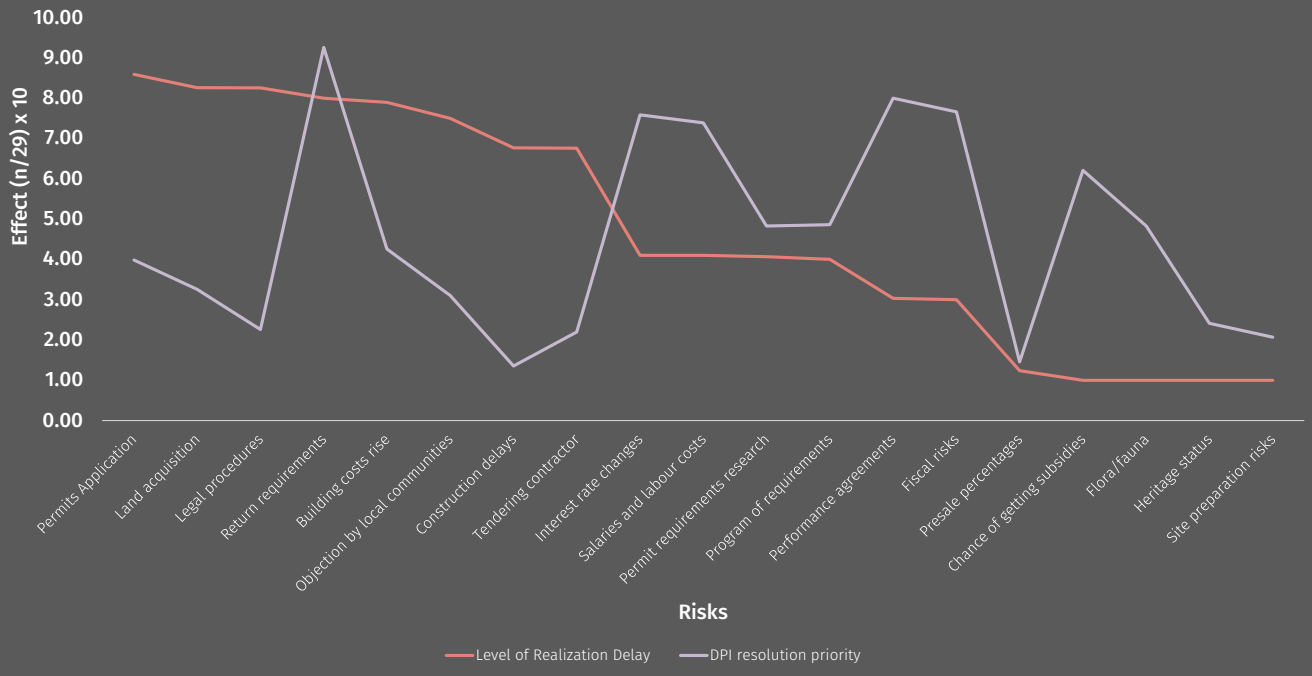
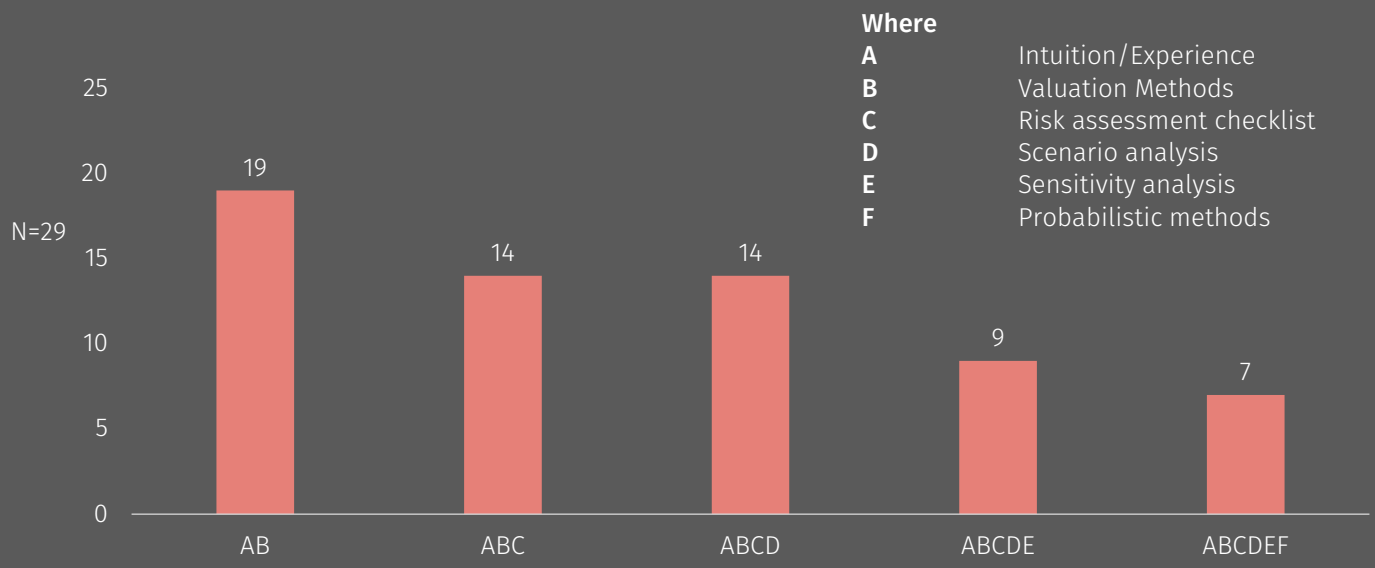
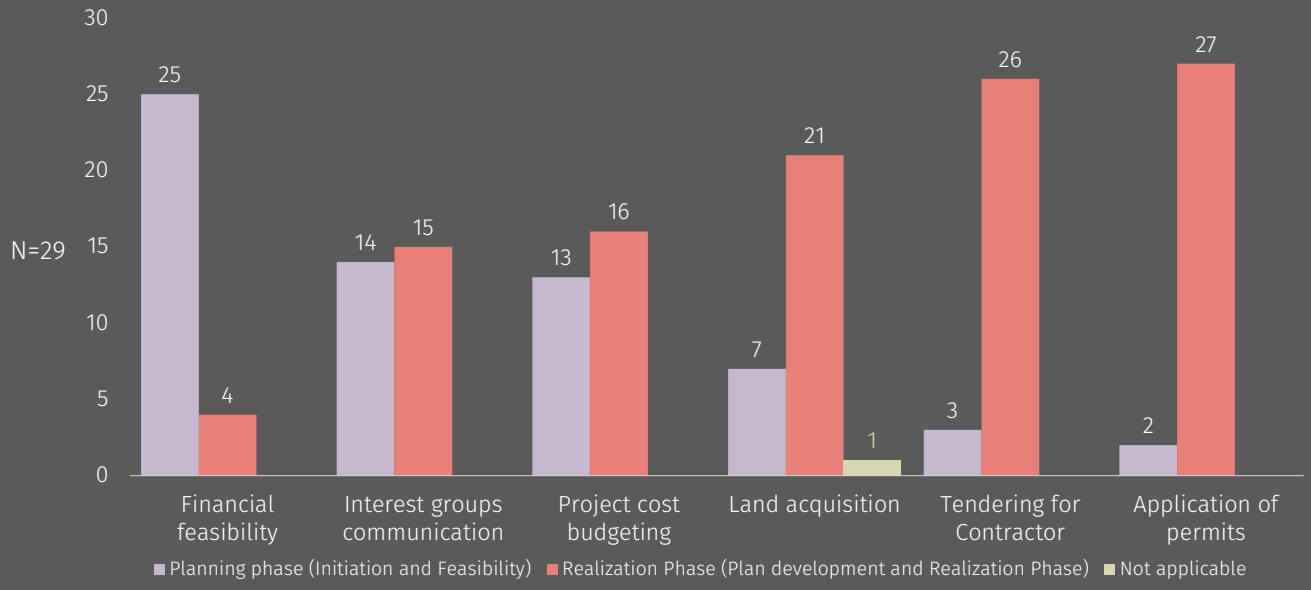


Figure 4: Most likely combinations of risk capturing methods.

The methods that HA's use to assess risks in investment forecasts were found to be mostly based on valuation methods with the most likely combination identified as to be valuation and personal experience. Other methods identified in order of most used were risk assessment checklist, scenario analysis, sensitivity analysis and probabilistic methods in that order.



When the activities of HA's are plotted against the time that they occur in the real estate development timeline, HA's place their activities into two main phases i.e., phase 01 inclusive of initiation and feasibility and phase 02 inclusive of plan development and realization. When the top delaying risks are isolated within the timeline, it is found that financial feasibility risks which are indexable systematic risks occur almost exclusively in the first phase of real estate development process. Unsystematic risks (land acquisition, tendering for contractor and permit applications occur mostly in the second realization phase. Building costs risks tend to occur in both first and second phases. Communication with local communities also occurred in both first and second phase.



Solutions to gaps in risks appraisal

It was found that investment forecast processes are too optimistic and lack realism. Realism of investment forecasts is defined as calculation and inclusion of risk that inhibit the realization of new build projects within the time they are predicted to be realized. It is also defined as the accurate prediction of time to deliver new build projects within the time they are predicted to be delivered. The quantitative study indicated that qualitative risks can be quantitatively represented as new build project indicators.

The indicators, which were part of the 57-sample dataset, were included in a multi linear regression. The model showed that there was linearity as assessed by partial regression plots and a plot of studentized residuals against the predicted values. There was independence of residuals, as assessed by a Durbin-Watson statistic of 1.847. There was homoscedasticity, as assessed by visual inspection of a plot of studentized residuals versus unstandardized predicted values. There was no evidence of multicollinearity, i.e., all tolerance values were greater than 0.1. There was no studentized deleted residuals greater than ±3 standard deviations, there were no values for Cook's distance above 1 but 3 cases had leverage values greater than 0.2. The assumption of normality was met, as assessed by a Q-Q Plot. The multiple regression model statistically significantly predicted total project time, $F(9, 47) = 3.795$, $p = 0.001$, adj. $R^2 = 0.310$. Input price index, construction type, municipal location and Building cost added statistically significantly to the prediction, $p < 0.05$.

The regression equation for predicting total project time using statistically significant variables is expressed as follows:

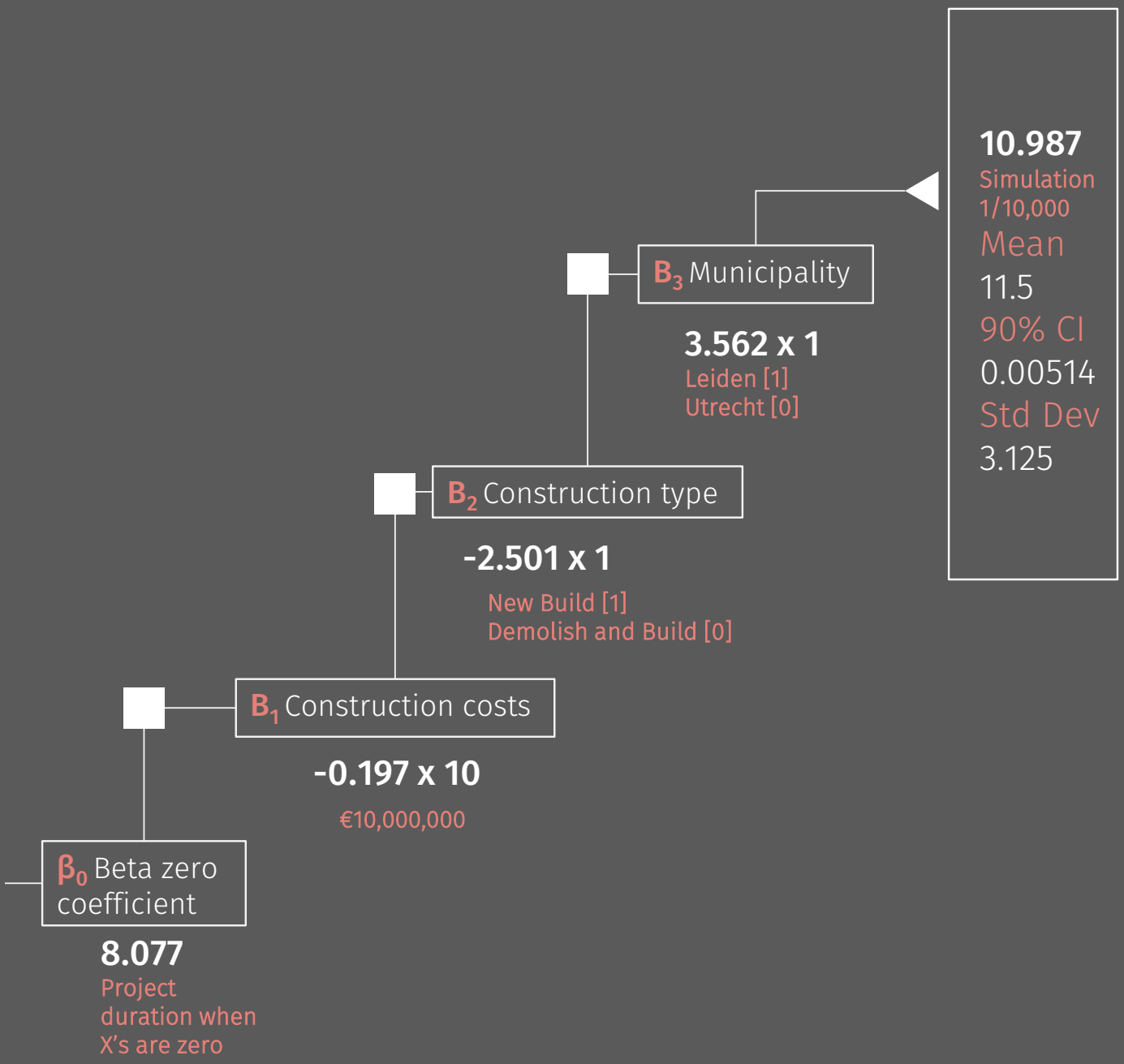
Total project time = β_0 + β_1 x construction costs) + (β_2 x input price index @ decision to tender) + (β_3 x construction type) + (β_4 x municipal location)

The stochastic decision model is represented mathematically as:

Total project time (years) = 7.837 + (0.322 x construction cost) - (0.080 x input price index @ decision to tender) – (0.291 x construction type) + (2.796 x municipality)

Weighting the unstandardized coefficients (β_0, β_1, β_2, β_3 and β_4) with standard errors provides a normal distribution of the coefficients that is represented in a stochastic decision tree model.

Inputs	Project characteristics	Value of X	Coefficients	Standard deviation	MCS B Coefficients
(Constant)			7,84	2,5090	8.077
Location	Leiden	1	2,80	1,2730	3.562
Construction cost per mln	€ 10.000.000	10,00	0,32	0,0970	0.197
Input price index	1,00	1	-0,08	0,0390	-0.1279
Construction Type	New build	1	-1,97	0,9570	-2.501



D Discussions

Risks and techniques affecting forecasts

The results indicate two perspectives of how HA's resolve risks for investment forecasts. The first perspective looks at how HA's view risks that delay new build plans. HA's view permit applications procedures (including legal procedures, zoning changes, objection by residents), land acquisition,return requirements, rise in building costs, tendering complexities, delays occasioned by contractors on site and municipal incapacity as risks that delay projects in line with several authors[3,8].

Regarding rising building costs, financial requirements and long tendering procedures, It has been found that the effects of rising construction costs apply in the both the planning and realization stage since no contractor could be found for plans within the desired budget leading to long tendering negotiations[9]. Difficulties in acquiring land by HA's from municipalities, developers or third parties which often leads to cancellations in case land cannot be confirmed is also mentioned [3,8,10]. This research indicated that municipalities lack resources like land and sufficient development and permitting professionals which tend to delay projects in line with previous research[8]. Dutch public housing has become a specialist field with a lot of jargon, rules, accountability and not enough professional exist to efficiently steer these processes leading to delays in new build projects[8].

The second perspectives involves how HA's view risk effects on their overall goals in comparison to their perspective on delaying risks. Return requirements, building costs rise, salaries/labour costs, interest rate changes and fiscal risks lead the list of risks that greatly affect the achievement of social and financial goals of HA's forecasts. This indicates that risk appraisal is not tackled in the same process, an indication further highlighted by the finding that HA's resolve financial and performance agreement risks for inclusion in the dPi and not top time delaying risks. As such, time effects of risks are omitted in the new build investment forecasts. This research found also that valuation methods play a big role in resolving risks. It is however noted by several authors[11,12,13] that while valuation methods are strong in evaluating risks associated to real estate development risk, they only capture risk of losses on financial investments caused by adverse market movements and omit the time effects of risks. As such, HA's risk processes focus on financial loss effects and omit time loss effects.

The results also indicate that the real estate development timeline includes two main phases ie first and second phase with financial risks located in the first phase and unsystematic risks (long permit procedures, land acquisition, tendering delays, municipal incapacity, and contractor delays) occurring mostly in the second phase. The results suggest that there is a separation in the timeline between risks that affect finances which tend to appear earlier in the process and risks that occur later in the project. The result is a mismatch between when risks are tackled in the timeline.

The results correspond with the perspective of several authors [11,12,13] who indicate that valuation methods when not combined with other methods assume that risks occur at a single point in time and exclude risks that occur later in the development process. Exclusion of time risks in valuation methods leads to incorrect time estimation which leads to incorrect valuation results, inaccurate budget provisions from variating building costs and delays and ultimately declining returns. Financial risks are subsequently also created by omission of time risks from forecasts.

While all risks mentioned in the real estate development process are included, there is an indication that financial risks of new build projects are prioritized for resolution in dPi while time delaying risks are minimally prioritize for resolution in the dPi. Valuation methods used for risk appraisal subsequently tend to focus on budgetary risks and do not capture time risk effects caused by time.

Quantifying time impacting risk effects

The addition of project risks indicators to investment forecasts is proposed to resolve the missing appraisal of time effects of risks in dPi forecasts. It is also noted that methods already exist to capture the effects of risks on time delay of projects as evidenced by Portaal. By measuring the impact of interest rate, salary and indexations risks with the number of delays that occur in months, Portaal qualitatively measures budgetary risks and mitigates time delaying risks at a budgetary financial level. For this reason, it can be observed that Portaal exhibits a relatively high new build realization rate index of 92% on its new build forecasts. It is however noted that while Portaal measures the impact of delay in projects, there exists no methodology to accurately measure project time in an explicit and quantitative manner.

The stochastic decision tree model indicated that the total project time increased by 0.322 years for each million euro of construction cost and reduced by 0.08 for every one unit increase of input price index. New build projects took 1.968 years shorter than demolish and build projects and projects in the municipality of Leiden lasted 2.796 years longer when compared to projects in Utrecht. It also indicated that in the absence of all risks, the expected time was 7.837 years.

The average time excluding risks, represented by β_0 was found to be approximately 7.84 years in line with previous research which notes that the average lead time from start to sale of a home in the Netherlands was almost 10 years. When the input price index increased, the project time reduced by 0.080 years because contractors tended to accelerate projects in bearish cost economies and vice versa. Increase in project budget increased time by 0.32 years because large projects were associated with complex elongated permit and construction procedures.
It was however noted that a tipping point occurred with the cost where large projects time effects normally distributed. New build projects take off approximately 1.968 years off the total project time as compared to demolish and build projects due to related tenant relocations, demolition permits and such extra regulatory requirements associated with demolition projects. Projects in Leiden took 2.796 years longer than projects in Utrecht due to

Leiden being an inner city municipality and having less capacity at municipal level.
The developed mathematical model indicates that a linear mathematical relationship can be established between the indicators of risks that affect time and the time it takes to realize new build real estate development projects. The stochastic decision tree model indicates that qualitative risks like land acquisition risks can be operationalized into their respective numeric indicators e.g. construction type. , by finding the relevant project indicators to quantitatively represent a qualitative risk, project time can be modelled to provide accurate new build forecasts. The model provides HA's with a means to determine the percentage of optimism in the budgets to counter check against plans proposed by asset managers and financial controllers.

Limitations of the study

First, the survey method to determine risks that delay projects was conducted in a qualitative as opposed to quantitative manner which would have allowed quantitative statistical analysis of the results. However, a non-parametric test was found to be useful in analysing the ranked and categorical data that included risk perceptions and assessment methods. The computations and interpretations were simpler to derive given the small sample size.

Second, the data used to run the linear regression was collected from Portaal, meaning that only one HA of the possible 70 large and extra-large HA's was collected, limiting the ability for the data to be generalizable. The results however provide a starting point to quantify project time among large and extra-large HA's who have the same make up as Portaal which is a representative HA in the Netherlands.

Third, the results of the linear regression model exhibit an R^2 value of 0.42 meaning that not all variations in the model are yet captured. The addition of more project specific characteristics to the model is needed to improve the variance. Nevertheless, the model establishes four statistically significant indicators that were useful in building the model.

E Conclusions and recommendations

Conclusion

In summary, the research explored how to capture risks that cause delays in new build plans of Dutch housing associations and make investment intentions inaccurate. Inaccurate forecasts lead to disappointments from tenant organizations and municipalities, reduced financial guarantees from lenders, long waiting times for tenants and affects financial feasibilities which rely on accurate prediction of time to completion of projects.

A main research question was proposed: *"How can time to deliver new build investments of Dutch housing associations be made accurately forecast?"* To answer the main question; three sub-questions were formulated: [a] "What are the main risks that affect accuracy of time taken to deliver new builds

as forecast by HA's?" [b] "What are the current gaps in how time affecting risks are integrated in predicting the delivery times of new build investment forecasts?" and third [c] "How can the current gaps in forecast of time to deliver new build projects be resolved to improve the accuracy of new build investment forecasting?"

First, the research indicated the key risks that affect HA's in their planning process as permit procedures (including permit and zoning applications, objections from local residents and legal procedures), rise in building costs, lack of or elongated land acquisition procedures, lengthened tendering of contractors, delays from contractors and lack of municiapl capacity when it comes to efficient permit approval times and proper development teams to initoate and steer projects at a municipal level.

The gaps found that in how delaying risks are integrated in predicting the delivery times of new build investment forecasts are that HA's use techniques that prioritize financial loss effects and omit time risks. Financial risks are prioritized for inclusion in the dPi while non indexable risks like lack of permits, land or contractors are not appraised for time effects on project delivery. This leads to overoptimism of plan prediction which ultimately makes the dPi plans which are the data that HA's submit to oversight bodies inaccurate.

To remedy these gaps, it was proposed to operationalize risks that cause delay into project specific indicators using a multiple regression model and a stochastic decision tree model. The results indicate that construction budget, municipality location, the input price index when decision to tender was made and finally the construction type i.e. whether a project was on empty land or had to be demolished and rebuilt are significant indicators that affect project time. Regressing these data and building a stochastic decision tree model provides predicted project time and budgets per year which provides accurate information for the dPi within a specific standard margin of error.

To accurately forecast new build investment plans, HA's risk appraisal processes must incorporate both time and financial loss effects in forecasts. Failure to recognize project-specific characteristics and their impact on project duration means that the capacity to realize investment projections within the timeframe anticipated will be hampered. This will accelerate the current trend of erroneous investment forecasts. Furthermore, financial return requirements rely on accurate project duration predictions, and as a result, poor project duration predictions have an influence on project financial feasibility and consequently a HA's financial health.

Recommendations for implementation

Because inaccurate prediction of delivery times has been noted to disappoint stakeholders, and lead to financial risk from inaccurate time inclusion of valuation, both supervisory bodies and HA's can benefit from the research.

Supervisory bodies including AW, WSW, AEDES and BZK can prioritize the collection of project specific information to better understand the intentions of housing associations in their new build investment forecasts. HA's on the other end can use project indicators to quantify risks in a quantitative way

besides using traditional valuation methods and thereby incorporate time risk effects into forecasts.
The research also provides opportunities for Ortec Finance as a company that helps housing associations to manage their investment decisions. Because Ortec Finance provides the technology and solutions for risk and return management for housing associations, this research provides a starting point for a decision model that can be used to predict project time.

Recommendations for future research

First, as the research is mainly bound to HA's with more than 10,000 VHE in the Netherlands, future research could focus on HA's below 10,000 to incorporate smaller housing associations as well.

Secondly, there remains several project characteristics that did not form part of the study due to time and unavailability of data at the time of the research. This resulted in adaptation of the project to fit available data. Accordingly, future research can focus on the linear relationships between delivery time and such project characteristics like Zoning plan application status, Local community discussions made before permit application, Land ownership status e.g., HA, municipality, developer.

Third, the role of internal planning of HA's regarding project indicators like change in staff compositions or experienced delay in finance application process should also be reviewed to determine time effect to forecasts.

Finally, this research used a qualitative survey to identify risks that affect delivery time for HA's new build projects. The results provided significant insights on the topic. However, future research can focus on a quantitative study to better capture qualitative views of HA's and supervisory bodies.

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