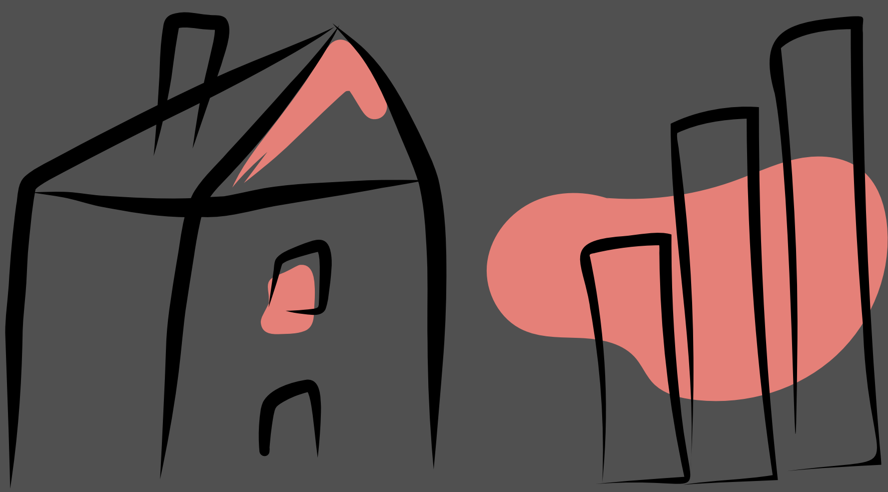
Quantifying investment risks

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



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To Alinda,

The haematologist who now knows
as much as I do about investment forecasts.
I am indebted that you always
made time to listen,

but mostly to both look and listen.

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.

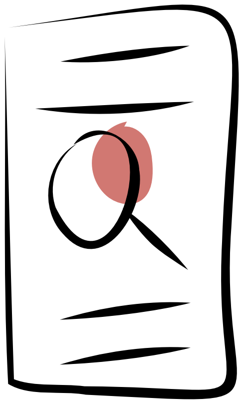
I also benefited from debating issues with my lovely wife Alinda Vos Seda to whom I am incredible grateful for the impeccable scientific rigour with which you looked at this research for the past 12 months and the shoulder to lean on through this entire research. If I ever lost interest in my masters,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

I hope you enjoy reading.

Edwin Seda

Delft, The Netherlands
10th June 2022

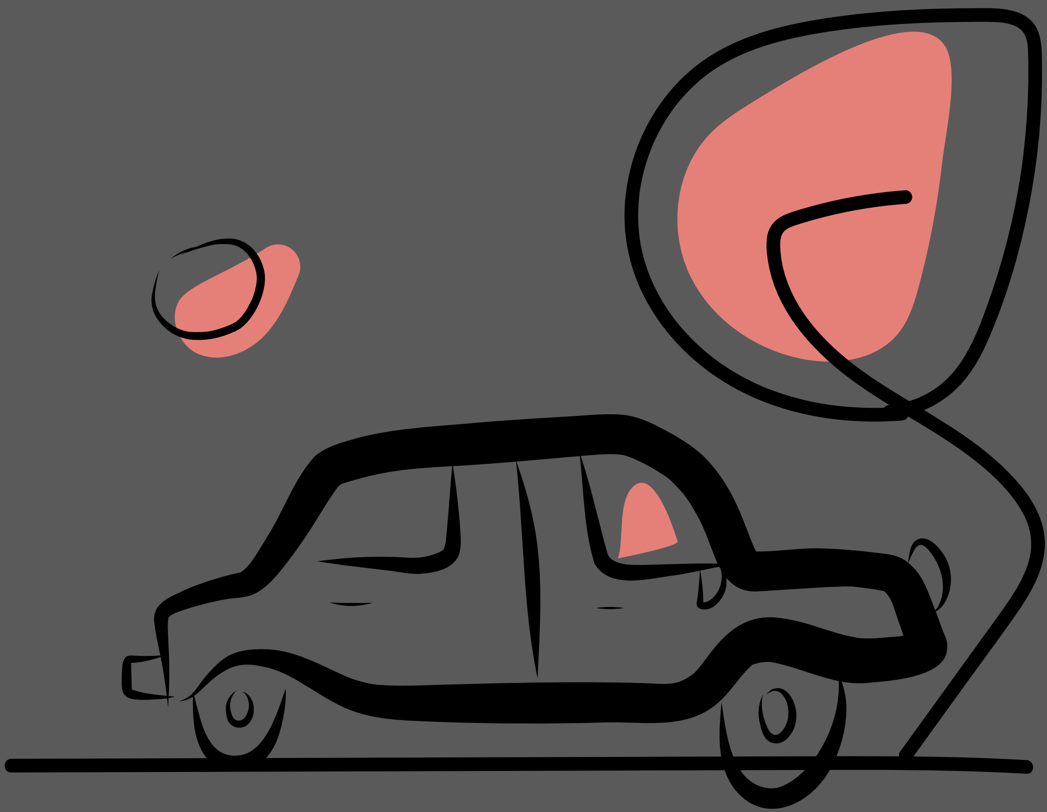
Abstract



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. HA's draw up their investment forecasts yearly for the next 5 years to construct, improve or maintain home 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 predict to be able to realize them. 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. New build investment forecast as currently forecast are inaccurate as evidenced by the declining rate of realization and is 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 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:

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

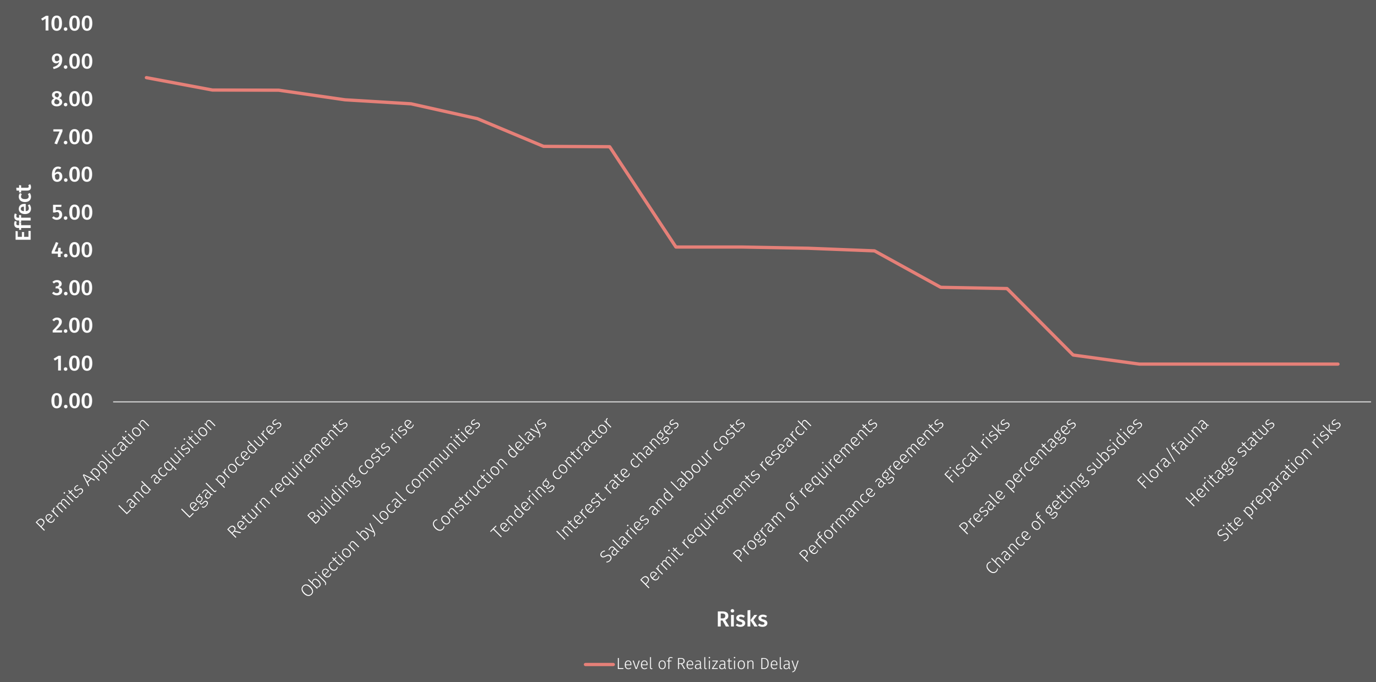
The resulting linear model was then converted into a stochastic decision tree model. The results were then presented back to the expert panel for review and discussion.

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.

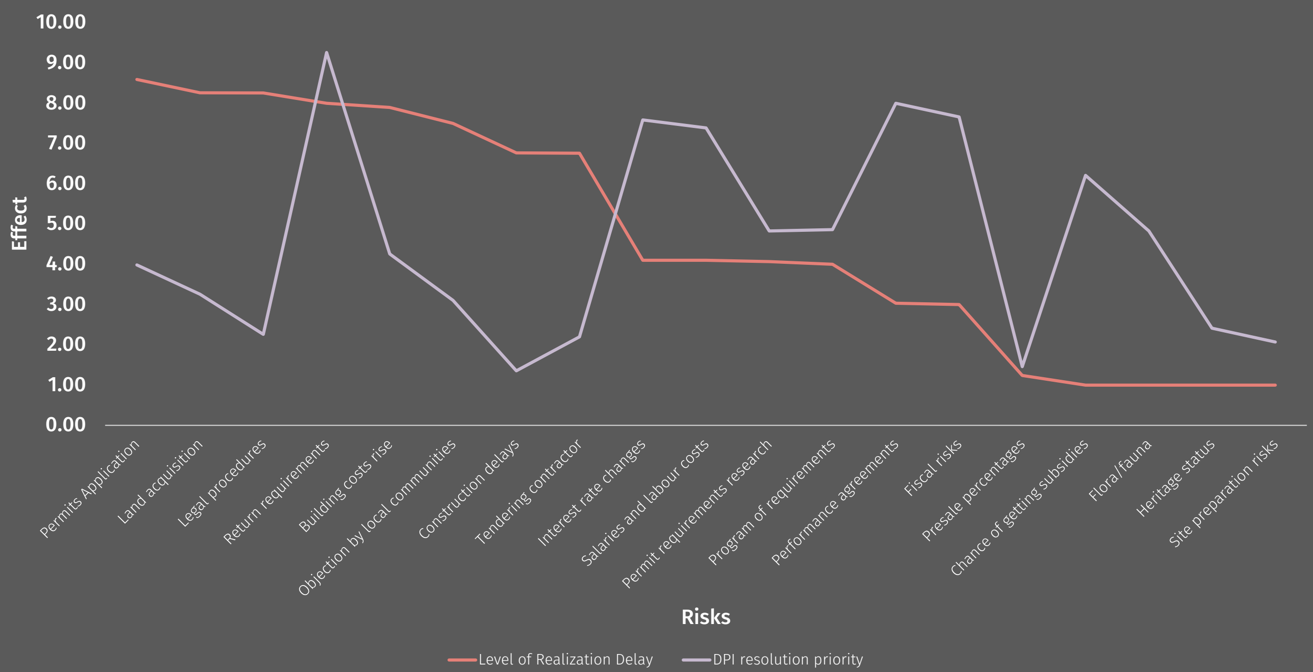
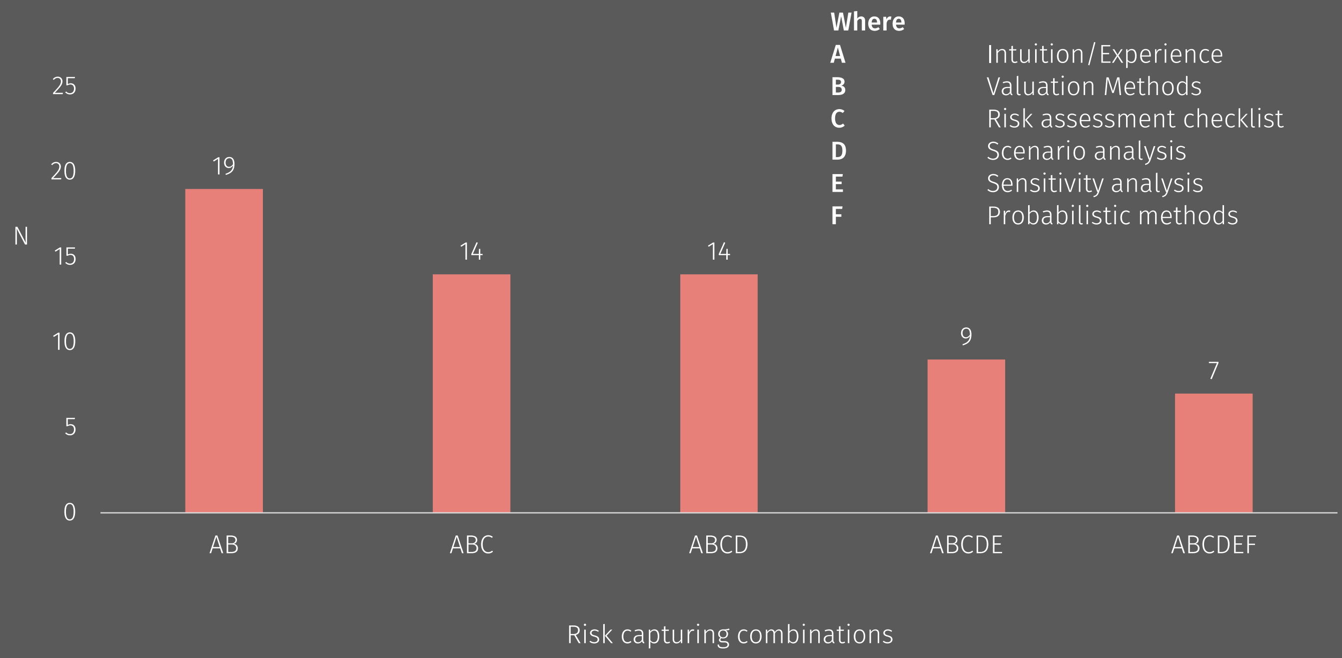
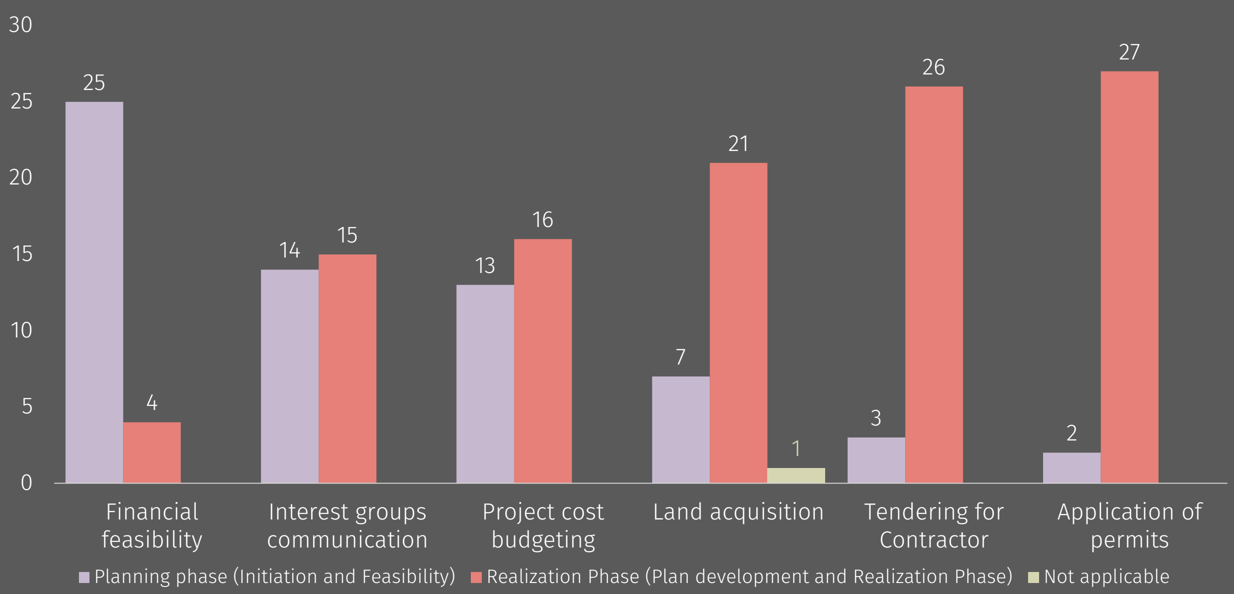


Figure 4: Most likely combinations of risk capturing methods.

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:

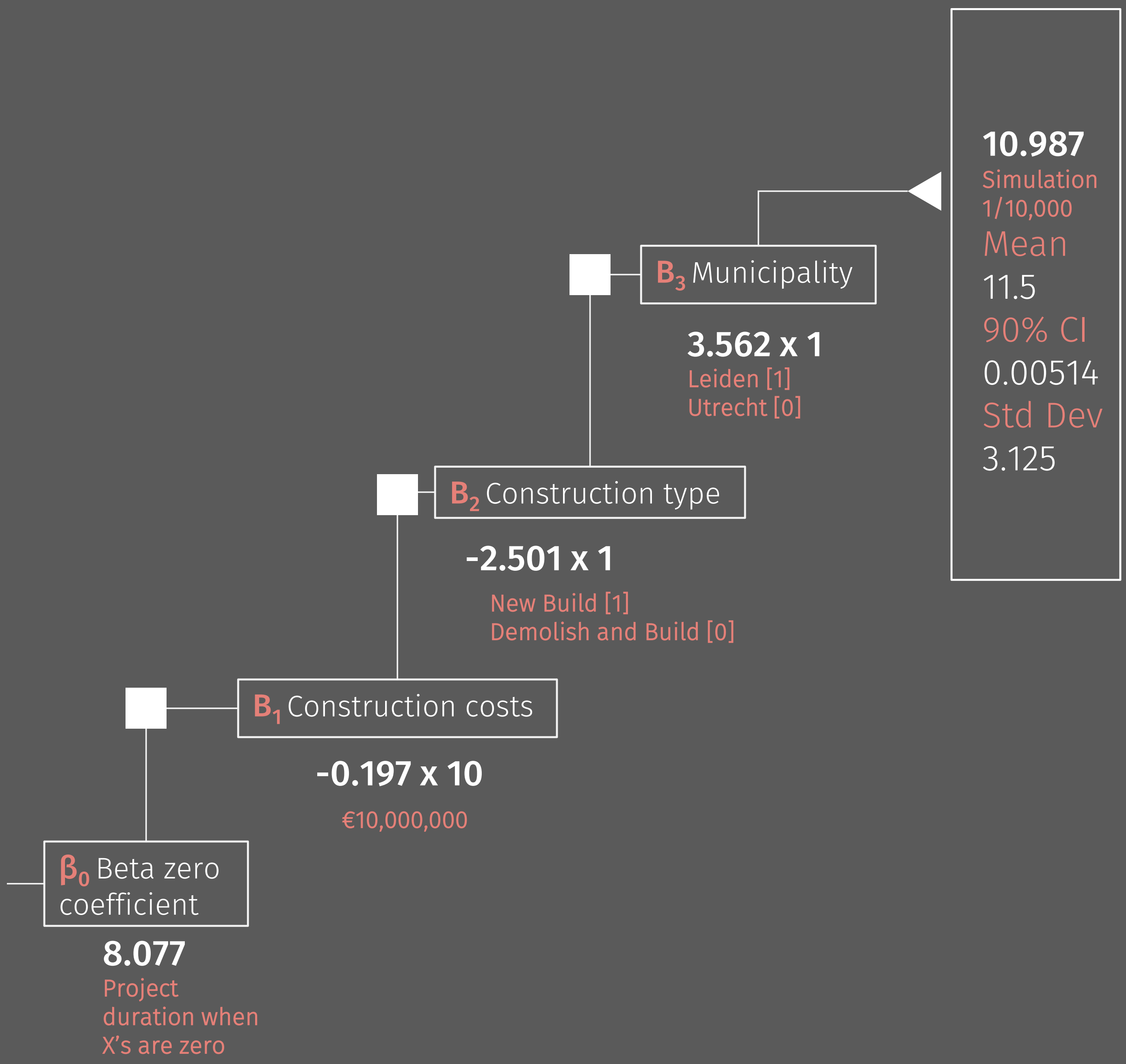
Total project time = β_0 + β_1 x construction costs) + (β_2 x input price index @ decision to tender) + (β_3 x construction type) + (β_4 x municipal location)

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 (Oudsten, 2021; van Os et al., 2021). Regarding rising building costs, financial requirements and long tendering procedures, AEDES (2019) 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. 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 by Gehner (2008), van Os et al. (2021) and Oudsten (2021). This research indicated that municipalities lack resources like land and sufficient development and permitting professionals which tend to delay projects. The results are in line with Oudsten (2021) who indicates that 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.

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 (Park & Herath, 2000; Pless et al., 2016; Schachter & Mancarella, 2016) 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 (Park & Herath, 2000; Pless et al., 2016; Schachter & Mancarella, 2016) 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. This matches the perspective of Geuting and de Leve (2018) who noted that 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

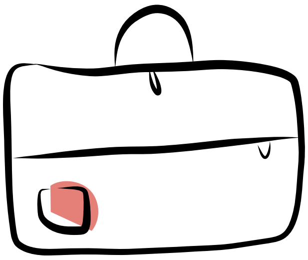
First, as the research is mainly bound to HA's with more than 10,000 VHE in the Netherlands, future research could focus on HA's below 10,000 to incorporate smaller housing associations as well.

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.

Contents



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Abbreviations	Definition
AEDES	Association for housing associations in the Netherlands
AW	Housing association authority - Autoriteit Woningcorporaties
BBSH	Decree on management of the social rental sector - Besluit beheer sociale-huursector
BNG	Dutch Bank for Municipalities - Bank Nederlandse Gemeenten
BOG/MOG	Public and Corporate real estate - maatschappelijk- en bedrijfsmatig vastgoed
Bruterings operatie	Grossing out process i.e., privatization of Dutch HA's
BZK	Ministry of internal affairs and Kingdom relations - Ministerie van binnenlandse zaken en koninkrijkrelaties
CBS	Dutch Central bureau of Statistics - Centraal Bureau voor de Statistiek
CFV	Central Funds for Public Housing - Centraal Fonds Volkshuisvesting
DCF	Discounted cash flow
dPi	Forecasted investment forecasts information - De prospectief informatie
DSCR	Debt service coverage ratio
DTA	Decision tree analysis
dVi	Realized investment forecasts Information - De verantowoordelijk informatie
EGW	Single family homes - Eengezinwoning
EMV	Expected measured value
FAIR	findability, accessibility, interoperability, and reusability
FCF	financing cash flow
FTE	Full time equivalent
GDPR	General data protection regulations
GDV	Gross development value
HA's	Housing associations(s)
ICF	Investment cash flow
ICR	Interest coverage ratio
IRR	Internal rate of return
LTV	Loan to value ratio
MCS	Monte Carlo simulation
MGW	Multifamily homes - Multigezinwoning
MLR	Multiple linear regression
MV	Market value
Non SGEI/Niet-DAEB	Non Services of General Economic Interests – Niet Diensten Van Algemeen Economisch Belang
NOI	Net operating income
NPV	Net present value
OCF	Operational cash flow
PIM	Probability index matrix
ROA	Real options analysis
SBR	Standard business reporting
SDTA	Stochastic decision tree analysis
SGEI/DAEB	Services of general economic interest
VIF	Variance inflation factor
VHE	Verhuureenheden – number of rental units
VPB	Corporate tax - Vennootschapsbelasting
WACC	Weighted average cost of capital
WSW	Guarantee fund for Dutch housing associations - Waarborgfonds Sociale Woningbouw

Glossary

Term	Definition
Adjusted R^2 value	Modified version of R-squared which has been adjusted for the number of predictors in the model.
concept	The abstract ideas being studied in the research
confidence intervals	The range of expected values expected when test is redone.
Deterministic model	A model that uses single inputs and outputs with no randomness involved.
Homoscedasticity	When the variance is equal for all values of the predicted dependent variable
Indicators	Something that points to, measures, or otherwise summarizes a specific concept.
Linearity	When the independent variables collectively are linearly related to the dependent variable;
Systematic (Market) risks	Risk inherent to the entire market or market segment that affects the overall market, not just a particular project.
Unsystematic (specific)risks	Risk that is unique to a specific company or project.
Monte Carlo simulation	Computational algorithms that rely on repeated random sampling to obtain numerical results.
Multicollinearity	When you have two or more independent variables that are highly correlated with each other.
Multiple linear regression	Used to predict a continuous dependent variable given two or more independent variables
Normality	Assumption that the dependent variable is approximately normally distributed for each group of the independent variable
Operationalization	The process of converting abstract concepts into measurable observations.
Outlier	An observation (data point) that does not follow the usual pattern of points
P-value	Measures the probability of obtaining the observed results, assuming that the null hypothesis is true
R Squared (R^2) Value	The proportion of the variation in the dependent variable that is predictable from the independent variable.
Residuals	Difference between an observed value of the response variable and the value of the response variable predicted from the regression line.
Stochastic	Having a random probability distribution or pattern that may be analysed statistically but may not be predicted precisely.
Univariate analysis	An analysis that explores each variable in a data set, separately.

1 Introduction

1.1 Research Context

The Dutch housing market, consisting of about 7.8 million homes, is characterised by the largest social sector in Europe with 29.1% of its stock being social housing. Approximately 69% of the 3.3 million rental homes in the Netherlands belong to housing associations (HA's) and the other 31% is private rental units (Housing Europe, 2020). HA's are organisations that are responsible for building, letting and selling social segment accommodation (Schilder & Scherpenisse, 2020).

The social housing sector, like other housing sectors in the Netherlands, are facing acute shortage of housing. An overall national shortage equates to roughly 3.4% of the total housing stock with 263,000 homes shortage by 2022 (Groenemeijer et al., 2020). Groenemeijer et al. (2020) adds that social segment (rent up to €752.33) faces a 92,000 homes shortage leading to 2023 and the middle-rent segment (€752.33 - € 988.61) will have a shortage of 83,000 homes within the same period.

"HA's draw up their investment forecasts yearly for the next 5 years to construct, improve or maintain homes"

HA's hold an important role in bridging the gap of the housing shortage specifically in the social housing sector. These organizations draw up their investment forecasts yearly for the next 5 years to construct, improve or maintain homes (Pittini et al., 2019). In recent years, investments are being increased to capture the housing deficit. "The most recent dPi show that HA's have significantly increased their (construction) ambitions in the SGEI branch. At sector level, the dPi for the period 2021-2025 includes an investment amount of €33.5 billion for new construction and purchases, and €18.8 billion for home improvement (including sustainability). This translates into a significant increase in the number of planned new-build homes in the coming years" (DGBRW Wonen, 2021, pp. 4-5).

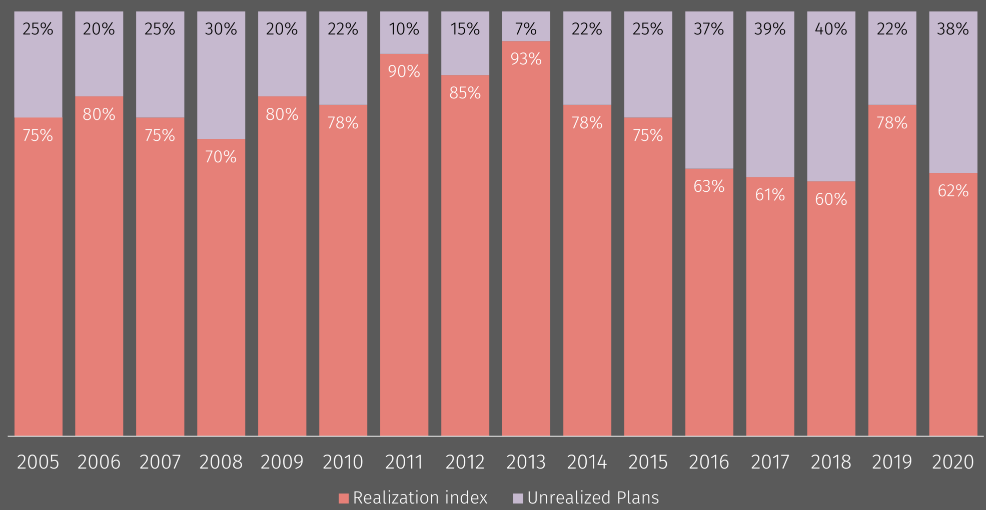
As part of the (financial) risk management framework of the national government, HA's make investment forecasts which includes plans of what they plan to do for the year and for the coming 5 years. Additionally, every year (on 1st July), HA's provide a look-back analysis where they review and publish the plans that they have realized to inform their performances. This process is necessary to indicate the performance of HA's towards their planned goals and in policy making for oversight bodies at a sectoral level (AW, 2022). The forecast are time direction related the forward-looking prediction is called prospective information (de prognose informatie or dPi) and the backward looking referred to as accountability information (de prognose veraantwoordelijk informatie or dVi) (Ligthart et al., 2019). The dVi look back process comprises the realized investment activities in the past year based on information on number of investments, valuation, expenses and income of the HA's in the past year (BZK, 2017). The dPi number includes the same information but is forward looking and includes planned activities for the coming year and five year outlook (Openstate EU, 2019).

a sense of the accuracy of the forecast. The first year of the forecast is therefore looked at in relation to the delivered plans. Dividing the dVi against the dPi yields the realization rate as a percentage, which is a numerical representation of the predictive power of HA's. 100% realization rate represents full realization of forecasts and anything lower represents deviations (van Os et al., 2021). If the forecast dPi deviates by more than 20% in a 5 year period, a HA's is considered by oversight authorities to have insufficient planning capacity to realize it plans (Spelbos et al., 2020). The predictive power of a HA's therefore indicates to what extent an association can realize its own investment forecasts and how well it has mastered its desired program of investments (Ligthart et al., 2017). The more the realization (dPi) deviates from the forecast (dPi), the greater the risk that the HA's does not manage the projected investment program and its policy properly (AW & WSW, 2018).

1.2 Problem Statement

Since 2013, the realization rate of new construction plans by HA's decreased due to the sharp drop in the completion rate of new construction. In 2018, the sector realized 60% of the budgeted new construction production for that year with 40% of predicted plans going unrealized. This was 93% in 2013 and 90% in 2011 (van Os et al., 2021) (see Figure 1.1).

Figure 1.1 New Build realization rates of Dutch HA's 2007-2019. van Os et al. (2021)



However, only 15,000 affordable rental homes were newly built in 2018, while the HA's had a target of 34,000 meaning that 56% of all plans in that year went unachieved. Systematic risks also known as market risk like unforeseen rising construction costs, the introduced landlord tax levy and additional corporate taxes (vennootschapsbelasting or Vpb) are some of the key reasons in the market that cause delays in production and delivery time of new build plans (Spelbos et al., 2020). Unsystematic risks also known as specific risks have also been identified as causes for major delays including unavailability of land locations or long acquisition times and lengthy permit procedures for projects which mean that HA's increasingly build fewer new homes as included in their annual budgets (AW, 2020).

HA's are struggling to make accurate forecasts of time taken to deliver their new build projects meaning that prediction of plans in the dPi are often inaccurate as they are never realized within the time that they are planned (Spelbos et al., 2020). In 2019, the realization rate of new construction rose again to 78% probably related to the WSW's strategy to forecast more realistically by incorporating financial ratios at portfolio level (van Os et al., 2021). However, HA's again indicated that they expect to realize lesser new build investments than forecast. Oudsten (2021) found that of the 109,550 new build forecasts in the 2020-2025 horizon, only 59% (64,911 homes) of the realization plans are according to plan. 17% (18,201 homes) expect a delay in completion of more than 3 months, 7% (8,108 homes) will not be built for various reasons. The remaining plans 17% falls within plans that are either duplicate submission or switched plans as shown on figure 1.2 (Oudsten, 2021).

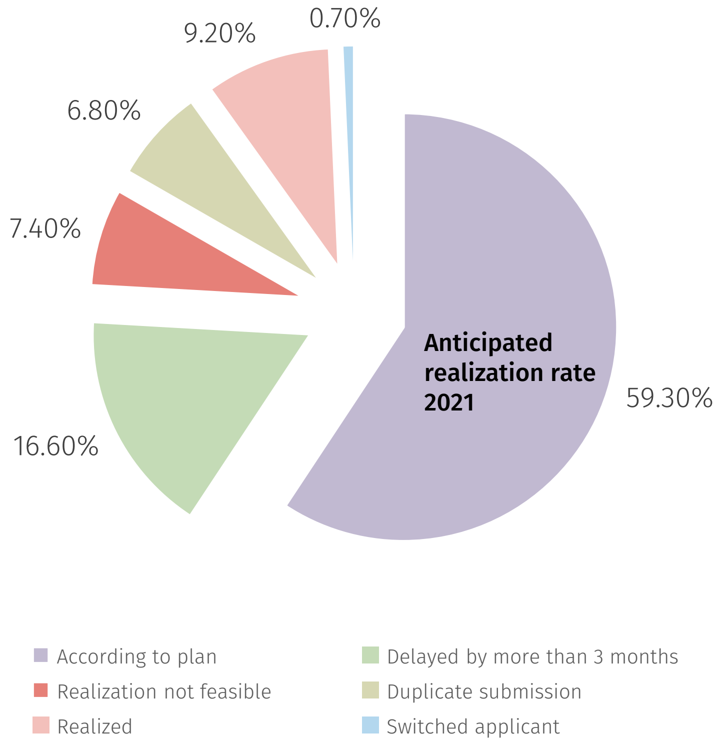


Figure 1.2 Overview of realization rate of plans in 2021. den Oudsten, 2021

While the rate of production has reduced, the rate of plan predictions has failed to be adjusted to match this reducing capacity. This means that HA's forecast to build more new construction within a specific time frame than they can realize. A mismatch occurs between the accurate time that plans can be realized and the actual time in which they are realized, leading to disparate forecast and achieved investment budget plans (van Os et al., 2021). This declining realization rate is especially concerning against the background of increasing pressure on HA's to provide more affordable housing (AW, 2020).

Inaccurate prediction of delivery times results indicates the inability of HA's to make accurate time of delivery forecasts. Inaccurate prediction of time to completion means that HA's future predictions of new build projects are never realized in the time they are planned. As a result, tenants must contend with long waiting times when promises for homes delivery are not met within the time they were planned. Tenant organizations, local and national government also contend with disappointments from unrealized plans and are unbale to accurately plan housing agendas when promised HA's plans of delivery deviates from the actual realization (van Os et al., 2021). Financial return requirements also rely on accurate prediction of project duration and inaccurate prediction of project durations impact financial feasibility of projects. This in turn leads to loss of social capital and equity leakage (AW & WSW, 2018).

To manage risks, HA's make forecasts that are largely dictated by income from their housing portfolios. These proceeds are exemplified by the construction cost expense and income stream value of their housing portfolio which is the net present value of future revenues and expenses generated by their real estate. The use of valuation methods that focus purely on financial loss in making forecasts brings specific problems (Remøy et al., 2018).

"The purpose of the research is therefore to explore how new build plans can be made more realistic by accurately predicting the delivery time of forecasts."

Valuation methods focus on indexable risks and capture financial loss. They however exclude the impact that risks have on time to deliver projects (Pless et al., 2016; Samis & Davis, 2014). Valuation methods tend to omit realism of project delivery times when making new build investment forecasts (Remøy et al., 2018).

The purpose of the research is to explore how new build plans can be made more realistic by accurately predicting the delivery time of made forecasts. This is conducted via exploring risks that affect delivery time and subsequently the accuracy with which HA's report their investment forecasts. Against this background, the following research question is explored and answered:

"How can time to deliver new build investments of Dutch housing associations be accurately forecast?"

This is done via answering the following three sub-questions:

[1] What are the main risks that affect accuracy of time taken to deliver new builds as forecast by HA's?

[2] What are the current gaps in how time affecting risks are integrated in predicting the delivery times of new build investment forecasts?

[3] 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?

The goal of the research is therefore to provides HA's managers with a model to quantify risks that affect the time to deliver projects and with this create a way to make accurate forecasts plans in the dPi.

1.3 Design

The first part of the study is exploratory and uses qualitative methods (surveys, interviews, and expert reviews) to explore risks that delay new build project delivery times and accuracy of forecasts. Additionally, the techniques identified in literature for managing new build investment forecast risks are explored. This is to highlight the main methods used to capture new build risks that affect time to deliver projects and the methods used to capture them including gaps that exist and alternative ways to resolve these omissions.

The second part uses qualitative results and operationalizes systematic and unsystematic risks into indicators used in the quantitative research that combines a multiple linear regression (MLR) statistical test with a stochastic decision tree analysis (SDTA) supported by Monte Carlo Simulation (MCS) technique to build a decision model that weighs risks and calculated expected delivery times and budgets for individual projects. The conceptual model of the research is therefore as per figure 1.3 which proposes that the accuracy of the investment forecasting process for new build projects are directly affected by specific new build investment risks. The effects can be modified by introduction of alternative risk management techniques.

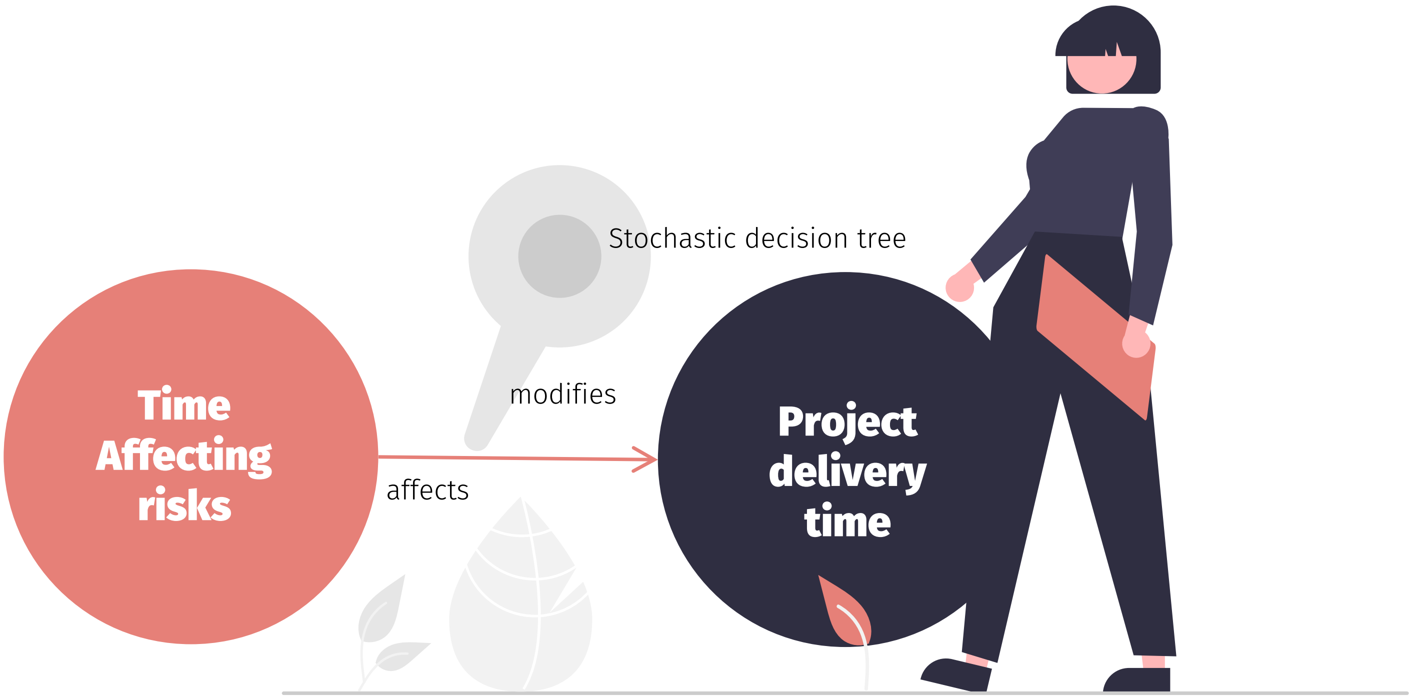
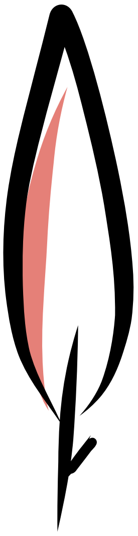


Figure 1.3 Research conceptual model. Author

1.3 Reading Guide

The research study is organized as follows: Section 2 is a literature review segment that identifies the context of the Dutch social housing sector, its history and investment regulatory context. It looks at the normative models that govern the management of investment forecasts for HA's to identify the investment forecasting process. It explores real estate risk management techniques currently used in the real estate industry including their strength and inherent gaps. Alternative techniques that can be used to solve these gaps are identified.
Section 3 explores the methodology i.e., both the qualitative (surveys, in depth interviews and expert opinion discussions) and quantitative processes (MLR, MCS and SDTA) are used to collect and analyse data. Section 4 and 5 presents the results and section 6 outlines the findings. Section 7 provides recommendations and conclusions.

1.5 Relevance

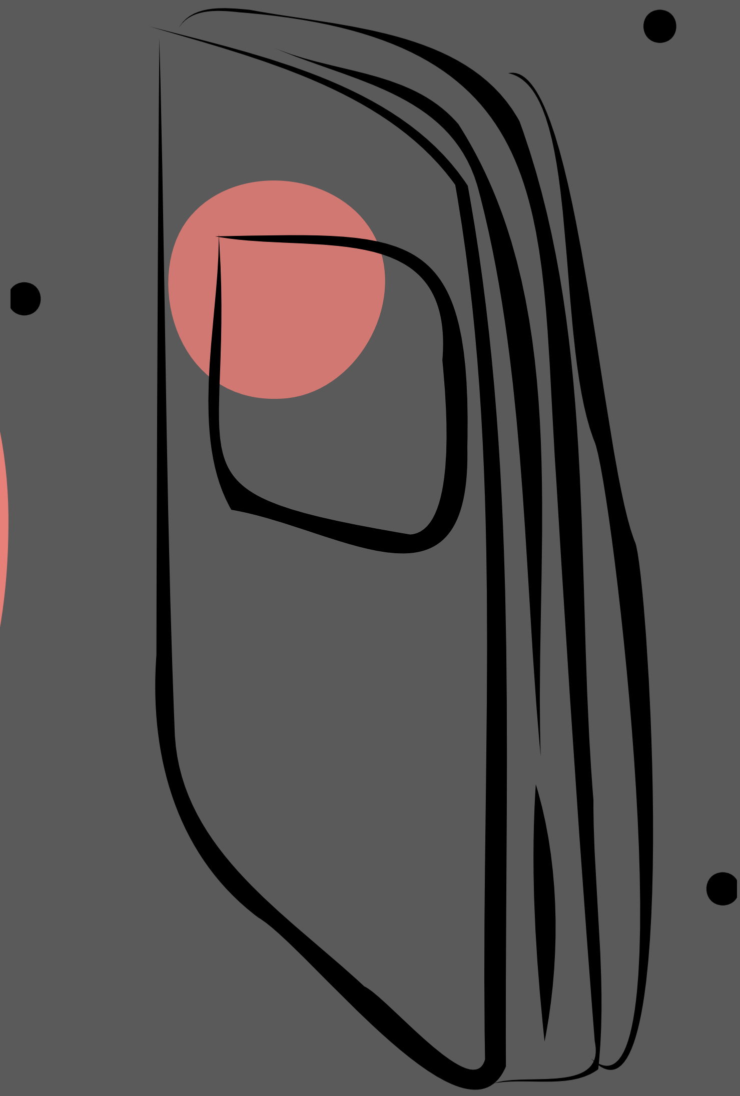


Scientific relevance

This study explores the combined application of MLR, MCS and SDTA risk techniques in real estate development specifically within the Dutch housing sector. Mathematical models, in different combinations, have been extensively used in real estate development to determine the pricing, return rates and valuation of real estate projects. Decision tree analysis combined with MCS and valuation methods are preferred in providing multiple scenarios of investment paths where risks and uncertainty are also multiple (Mun, 2006a; Samis & Davis, 2014; Topal, 2008). Geltner and de Neufville (2018) also acknowledges the role of MCS when combined with Discounted cash flow method in providing multiple investment decision paths. MLR has been used as well extensively in real estate development to determine the valuation and the housing price of real estate by looking at project specific characteristics to determine the dependent housing price (Alfiyatin et al., 2017; Amri & Tularam, 2012; Zhou et al., 2018). However, little research exists that uses the techniques to quantify risks to predict the delivery time of new build investment predictions of Dutch HA's. For this reason, this research forms a bridge between quantitative techniques and the investment forecast process of Dutch HA's.

Societal relevance

HA's are charged with both financial and social functions by Dutch government oversight bodies. This means that they should be financially healthy enough to continue their social function which is to predominantly provide housing for the regulated housing sector. Due to increasing uncertainties, HA's are no longer able to accurately predict the delivery of plans above the 80% threshold expected by oversight authorities. The Autoriteit Woningcorporaties (Aw) in the most recent "Staat van de corporatiesector 2022" report which gives the status of the social housing sector writes that "investment intentions do not provide insight into future performance "meaning that the predictions as currently made are highly optimistic and are almost always never achieved at a sectoral level (AW, 2022, p. 10). While inaccuracies in prediction can jeopardize the financial and social functions of HA's, they subsequently also hinder the national and local governments from making accurate policies for the delivery of social housing plans. Additionally, oversight bodies who are charged with overseeing the activities and performances of HA's in their production of new build housing, are unable to monitor plans due to lack of quantifiable risks at a sectoral level. The research therefore provides a means to first identify the impact of risks to the delivery times, and to help HA's plan realistically. Information can therefore as well be used at a sectoral level to help steer agreements and oversight.



2 Dutch Housing Associations' forecast process

2.1 History of Dutch Social Housing

Dutch HA's collectively own the highest proportion of social housing in the EU, accounting for around 32% of total housing stock and 75% of rental stock (Pittini et al., 2019). Whereas the Dutch Legislation (Article 22) states that the advancement of adequate housing is the responsibility of public authorities, and the Dutch Housing Act of 1901 provides a legal framework for the way social housing is organized, there is no single definition of social housing in the Netherlands. The European commission therefore decided to define public housing as that rented below market price and for target group of socially and economically underprivileged groups and certain categories of key workers and these are defined by public authorities like municipalities at local level (Housing Europe, 2010). This forms the focus of the research within the Netherlands and the social segment in the Netherlands as at 2021 is currently homes rented at a maximum rent of €752.33 and the middle-rent segment at between €752.33 and € 988.61 (Groenemeijer et al., 2020).

2.1.1 Dutch social housing in pre- and post-World War II

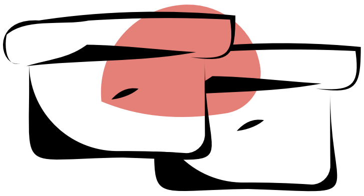
The Netherlands established a social housing sector with the 1901 Housing act which enabled social housing landlords to become active. HA's are therefore private but publicly registered and accredited with non-profit functions (Elsinga & Haffner, 2020; Haffner, 2002). They obtained subsidies from the government especially after the Second World War where housing shortage and quality was severe. This defined the government agenda leading to policies geared at increasing quality and supply of housing via subsidies, rent and eviction protection (Elsinga & Haffner, 2020). The government determined locations of newly built houses and granted HA's 50 year subsidy guarantees per dwelling to offset losses from regulated low rents (Ouwehand, 2002). As a result, the amount of social housing boomed in both density and scale in the period between 1947 which had 12% of the total stock to its peak in the 1980s where the stock was around 40% and the highest it HAs been (Elsinga & Haffner, 2020).

2.1.2 Grossing out and Independence of HA's

In the 1980s, social housing costs burdened the Dutch governmental budget leading to a change to make HA's both administratively (Housing Act 1993) and financially (Housing Act 1995) independent of the central government (Conijn, 2011; Hoekstra, 2013). The Dutch preparations for the new currency under European union financial requirements conflicted with the subsidy structure of the Dutch government and the 50-year subsidy obligation was stopped (Elsinga & Haffner, 2020; Elsinga et al., 2008; Hoekstra, 2013). The government therefore paid out all future subsidy obligations in a lump sum to social and private landlords in a process termed 'grossing and balancing' (bruteringoperatie) in 1995 cutting all financial ties and obligations HA's were financially and administratively self-sufficient henceforth.

The Social Housing Management Decree (Besluit Beheer Sociale Huursector, BBSH) was also set up to regulate the tasks of the independent HA. BBSH ensured quality of the housing, affordable rental of the houses, involving residents in policy /management, liveability, and assisting people in need of housing care (Overheid Wettenbank, 2015).
HA's also had to ensure financial continuity and were grouped into revolving

funds that meant that income earned was to be pumped back into the real estate to provide social services (Elsinga & Haffner, 2020; Hoekstra, 2013). To facilitate and oversee financial independence and activities of the independent HA's, the government via the Ministry of Interior and Kingdom Relations (BZK) set up two oversight organizations. The first was the Central Public Housing Fund (CFV Centraal Fonds Volkshuisvesting) that guarded associations against bankruptcy. Secondly, the Guarantee Fund for Social Housing Construction (WSW – Waarborgfonds Sociale Woningbouw) to provide guarantees for loans taken out by HA's from financing parties like Bank of Dutch Municipalities (BNG) and the Nederlandse Waterschapsbank (NW) to finance their activities. The WSW was backed by the national and municipal governments and look at the financial ratios and health of HA's to govern investment forecasts. Government initiated new land policies to lower and cap the price of land for new construction of social housing. AEDES, the sector association of HA's in the Netherlands, was also formed to lobby for the interests of HA's (Haffner, 2021). Due to revised financial and land policy backing, the financial position of HA's in the 2000s improved aided by low interest rates and increasing housing prices. They were able to sell dwellings at favourable rates and build equity leading to HA's expanding their activities beyond social functions into market functions (Hoekstra, 2013). The ambitious activities culminated in mismanagement and fraud as evidenced in scandals like the "Vestia-affair" which was in danger of collapsing due to large derivative experiments. Coupled by the financial crisis, these activities led to severe damages within financial and real estate institutions (B. Aalbers et al., 2021).



"Restrictions and obligations post Housing act 2015 reduced HA's incomes and resulted in reduced new development projects."

2.1.3 Post Housing Act of 2015

The introduction of several policies after 2015 via the housing act was meant to reign in HA's spending and investment forecasts and contain the activities of organizations. The Dutch senate approved a new legislation (housing act 2015) aimed at defining the core tasks of HA's to limit the broad scope of organizations to providing affordable housing to people of low income (Haffner, 2021).

The new 2015 act ensured a strict separation between commercial and social activities legally and administratively meaning that commercial activities of HA's were classified as market based and were no longer guaranteed by the WSW for low interest rates. The designations Services of General Economic Interest (SGEI) (DAEB) and non-SGEI (niet-DAEB) were formulated. This meant that all homes rented at a maximum rent (€763.48 as of 2021) would be designated SGEI and would be financially guaranteed within subsidized loan rates. Middle rent segment (between €763.48 and € 988.61 as of 2022) would be non-SGEI and subject to market lending and taxes when borrowing (Groenemeijer et al., 2020).

There was an introduction of the landlord levy to landlords that let more than 50 homes in the social housing sector. HA's were also deemed to be under the scope of the law, and had to pay a corporate income tax (Vpb) on profits made to guard against speculation particularly, lowering social

landlords' investment capacity (Haffner, 2021).
Before the 2015 Housing Act, municipalities supported production costs by providing land for HA's at a discount. Since 2015, however, they are no longer guaranteed discounts and are required to engage in annual performance agreements with local municipalities and tenant associations representatives to determine policy on new construction, investments in sustainability and rent policies including increases. HA's therefore often must bid against each other to obtain concessions (Schilder & Scherpenisse, 2020).

All these restrictions resulting from the Housing 2015 act coupled with obligations for social landlords to pay corporate income tax, landlord levy and reduced incomes from focusing on lower rent homes slashed financial strength of HA's and resulted in reduced new development projects in both scale and supply. HA's increasingly operated in tough regulatory and financial markets and implemented tough cost cutting measures including cutting real estate development teams and reducing new construction projections (van Os et al., 2021). The figure 2.1 below summarizes the social and financial development of HA's.

Figure 2.1 Summary of social and financial development of housing associations. Author modified

2.2 Regulatory impact on Dutch HA's forecasts

The "grossing out" process of the financial and administrative activities of Dutch HA's meant that direct financial support (financial subsidies) was reduced meaning that HA's were free to make their own policies regarding how their financial and social gaols were achieved. However, to keep HA's accountable, government established oversight bodies (AW and WSW) which increased close monitoring of investment ensuring that HA'soperate in increasingly strict regulatory environments and tough financial markets to deliver their targets (Nieboer, 2007). Regulatory bodies oversee the activities of HA's via strict financial regulations like financial ratios and standard business reporting criteria commonly related to market real estate business activities. standards include requirements to fit within desired market valuations of the real estate portfolio overseen by HA's and financial ratios. The housing act of 2015 further exacerbated the need for internal organisation because HA's had to ensure their portfolio was predominantly affordable i.e. restricted to mainly regulated rent, available in multiple typologies and was of high quality (Gruis & Nieboer, 2004). These policy changes have increased the importance of prudent financial planning, risk evaluation, and competitive strategy in social housing management. To continue to play a significant role in the (social) housing market, HA's have had to change their strategies to anticipate market developments and adjust their investment decisions accordingly. To continue to remain competitive, HA's have adopted the planning activities of commercial landlords into their management activities in a process known as "strategic housing management which contains three main levels namely portfolio management, asset management and property management (Miles et al., 2000).

Portfolio management represents the strategic level within landlords who invest in multi-portfolio types like real estate and bonds. However, since social landlords can only invest in housing (SGEI and non-SGEI), their portfolio is restricted to only one investment category and the term is therefore not fully representative within HA's management activities. Asset management represents the management strategies of social landlords since the process involves the specification of intended mix of housing (housing types and prices), performance analysis and setting of strategies for acquisition, disposal, and management of dwellings. It therefore denotes the management of individual buildings or 'complexen' (Gruis & Nieboer, 2004). Property management on the other hand deals more with the administrative, technical, and commercial management and therefore is generally involved with the day to day running of the property (Nieboer, 2007). Asset management therefore represents the individual management practices employed by HA's towards their buildings to ensure financial control and social tasks are not jeporadized (Gruis & Nieboer, 2004). Several models on asset management have been developed to explain the investment forecasting and management process of HA's (Nieboer, 2007; Spelbos et al., 2020; Van den Broeke, 1998; van Os, 2013). While these models have separate number of steps and all include different contents, the common consensus is that they contain similar steps in the management process (figure 2.3). First, policy options are created at a strategic level. Second the policies are tested and evaluated. Lastly the chosen policy is implemented, monitored, and adjusted accordingly.

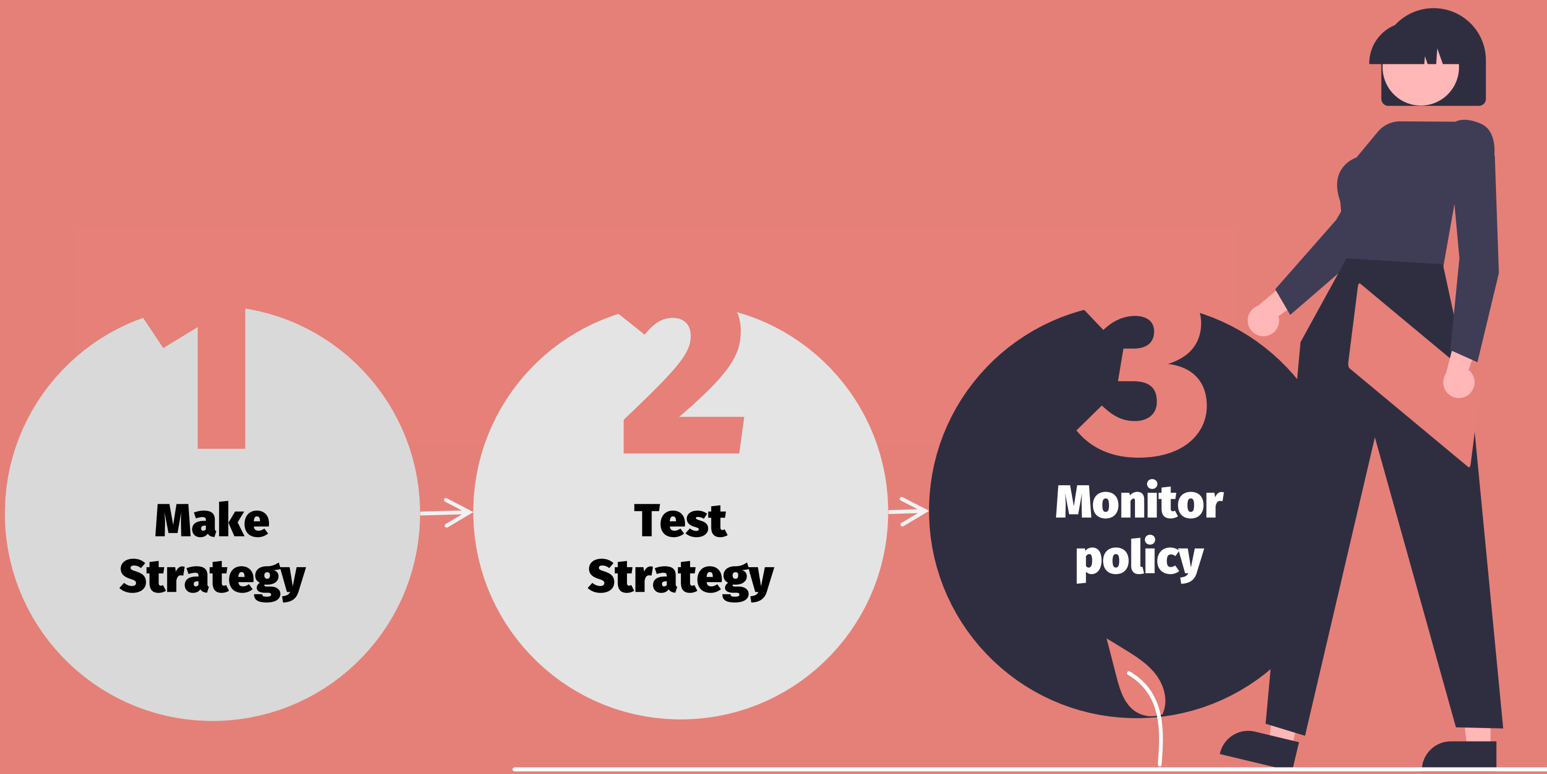


Figure 2.2 Typical real estate management processes. Adapted from (Nieboer, 2007)

HA's use the planning and control cycle to form strategy, test policies and eventually monitor plans. The planning and control cycle therefore represents the normative models of asset management and can be grouped into activities involving formulation of objectives, implementation and monitoring of policies (Spelbos et al., 2020). In formulating policies, HA's form strategies where they analyse the environment by identifying risks and goals that are incorporated into the portfolio and business plan strategy. Here a HA also decides on its target groups, product mixes, standards of quality and financial return conditions that guide policies. (AW & WSW, 2018; Spelbos et al., 2020; van Os et al., 2021).

Thereafter, an annual plan makes the objectives tangible by tackling themes like increased affordable housing, energy transition, maintenance and sustainability are formulated. The goals are translated into policy plans which represent investment categories that HA's are involved in. Policy plans therefore include investment activities in new construction, sale, purchase, improvement, or demolition of obsolete property. These plans are usually divided into two i.e., hard plans and soft plans. Hard plans represent solid plans already agreed upon by contractors or 3-year horizon plans while soft plans are intermediate plans still in discussion stage. These projects often only include potential locations (land) for housing and are often referred to as 'labels' (Michielsen et al., 2019).

Thirdly, a multiyear budget is formed where policy plans are converted into investment budgets and financial commitments. Policies are therefore translated into proposed income streams, cashflow streams and asset values of the HA's (Bernadina et al., 2020).

Investment cashflows represents construction costs, land values, management costs, number of homes projected, sustainability levels.

The income stream includes revenues and expense forecasts of the HA's. Several real estate characteristics define the income of a HA including rental classes, property types, lease types and unit types (Spelbos et al., 2020). The cash flow streams predicts the cash flow position of the HA's and has three types of cash statements including operation (OCF), investment (ICF), and financing (FCF) forecasts. The investment cash flows represents the investment amounts set aside for conducting of policy plans set in step 2. Investment cash flows contain aspects like construction costs, land values, management costs, number of homes projected, sustainability levels of investments and several regulations for holding term of the assets are considered. (SBR-Wonen, 2021). Finally, asset values are defined by the balance sheets which shows the strength of a HA within the valuation and financial ratios set by regulatory authorities (AW/WSW). The balance sheet forecast contains market values of a HA's assets if it was operated according to market conditions and also policy value which reflects social destinations as lower policy rents, higher management expenses and extra maintenance costs not common to market parties. Both values show the financial strength of a HA (Gruis, 2000).

The valuation parameters are useful for regulators to monitor a HA investments forecasts and determine aspects like financial ratios (continuity and discontinuity indicating ratios) within which a HA can plan investments (Spelbos et al., 2020). Table 2.1 shows indicative ratios that are important to gauge financial health at a portfolio level (Conijn & Claessens, 2013).

Table 2.1 Portfolio level financial ratios. Author

Ratios	Explanation
Continuity ratios	
Solvency Ratio shareholder equity / policy value	Provides insights about the equity position of the HA and to what extent it can meet its long-term obligations.
Interest Coverage Ratio (ICR) cashflow / financing interest costs	Indicates to the WSW how easily a HA can pay outstanding interest payments on outstanding debt from the net operating income.
Loan to value (LTV) debt / policy value	Provides insight into whether the property portfolio generates sufficient value in the long term compared to the debt position. The underlying cash flows consider the social policy of the HA.
Discontinuity ratios	
Collateral ratio (Onderpandsratio) - market value assets loans guaranteed by WSW/ market value assets of WSW collateral)	Compares the value of collateral (SGEI and non-SGEI) to the loan (guaranteed by WSW) it is meant to secure.
Coverage ratio (Dekkingsratio) market value loans/market value assets	Indicates whether the market value of the property is sufficient to repay the loans of a corporation, also at market value.

The results of the multi year budget yield the forecast plans for the coming period and forms the prospective information referred to as the dPi. The look back process additionally produces the dVi.

The comparison between the realized dVi and the forecast dPi information forms part of the implementation and monitoring plan to ensure HA's remain financially and socially healthy (Spelbos et al., 2020). The planning and control cycle process can therefore be summarized as per figure 2.3.

Figure 2.3 The Dutch Housing association investment forecasting process. Own figure

2.3 Risks in real estate development investment forecasts

Risk is defined in financial terms as the probability that the actual profits from a result or investment will differ from the projected result or return. It is possible to lose some or all of one's initial investment because investment decisions are contingent on several risks and expected returns (Loizou & French, 2012). In general risk management theory classifies investment risks affecting asset values into two categories: systematic and unsystematic risks. Real estate investments are therefore affected by both risks (Beja, 1972).

Systematic risks, also referred to as market risks, are those that can influence a complete economic market or a significant portion of it. Market risk refers to the possibility of losing money because of factors affecting the overall market's performance, such as global political and macroeconomic risk. Interest rate risk, inflation risk, currency risk, liquidity risk, country risk, and socio-political risk are all examples of systematic risk. Unsystematic risk, also known as specific risk or idiosyncratic risk, is a category of risk that only affects an industry, particular organization, or venture. Unsystematic risk is the risk of experiencing loss in an investment due to company or industry-specific hazard. Examples include a change in management, a product recall, a regulatory change that could drive down an organization’s sales (Waemustafa & Sukri, 2016).

A substantial cost overrun or revenue decrease (due to tender in a tight construction market or negative yield growth) and delays (due to application procedure taking longer or rental rates lagging expectations) are losses that emerge from risks in the real estate development process. Risk impact can also be measured in terms of low quality or major injuries (Gehner, 2008).

The most significant risks have the greatest impact on the critical time path of the development process, as well as the continuance of other activities. The result could be the project's failure or a significant delay. Another important set of risks is those that have such a large influence on costs or revenues that they jeopardize a project feasibility (Gehner, 2003). Gehner et al. (2006) found that systematic risks like construction cost rises, labour costs and interest rates were the most mentioned risks contributing to cost overruns and decreased revenues. Unsystematic risks namely delay due to planning applications, sales/rental risks, and contractor tendering risks were also the three most reported risks by Dutch real estate developers that hindered project completion within expected timelines.

2.3.1 Systematic project delaying risks

The income on new build projects has been under pressure for HA’s largely due to the impact of the landlord levy, the corporate tax (Vpb) and due to the Housing act of 2015, which further restricted annual rent adjustments. Subsequently, the initial rent of new homes fell after the introduction of appropriate allocation which split SGEI and non-SGEI real estate assets (Luijkx, 2019). AEDES (2021) indicates that even though HA’s have experienced lower controllable operating expenses in recent years, the return requirements have kept the production of new homes low and delayed other projects which could not meet return requirements. The limited returns are sustained by rising construction costs since 2015 meaning the decline of new construction has persisted (van Os et al., 2021).

The effects of rising construction costs apply in the both the planning and realization stage since the process of finding contractors in bullish markets involves long tendering negotiations as a result of set requirements by contractors to meet financial feasibility goals. It is noted that after the 2015, 25% increase in construction costs because of a change of input price indexes above the inflation rate was above the capping limits in the rental policy and the rental development itself. Rising construction costs has therefore led to the decline in realization rates of new build projects (AEDES, 2019). However, because the decline in new construction started as well in a period when construction costs were reducing, it is not the only explanation of the falling realization rate (van Os et al., 2021).

2.3.1 Unsystematic project delaying risks

The most significant systematic and unsystematic risks have the greatest impact on the critical time path of the development process.

Long permit obtaining procedures have been considered the leading causes of delays or abandonment of HA's new build projects. These procedures include plan objections from local reidents, challenging variety of standards and legislation and land use modification to correct zoning plans (van Os et al., 2021). HA's receive a reduction in the levy upon realization and notification of completion of homes within 5 years after the application and therefore have an incentive to complete projects within time. The physical construction process of homes takes between 1 and 1.5 years on average. However, prior to construction commencement, several permits and permissions must be applied for and granted by local governments. Zoning plans must also be adjusted in case a project's plans deviates from the designation set within the current land use plan (Oudsten, 2021). In the permit phase, projects are confronted with different requirements and legislation. The time it takes to get through this critical permit phase has a large bandwidth. In the best case, this takes 1 year, but longer seems to be the rule rather than the exception (van Os et al., 2021). Zoning plans further take 1 to 3 years extra time onto the permit application process. It is noted that almost all social housing projects go through this process. It has been noted that the average lead time from start to sale of a home in the Netherlands is almost 10 years. The municipality also sometimes offers the 'letter of competent authority' in which the municipality indicates that it is positive about the realisation of the houses to be built. But because such a letter of intent can still have resolutive conditions attached to it, it is not guaranteed that the requested homes can be built at the intended location. Permits are never guaranteed even with prior agreements (Geuting & de Leve, 2018).

Difficulties in acquiring land by HA's from municipalities, developers or third parties often leads to cancellations in case land cannot be confirmed (Oudsten, 2021; van Os et al., 2021). The land acquisition step of a new-build development process takes the longest (on average almost 7 years, partly parallel to other phases). This is true across the Netherlands, for both infill brown zones and expansion green field zones. On average, municipal initiatives take longer to implement than those initiated by builders and real estate developers. This is primarily due to the way land is acquired. Municipal projects may have a more complicated acquisition procedure, with more fragmented initial land ownership, or governments purchasing land at an early stage (Geuting & de Leve, 2018).
Building homes, with the associated spatial planning process including

permits, takes time and expertise. In addition, Dutch public housing has become a specialist field with a lot of jargon, rules, accountability mechanisms and institutions. This makes the task difficult to fathom, even for people who have experience with real estate development and spatial planning (Oudsten, 2021). The central government and the provinces offer extra capacity and expertise. But the number of professionals on the side of corporations, market parties and the government are limited and in combination with the pressure on the market, this contributes to delays. Capacity by HA's in determining building costs on time and appointing contractors is also considered a delaying factor (van Os et al., 2021).

2.4 Real estate risk appraisal techniques

2.4.1 Valuation techniques in risk appraisal of new build investment forecasts

HA's planning and control process revolves around real estate assets as the main asset base and budgeting for production, operation and replacement of these assets becomes central in determining investment forecasts. Such processes that determine the planned budgets and investment activities to be made are referred to as valuation. For HA's, two main methods (income approach and cost approach) are used to value real estate production and operation (Gruis, 2002).

The cost approach or development method is often also called the contractor's approach and is used to value the total monetary cost to produce an asset including risks such as building costs rise, labour costs and costs to borrow financing. (Loizou & French, 2012). The income approach method on the other hand explores the income generation capacity of the planned investments and relies on cash flow obtained via rent to capitalise an investment. HA's therefore invest a certain amount with the expectation of a certain return gained via annual returns in the form of net incomes that represents an acceptable rate of return given risks involved (Gruis & Nieboer, 2004).

The most used income approach in real estate is the Discounted cash flow method (DCF) which uses the time value of money and proposes that the cost of implementation, acquisition, and development of the property is deducted from the present value of cash flows to generate a net present value (NPV). The cash flow stream is therefore discounted at a specific risk rate called the discounted rate. The discount rate is commonly calculated by using a risk-free rate and accounting for the systematic risk associated with real estate. Long-term government bond yields can be used as a risk-free rate, whereas common systematic risk associated with real estate include liquidity, rent risk, wage risk, capital risk, depreciation, lease terms, condition, and vacancy risks.

Both these methods rely on indexing market related risks to perform risk assessment (Shapiro et al., 2019). Research on academic literature supports that valuation methods are relatively easy to implement and widely accepted because they follow international reporting standards which makes oversight and risk control for investments forecasts clear and transparent (Park & Herath, 2000; Pless et al., 2016; Schachter & Mancarella, 2016).

Risks in valuation methods are indexed into spreadsheets that ensure results out of the model are the same regardless of risk preferences of investors. The methods ensure economically rational, precise, and quantitative calculations and are important because they mitigate potential financial losses. Further, valuation methods are widely used in real estate development risk appraisal circles, are simple to explain and conform to international financial reporting standards (Mun, 2006b).

2.4.2 Gaps in traditional valuation methods

Several uncertain factors affect decision-making capabilities when making investment forecasts of real estate development projects meaning that risks and uncertainties abound in the process of making new build investment forecasts (Mun, 2012). While valuation methods are strong in evaluating risks associated to financial losses, gaps are also observed. Valuation methods focus on monetary risks meaning that they only capture risk of losses on financial investments caused by adverse market movements. As such, they only capture financial loss effects of risks (Remøy et al., 2018). Real estate development process however involves several activities with each having a possibility of losses beyond finances. Gehner (2008) found that the process involves seven main stages with each stage having its unique activities divided into five main activity groups as per table 2.3.

Table 2.2 Real estate development phases and activities. Gehner 2008.

	Initiation	Feasibility	Commitment	Construction	Management
Land development	Land acquisition	Soil investigation	Land purchase	Site preparation	
Design	Spatial concept	Program of requirements	Design engineering		
Entitlement	Zoning and permit research	Environmental research	Permit application and interest group communication		
Financing	Analyzing 'Back of Envelope' proforma	Analysing economic feasibility	Finance arrangement	Budget control	Loan payments Profit generation
Construction		Cost engineering	Contractor selection	Execute contracts and supervision	Technical and maintenance agreements
Leasing	Watch market trends & determine target groups	Market analysis and feasibility studies	Marketing and promotion, pre-rental sales		Rental agreements
Sale	Watch economic trends	Market analysis and feasibility studies	Marketing plan		Sales and management contracts

Remøy et al. (2018) found that each activity has its own unique risks per project and real estate development risks are varied per phase and activity including land acquisition risks, building permit acquisition, interest rate, building costs and financing risks. These activities which are all unique per project mean that real estate projects contain inherent systematic and unsystematic risks. Because valuation methods focus on risks that affect cashflows and financial loss, they do well to capture systematic risk risks like volatility in interest rates, building cost variations, labour costs, growth yields and sale risks.

Valuation methods struggle to capture time risks of systematic and unsystematic risks. Such risks effects are omitted in such methods which assume that despite the uncertain nature of real estate processes, projects will be initiated and completed in the time frame that they were conceptualised within (Samis & Davis, 2014). However, the reality is that real estate developments are often postponed, phased, or even completely abandoned because of sequential decision making by development managers due to arising information and uncertainty on a project basis (Geltner & de Neufville, 2018).

Valuation methods, when not combined with other methods, therefore assume in their risk appraisals outputs that despite the high degree of uncertainty in real estate development, a project will be initiated and implemented within the same time frame proposed (Park & Herath, 2000; Pless et al., 2016; Schachter & Mancarella, 2016). The weakness of valuation methods remains that the likelihood of static proposed outcomes being exactly as predicted is not stated and time affecting risks are not integrated in the model. The probabilities of potential different outcomes due to effects resulting from risks, some of which may be better or worse for the investor are disregarded (Geltner & de Neufville, 2018).

2.5 Quantifying time loss impacts of risks in investment risk appraisal

Valuation methods are easy to use, transparent and widely accepted in the real estate development sector (Mintah et al., 2020; Mun, 2006a, 2006b; Samis & Davis, 2014). In the evolution of these techniques however, it has been noted that risks which lead to delay in project delivery times in real estate development projects is not fully captured. The results obtained from traditional valuation methods make it difficult to analyse distinct but time affecting risks that occur sequentially at different points in time in the real estate development process (de Neufville, 1990b). This gap makes the valuation techniques used by HA'S to analyse risks for new build investment forecasts incomplete.

Risk in real estate is defined as a function of probability and impact. Probability is the likelihood of the event occurring and impact is the deviation from the expected outcomes. If land or zoning permits cannot be acquired in a real estate development project and or costs are not predicted correctly, revenues, growth yields, project completion dates and project feasibilities (herein defined as expectations) can be affected to various extents. The time affecting risk herein becomes the uncertain input with varied likelihoods of it occurring. Its effect can for example be measured in change in yield and or delay in projected completion dates (Gehner, 2008).

Probabilistic risk modelling techniques can therefore resolve the omission of time effect of risks in investment forecast processes by quantifying both cash flow and time delaying effects (Hespos & Strassmann, 1965; Magee, 1964; Remøy et al., 2018). Arnison and Barrett (1985) has specifically proposed the decision tree analysis method to calculate sequential decision affecting risks and quantifying them as a probability of chance and effect. The method has also been used to quantify the effect of permit delays in valuation processes of real estate projects (Remøy et al., 2018). It has further been used in evaluation of time effect of risks associated to mining projects (Topal, 2008) and in valuing risks arising from stepwise industrial manufacturing processes (Magee, 1964).

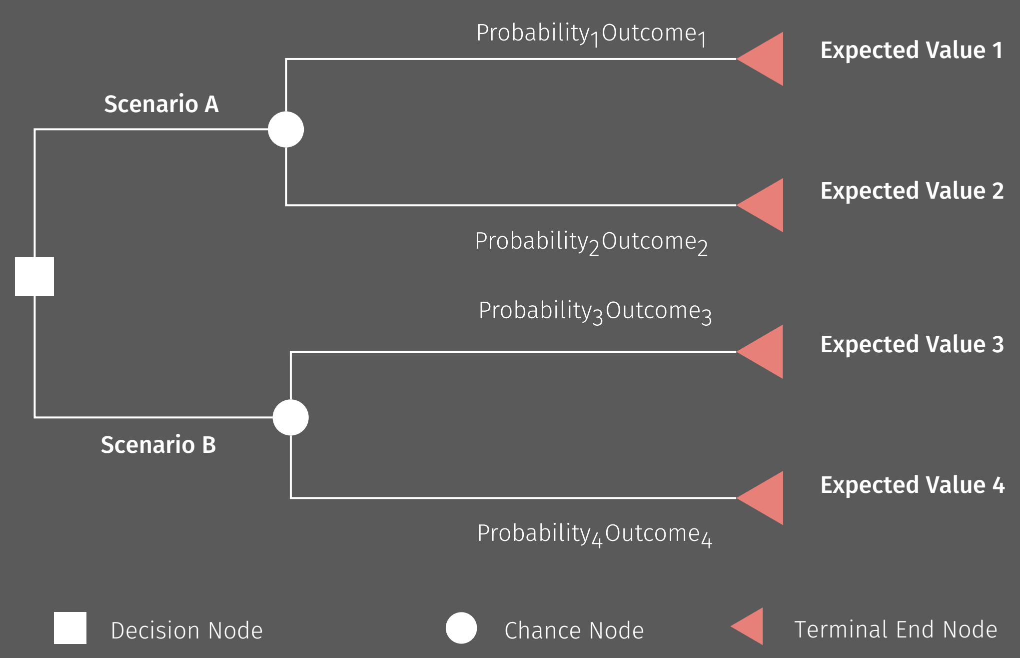
2.5.1 Decision tree analysis

Decision trees are statistical graphs with nodes and branches comprising various decision paths and probability occurrences at various time positions in an investment analysis The method was first advocated by mentioned by Magee (1964) and has been used extensively for capital intensive investment decisions (de Neufville, 1990b). DTA depicts strategic future pathways that an investor can follow based on several possible future outcomes and represents them graphically while capturing opportunities over time. These model can be used to capture any number of risks types including systematic and unsystematic risks that affect time sequentially across the planning and production process (Myers, 1977). The DTA model works on the premise that a problem has several paths that it can follow with each path providing a range of best case to worst case effects. The various paths are considered probabilities while the effects regarded as outcomes. To find the expected return of each paths, D_i is considered as the expected value of a probability-weighted average of its return in all future scenarios (de Neufville, 1990b). If P_j is the probability weight of scenario j and O_{ij} is the probability of the outcome then the average value can be expressed as (de Neufville, 1990b):

$$EV\left(D_i\right)= \sum_j P_j O_{ij}$$

According to (de Neufville, 1990b), DTA structures the problem in an otherwise complex environment and provides optimal choices for any period via its expected value methodology. It also provides these optimal choices over multiple other time periods beyond the initial decision point. DTA-trees are made of three nodes: The decision nodes (square) are where potential decision paths are reviewed and made, chance nodes (circle) bear probabilities that should all be equal to 1 and are where potential outcomes are determined by resulting events. Finally terminal nodes (triangle) are where a project is completed or abandoned, and terminal value provided. The model therefore provides opportunities for weighing probabilities and outcomes of different scenarios as per figure 2.4.

Figure 2.4 Methodology of a Decision Tree Analysis model. Author



Emerging risks provide the opportunity to estimate the consequences of occurences.

If the node is a chance event node, the expected value is calculated for all the branches emanating from that node. If the node is a decision point, the expected value is calculated for each branch emanating from that node, and the highest is selected. The decision tree approach introduces project related risks such as permit procedures or lack of land which tend to cause delays or cancellation of projects. The probabilities of such risks therefore need to be weighed and their effects tabulated. Emerging risks provide the opportunity to estimate the consequences of occurrences. Any decision problem therefore has opportunities for gathering new information and determining probabilities or the chances of the events occurring (de Neufville, 1990b).

The DTA method exposes visually all uncertainties and accompanying flexibilities in a project via a stepwise decision-making process that captures the value in alternative paths that a project could take, herein capturing both financial and time risks effects. It is also very open and avoids the "black box" phenomena that categorizes most binomial statistical methods that use random walks and built-in engines to simulate risks (De Neufville, 1990a).

The method however exhibits several gaps when used in solitude. Firstly, the decision tree approach quickly becomes unwieldy as the number of decisions grows with each option and the chance connected with it. This is due to the sheer complexity of decision-making processes in the real world. There would be an infinite number of possibilities and actions by managers for each given future event. If all alternatives are included, the decision model may be transformed into a "choice bush analysis," in which the number of routes increases geometrically with the number of decisions, making outcome variables and states highly reproducible. This would make any analytic work difficult and time-consuming, causing crucial discoveries to be overlooked. It is therefore critical to prune models by identifying critical variables and conditions for success and focus on them as opposed to the entire set of outcomes (de Neufville & Scholtes, 2011) .

Another key aspect of decision trees is that they have finite discrete choices, whereas in the actual world, there are infinite outcomes that might be continuous or discrete. As a result, rather than a fixed percentage IRR, the value of a project would encompass a range of acceptable values. Incorporating too many branches to cover every circumstance could result in a tremendously complex and arduous decision tree (De Neufville, 1990a). Most data on probabilities are derived through subjective judgments on input variables that influence the results. Because expert opinion can be skewed, reliable data is required to statistically run systematic analyses on trends. This provides the ability to evaluate mathematically how specific events affect the results. A lot of data is therefore needed to validate probabilities rigorous statistical analysis and extensive simulations would be required (de Neufville & Scholtes, 2011; Geltner & de Neufville, 2018).

The DTA model provides opportunities to identify both systematic and unsystematic risks and providing ways to quantify them. While it cannot be used in solitude since it still relies on the outputs of valuation methods, it enables time effects of risks to be captured for decision making (Arnison & Barrett, 1985).

2.5.2 Stochastic Decision Tree Analysis (SDTA)

The strengths in standard DTA indicate that the methods can be used to eliminate the weaknesses exhibited by standard valuation methods. The method has however been faulted with being unwieldy due to multiple decision paths that could arise when trying to capture all the possible ranges of events and decisions (de Neufville, 1990b). Stochastic decision tree analysis (SDTA) method is proposed to integrate to consolidate the branches of decision trees and avoid the unwieldy nature of such models. According to Hespos and Strassmann (1965), SDTA follows the logic of DTA but uses distribution ranges as opposed to static discrete inputs. When a node has multiple decision paths, these nodes are converted into a range of outcomes ranging from one possible extreme to another. All inputs (decision and chance nodes) and outputs (terminal nodes) can be represented as continuous empirical distributions. Distribution inputs and outputs reduce the complexity of the chance node by providing an empirical probability distribution as per figure 2.8 (de Neufville & Scholtes, 2011).

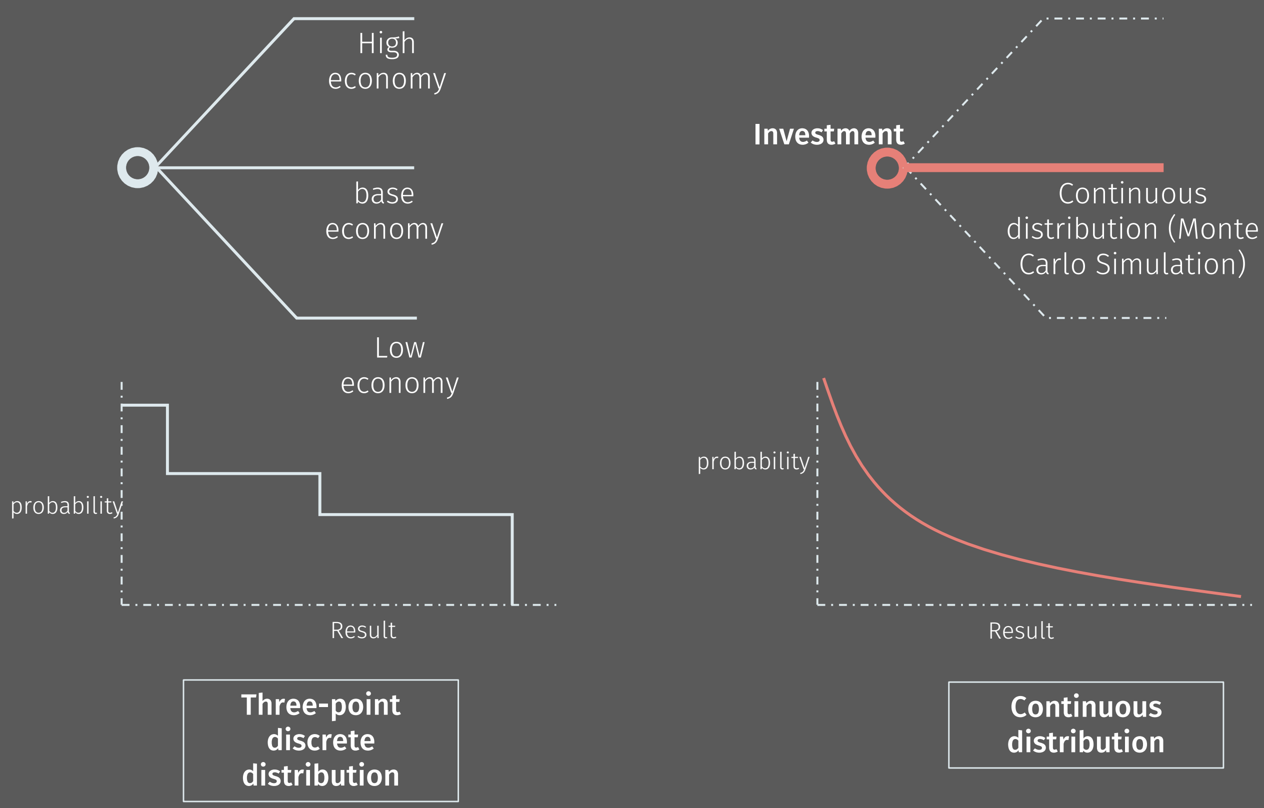


Figure 2.5 Empirical probability distribution of a stochastic chance node. Author

The elimination of nodes to create continuous distributions makes use of the risk analysis technique. The technique involves estimating the probability distribution of each factor that affects an investment decision and finding the possible combinations that each sceanrio could have. This enables results that incorporate the range of possibilities and probabilities that each risk factor possesses as a continuous distribution (Geltner & de Neufville, 2018). This technique therefore moves away from discrete values to a range of outcomes. The outputs of results become a range of values that provide the decision maker with alternative solutions (Loizou & French, 2012).

Risk analysis technique relies upon Monte Carlo experiments to model the uncertainty surrounding decisions (Loizou & French, 2012). Montecarlo simulation (MCS) is a "repetitive process, based on input probability distributions and a model of the functioning of the project in each period, generating independent, random future scenarios that collectively mimic what could happen, in principle covering the entire range of possible outcomes" (Geltner & de Neufville, 2018, p. 215).

The method involves determining the inputs, identifying uncertainty in the estimates by providing possible values of the inputs with probability ranges (distributions) and lastly simulating the model repeatedly (over several steps) to determine the range and probabilities of all possible outcomes of the model. The original values are called deterministic because they represent single point values while the results which are distributed in terms of probable outcomes are considered contingencies (Loizou & French, 2012). Stochastic decision trees combine the best features of both risk analysis and conventional decision trees and are simpler to construct and use then either of these (Hespos & Strassmann, 1965).

The stochastic modelling process would involve gathering quantitative data that can be used for estimates, modelling relationships between the data via a variety of methods including statistical tests and finally pruning the resultant decision tree via stochastic means like MCS to have as little paths as possible (Topal, 2008). The resultant stochastic model allows for risks to be calculated and their time impacts quantified. Such information would be useful to quantify the effects and magnitudes of specific project related risks to the real estate development process, the likelihood of such events happening and the extents of the effects (de Neufville, 1990b).

2.6 Theoretical framework summary

Dutch social housing management and investment forecasts has changed from its inception in the 1900s. While HA's have received more autonomy in their financial and administrative tasks, oversight and strict rules have meant that investment forecasts are strictly regulated.

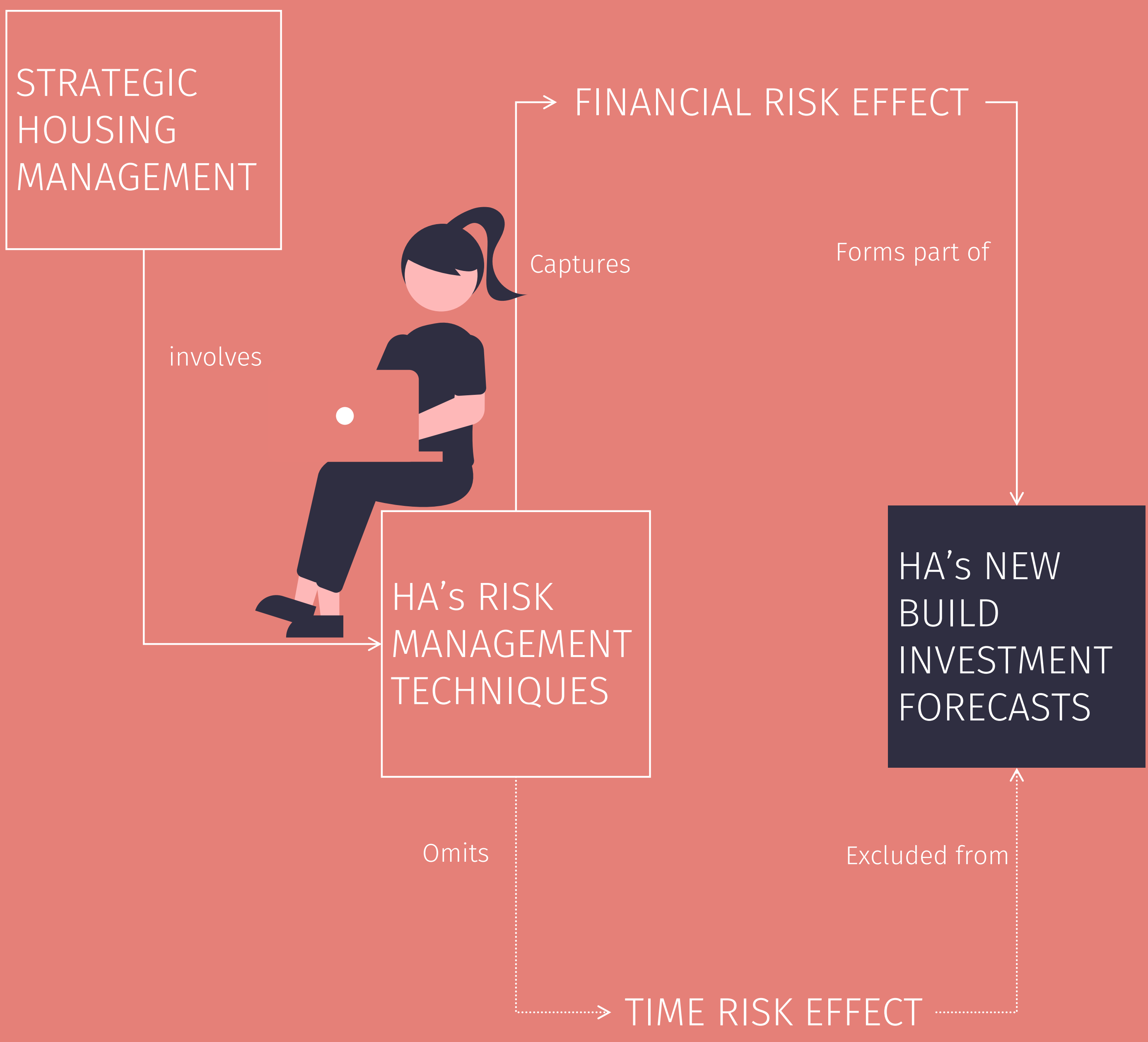
Strict regulations have resulted in the grossing out process where HA's were provided with more financial and administrative control but later restricted via the housing act 2015 that restricted HA's to almost exclusive production of homes within the services of general economic interest (regulated rent). Oversight bodies introduced strict financial conditions for borrowing, investment and planning of multi-year budgets as the main tool for investment forecasting.

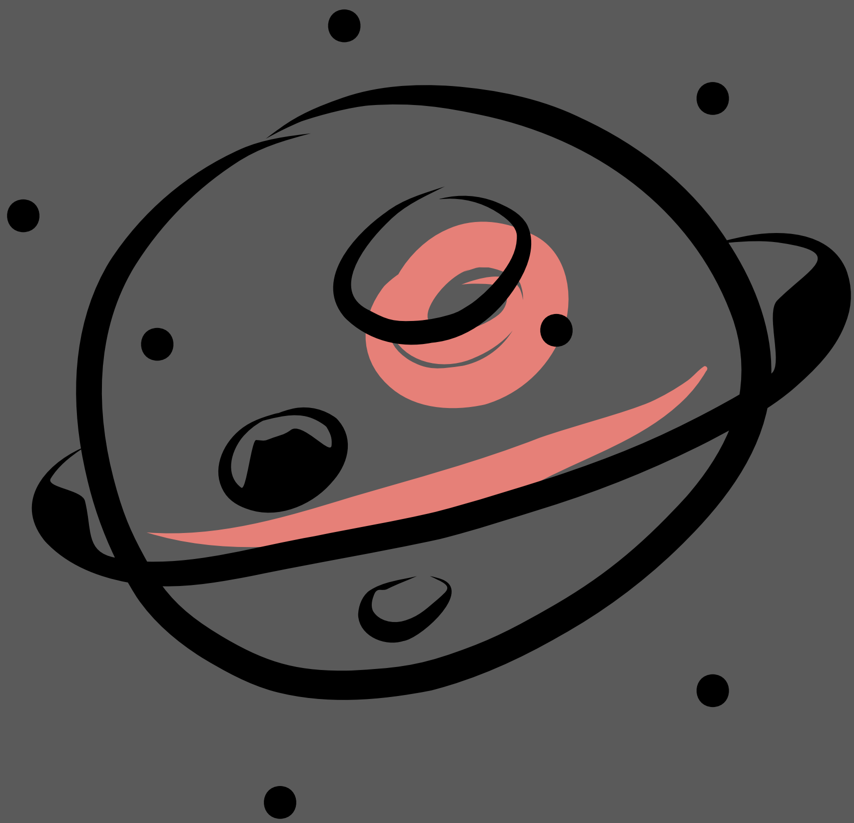
HA's in their new build investment forecast process have therefore adopted more market-oriented asset management processes including risk appraisal methods that are geared at mitigating the loss effects of risk including financial, time and quality deficiencies. HA's therefore use valuation methods extensively to capture the systematic risks which are risks inherent to the entire real estate development market including interest rate risk, inflation risk, currency risk, liquidity risk, country risk, and socio-political risk. Risk appraisal methods are used to mitigate against the potential loss of capital.

They however fail at capturing time effects of risks which are mentioned as the main causes of time delays in new build forecasts of HA's. Unsystematic risks also known as specific risk is a category of risk that affects HA's and their investment project plans specifically and are not prone to market wide effect.

The risks identified include elongated permit procedures, lack of or elongated land acquisition processes and capacity issues at both municipal and HA level which often delay real estate plans for new build projects. Traditional valuation methods therefore need to be augmented with alternative methods like SDTA for HA's to be able to holistically capture the loss effects of both systematic risks (mainly financial loss) and unsystematic risks identified as time loss resulting in delay). The figure 2.6 provides a theoretical framework summary for the literature review.

Figure 2.6 Theoretical framework indicating factors that affect realisation of new build investment forecasts. Author





3 Methods

3.1 Introduction

The following chapter discusses the methodology applied in this research. To find a comprehensive answer to the main and sub research questions, multiple methodologies and analyses were used. The research was conducted as part of a graduation internship at Ortec Finance who 'design, build and deliver software models for asset management, risk management, portfolio building, performance measurement and allocation and financial planning' (Ortec Finance, 2022). Ortec Finance produces software's (e.g., WALS) that aid HA's to plan and forecast their investment decisions. As part of asset and risk management, Ortec Finance builds scenarios for HA's at a portfolio strategy level via WALS software which helps HA's to forecast their investment. The software assists to produce data for dPi forecasts and dVi reviews. It however currently lacks the ability to simulate time delaying risks like increasing costs that delay tender procedures, lack of permit plans and land availability which affect delivery time. The research was undertaken with the support of Ortec Finance to explore how time delaying risks can be quantified to measure time affecting risks and quantify delivery times to correctly report realistic delivery times for forecast new build projects.

The main research question as per section 1.2 was reviewed in both a qualitative and quantitative way. To proceed with the research, the following hypothesis was proposed:

"Project indicators can be used to predict project time in new build investment forecasts of Dutch HA's."

The hypothesis was tested via literature review, in-depth interviews, surveys, and expert opinion. Literature study shows that current conventional investment forecasting techniques do not effectively capture or exclude project related risks. While systematic risk like inflation, building prices and interest rate risks are effectively captured, project related risks like lack of permitting procedures and land acquisition remain difficult to integrate in investment forecasting processes.

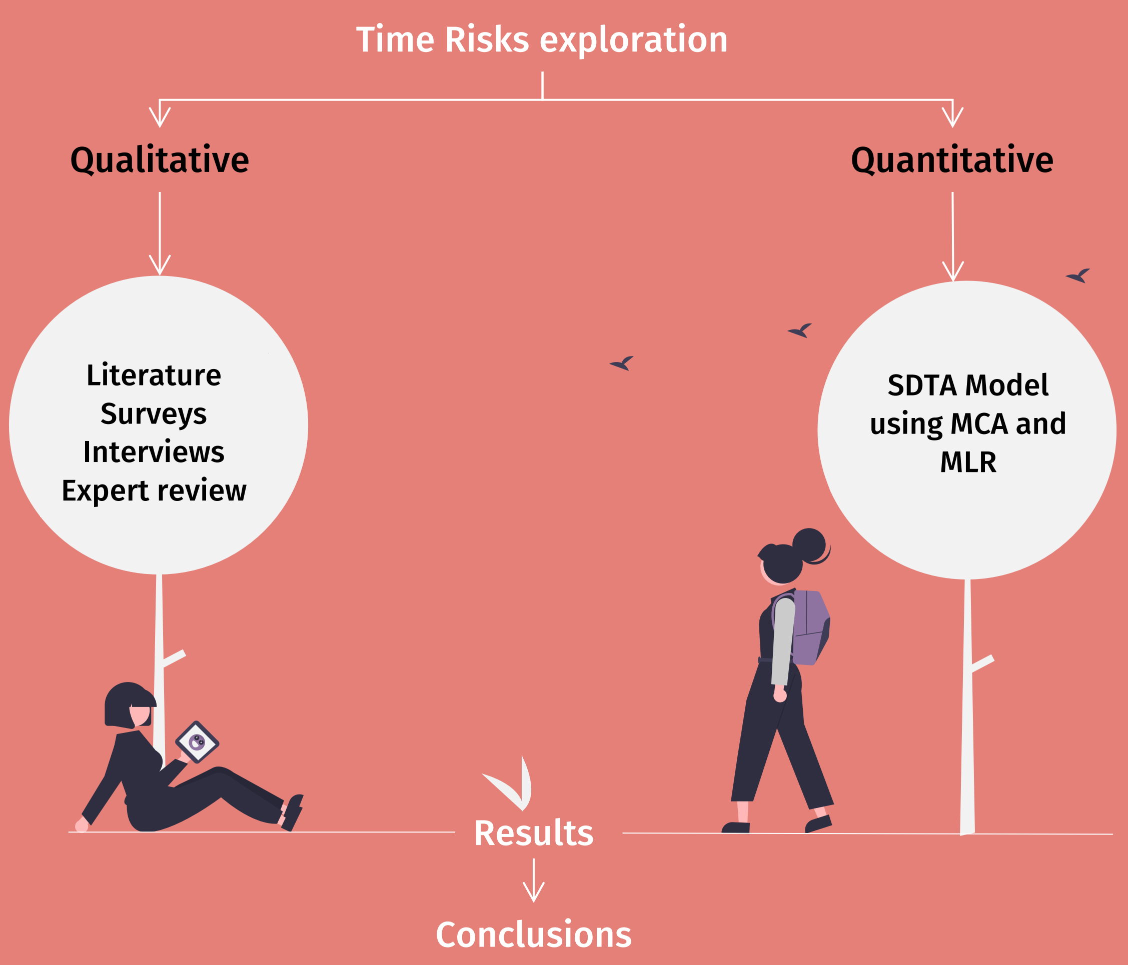
3.2 Research method

Empirical research was conducted to resolve the research questions as per section 1.2. The aim of the mixed method used for the research design was to explore the relationship between risks and time taken to deliver projects. The measurement indicator of risk was estimated as time taken to complete a project from initiation to end of construction. This was done via investigating the impact of both systematic and unsystematic risks on the time it takes to complete the proposed plans. Since this relationship was explored via looking at the most pertinent risks that affect investment forecasts of Dutch HA's, more insight was needed from several stakeholders involved in the creation, management, and assessment of HA's new build investment forecasts. The research therefore followed a mixed method of both qualitative and quantitative design.

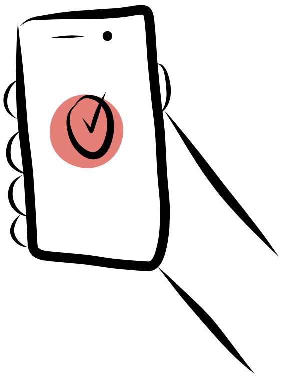
Qualitative primary data was collected and analysed to provide insight into the critical risks that delay projects and risk management techniques from the perspective of both supervisory bodies and HA's. This was conducted via literature review, expert reviews, in-depth interviewing, and surveys. Qualitative research was chosen since it provided in-depth insights into new build investment risks that are used in the quantitative stage. The method also provided a way to understand the investment forecasting process broadly, including the various stages, activities and decisions involved. This information was useful to administer recommendations in relation to the various stakeholders involved in the research.

Quantitative research was conducted via building a prediction model using a secondary dataset obtained from Portaal, an extra-large (>25,000 homes) Housing Association with approximately 50,000 homes in 10 municipalities (AEDES, 2021). The two quantitative methods used were a multiple linear regression (MLR) test and a stochastic decision tree model (SDTA) that used Monte Carlo Simulation (MCS). The dataset contained total project times (from initiation date to end of construction date) and other information relevant for the correlation study as per appendix G. The quantitative study was chosen because budgets and investment forecasts by HA's are generally expressed in numbers and a quantitative analysis converted qualitative risks into quantitative indicators that predicted project time. This aided in providing accurate predictions for project times given risks affecting a project. Figure 3.1 provides a summary of the research methodology.

Figure 3.1 Summary of research methodology. Author



3.3 Data collection



3.3.1 Qualitative and quantitative data

The mixed method used resulted in several techniques for data collection to answer the research questions. The methods are explained and lead to different methods of collecting data.

Literature review was first conducted along three main themes. First, the history of Dutch HA's was explored to understand the background of the investment forecasting process against the field in which HA's play. Normative risk management techniques of HA's including risk types (systematic and unsystematic) and their effects were identified. Additionally, the techniques used to capture them were identified and gaps inherent in them were also highlighted. Solutions available in literature were also reviewed to guide the field data collection.

Secondly, semi structured in-depth interviews in English language were conducted with officials from AEDES, BZK, Aw and WSW which are the organizations that financially and socially govern the activities of Dutch HA's in their investment forecasting process. This was conducted to determine the perspective of supervisory bodies. The purpose of structured interviews, according to (Bryman, 2012), was to standardize the interviewing of respondents so that discrepancies between interviews in any research study could be reduced. Every respondent received the same interview stimulation as everyone else. The purpose of this type of interviewing was to ensure that the responses of interviewees could be aggregated for analysis, which could only be done reliably if those responses were in reaction to identical signals. An interview protocol (Appendix A) was devised and evaluated in advance to minimize typical causes of mistake and reduce variation (Bryman, 2012). The evaluation of the interview protocol was done in two iterations using comments from the research's 1st mentor and talks with policy managers in the social housing field. The participants of the interviews were identified via their job roles i.e., either data manager or policy manager and were contacted via email. All interviewees were approached in two steps. First, a preliminary discussion was conducted to discuss the research topic in an informal capacity. This was also meant to gather more information on the research question and the current state of the housing sector including new developments. The discussions led to further development of the interview protocol. The participants were thereafter invited via email and in-depth interviews (lasting 1 hour each) were conducted via video call. A detailed list of all interviewees including their roles is found on appendix D. The findings are presented in a cross-interview co-occurrence analysis.

Thirdly, a survey was developed in Dutch as the preferred working language of Housing association professional to collect the HA's perspectives. The survey was reviewed by industry experts including a portfolio manager from Portaal HA, a senior consultant and a business specialist from Ortec Finance. The top risks that affect the overall goals and time delays for HA's were collected from discussions with HA's professionals and literature review (Gehner, 2008; Gehner et al., 2006; Oudsten, 2021; Spelbos et al., 2020; van Os et al., 2021) .

All the mapped activities and risks are as per question 4 and 5 in appendix H.

According to van Os et al. (2021), the realization rates of associations is related to the number of rental units (VHEs) owned, where the realization rate roughly increases with VHEs owned. In the period 2017 to 2019 the realization rate of the extra-large HA's was 80%, while this was less than 60% for the much smaller ones. Large (10,000-25,000 VHEs) and extra-large (above 25,000 VHEs) HA's therefore perform better than small and medium HA's. Large (10,000 – 25,000 homes) and extra-large (>25,000 VHEs) HA's were preferred for the survey as they have a diverse portfolio in multiple municipalities and adopt representative risks assessment techniques within the sector. This segment was also preferred because specific HA's in the Large and extra-large category still struggle to reach high realization rates (above 80%) making this a representative segment with both high and low performance.

The realization rates of associations is related to the number of rental units (VHEs) owned.

The 70 HA's were identified from a list of AEDES members with more than 10,000 rental units (VHEs) as per appendix C. The HA's are categorized as L and XL i.e. 25% of the 282 HA's in the Netherlands (AEDES, 2021). The constituent VHEs had to be predominantly homes and the composition of the portfolio was requested as part of the survey to ensure this category dominated the typology of ownership. Further, because investment forecasts is conducted by different roles per HA, the following roles were identified as professionals who engaged in investment forecasts. These roles were also preferred because they engaged subsequently dabble in activities involving budgeting and project management roles. The target professional roles were identified as portfolio and asset managers, financial and business controllers, and real estate developers. It was also desired that the total participants have an average of approximately 100 FTE or higher because this indicated the diversity and complexity of roles in risks management. Of the qualifying 70 HA's, 33 HA's, responded. 31 respondents expressed interest to participate while 2 declined. Of the 31 positive responses, 29 associations participated in the responses and 2 did not participate. The 29 HA's therefore form the sample of the 70 HA's that form the target population. It was also desirable, with the small population size, to sample participants from all provinces to increase the chance of participation increasing variety and avoiding sampling error.

Finally, a two-phase expert review interview session was set up to synthesize the two sets of data collected from the survey and in-depth interview. According to (Bryman, 2012, p. 501), expert review is a "technique is a method of interviewing that involves more than one, usually at least four, interviewees and is useful to explore how individuals discuss a certain issue as members of a group, rather than simply as individuals." An expert opinion interview of 3 experts from Portaal (appendix E) was used to bring to the fore perspectives on the unsystematic risks identified in surveys and in-depth interviews. In the first session, a structured questionnaire was administered as per appendix H and results used to develop a table that synthesized and converted qualitative views into agreed quantitative indicators with the expert review. The risks were derived from the first two studies conducted via in-depth interviews and surveys. The variables were then used for a multiple linear regression statistical test. A dataset of 57 projects was then compiled by Portaal as per the configuration in appendix G.

3.3.2 Adaptation of data collection plan

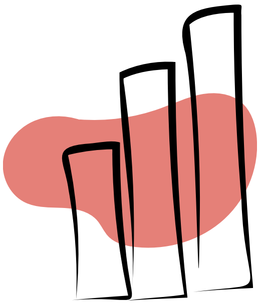
The data collection plan experienced several changes in plan from the initial set plan. Qualitatively, the initial survey plan proposed to collect data from 70 HA's via a survey and further conduct in depth interviews with 4 HA's on the same content. Questionnaires and interviews are often used together in mixed method studies investigating educational assessment (e.g., Brookhart & Durkin, 2003; Lai & Waltman, 2008). While questionnaires can provide evidence of patterns amongst large populations, qualitative interview data often gather more in-depth insights on participant attitudes, thoughts, and actions (Kendall, 2008). Due to time constraints and additionally the complex nature of HA's activities, it was decided that one HA's (Portaal) will be used to operationalize the results of the survey for the quantitative section of the research. Additionally, it proved challenging to collect multiple HA's experts from different HA's due to unavailability of approached experts for multiple reasons.

Quantitatively, the research sort to collect project level data at a sectoral level. It was understood that the Ministry of Internal affairs and kingdom relations possess sector wide data from HA's that was collected up to 2019 as part of the dPi process. This information however was classified and several attempts to access it from supervisory bodies were unsuccessful. Further, the conversion of systematic and unsystematic risks to indicators was envisioned following the premise that information as per table below was available for collection. Several information was unavailable which forced the regression analysis to be conducted with substituted data as indicated in the data analysis section for the respective risks.

Table 3.1 Initial desired indicators for regression. Author

Risks	Indicators	Status
Permit procedures	Zoning plan applied or not applied	Unavailable
	Local community discussions made before permit application	Unavailable
	Multifamily Homes (MGW) vs Single family Homes (EGW)*	Alternative
	Number of Homes	Available
Land acquisition	Land ownership status e.g., HA, municipality, developer	Unavailable
	New Build vs Demolish and build status	Available
Contractor processes (appointment and construction delay risks)	Construction period delay logged against contractor	Unavailable
	FTE of contracting company	Unavailable
	Volume of production of construction company	Unavailable
	Tendering method e.g., Tender procedure, turnkey, direct appointment	Unavailable
	Construction Budget	Alternative
Municipal capacity	Presence of real estate developer team	Available
	FTE real estate development department	Available
	Municipality location	Alternative
Building costs changes	Input price index	Available

3.4 Data Analysis



3.4.1 In-depth interviews

The data collected from both the housing association and oversight bodies study were transcribed and then analysed and coded using Atlas.ti Windows (Version 22.0.10.0-2022-03-09). In the program, each of the interviews is analysed based on codes with the interviewees coded as groups. Coding is "the key process in grounded theory, whereby data are broken down into component parts, which are given names. It begins soon after the collection of initial data.

The key concepts identified were therefore constantly compared across the interviews to "maintain a close connection between data and conceptualization, so that the correspondence between concepts and categories with their indicators was not lost." (Bryman, 2012, p. 568). This resulted in emergence of normative concepts like "gaps in data" or risk effects of data" which were predetermined in the semi structured theoretical sampling. The following examples, based on brief snippets from the interview transcriptions, demonstrate the use of codes in data analysis:

Participant Code	"The dPi in a way, it is a bit problematic for that because sometimes we get asked like so what are the housing associations going to do in the next five years? And we take the dPi and then we find out they only do like 60 or 70% of the newly built housing plans so the realization rate is lower, so we're like, OK, what's happening? But then the dPi it has not really made to have prediction, but it's more like claiming the budget space."

The coding process in the software assisted in organizing the data according to the defined themes of the theoretical framework and facilitates the comparability of information across the cases. Each interview was coded and analysed individually and correlated to the results of the corresponding oversight bodies. The codes were arranged within code co-occurrence tables with numbers representing several information inputs. All code occurrence tables in Atlas.ti are outlined in appendix L. The numbers in the code occurrence tables form a matrix like a statistical correlation matrix which indicates how often the code was applied in the entire analysis to identify the number of co-occurrences in the table cells. The numbers indicate how often the two codes i.e., column and row occurred, counting number of co-occurring 'events' (Atlas.ti, 2022, p. 1).

3.4.2 Surveys

The survey results were downloaded from the Qualtrics environment and analysed via Microsoft® Excel® for Microsoft 365 MSO (Version 2204 Build 16.0.15128.20158) software. The collected data was converted into pivot tables and analysed using the number of respondents that mentioned an attribute. Because the sample size was not statistically significant, the results were analysed non-parametrically and group of questions related were correlated and represented as a distribution to find the weighted results per group of questions.

3.4.3 Expert Opinion

The insights collected from the expert interviews with three Portaal employees led to conversion of qualitative risks leading to project delay into quantitative indicators. The qualitative indicators as per the first expert review were discussed and agreed upon by all three experts and a variable(s) chosen to represent the qualitative risk that affected the project time. The variables are presented in the results section.

"The expert opinion was meant to enable the conversion of qualitative risks leading to project delay into quantitative indicators"

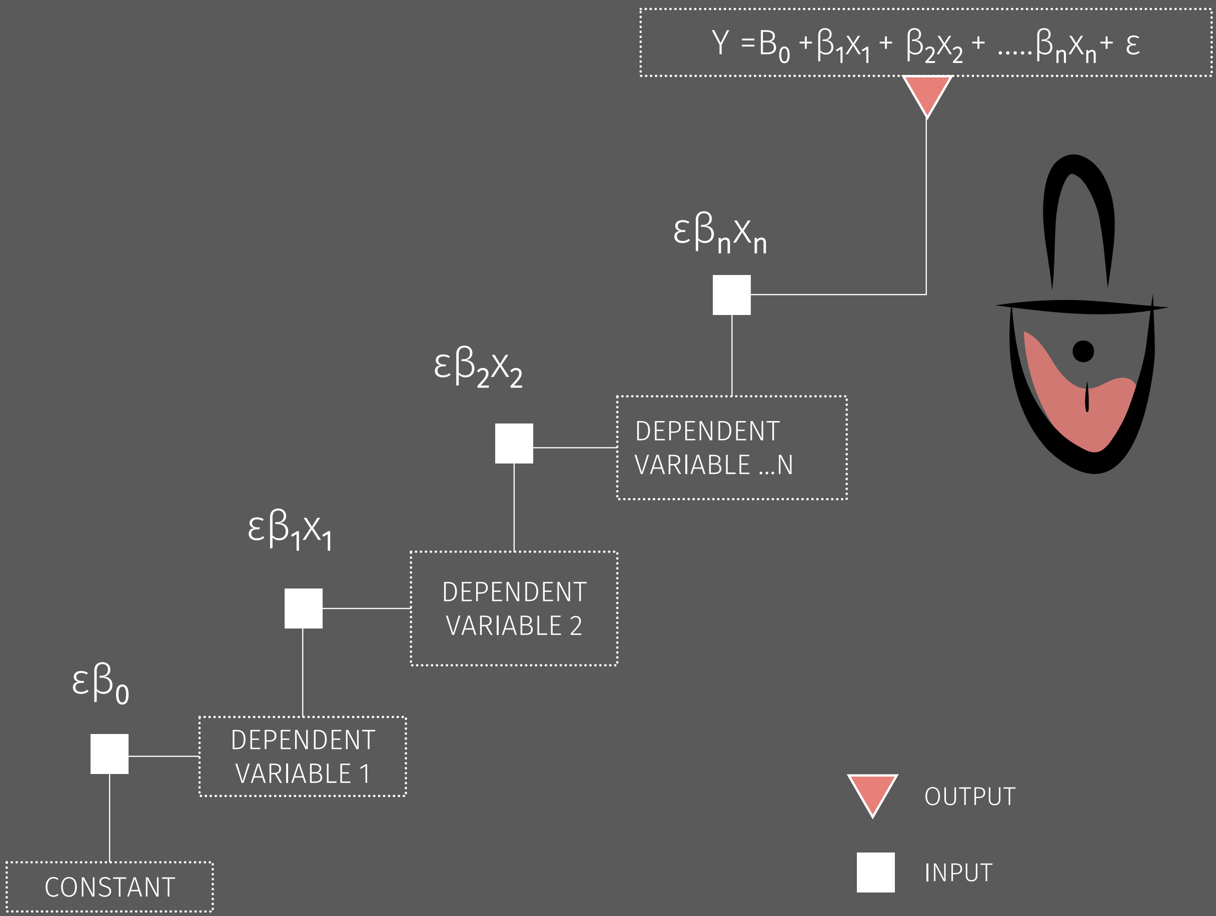
The indicator variables were then used together with data obtained from Portaal and Statistics Netherlands to run a multiple linear regression in IBM SPSS Statistics for Windows, version 28 (IBM Corp., Armonk, N.Y., USA)'. The chosen statistical test was a multiple regression model which is a method of modelling a relationship between multiple independent factors and a single dependent variable, with the independent variables explaining the dependent variable. If the factors are "x_1" through "x_6," and the dependent variable is "Y," a multiple regression model can be expressed as follows:

$$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \ldots + \beta_n x_n + \varepsilon$$

Where β_0 represents the intercept or constant, β_1 is the slope coefficient for x_1 and so on. ε represents the standard errors. To be able to conduct this test, two main assumptions were reviewed. First, the dependent variable in the regression (total project time) is measured at the continuous level. To be able to conduct this test, two main assumptions were reviewed. First, the dependent variable in the regression (total project time) is measured at the continuous level. Secondly, there are more than one independent variable that are measured either at the continuous or nominal level. Several other assumptions were also tested to ensure the multiple regression met them. These include ensuring a) there is independence of errors (residuals); (b) linear relationship between the predictor variables (and composite) and the dependent variable; (c) homoscedasticity of residuals (equal error variances); (d) no multicollinearity; (e) no significant outliers, high leverage points or highly influential points; and finally, that (f) the errors (residuals) were approximately normally distributed. A multiple regression analysis yielded constant and independent variable coefficients which were then tested and the subsequent assumptions (c to f). A prediction to calculate 95% confidence intervals of the dependent variable "total project time" was made using IBM SPSS Statistics Syntax Editor to build a univariate general linear model. The prediction results are displayed in the Contrast Results (K Matrix).

The resulting linear regression model with only the variables that statistically significantly predicted the dependent variable “Total project time” were then used to build a stochastic decision tree according to the method proposed by (de Neufville, 1990b). The variables are presented in the results section. The model is built using Palisade Precision tree 8.2.1 (Build 47) and Microsoft® Excel® for Microsoft 365 MSO (Version 2204 Build 16.0.15128.20158). The Y Variable is read at the right of the model. All nodes represent a coefficient and independent variable with the β0 represented at the beginning of the model. The inputs (respective co-efficient multiplied by respective independent variable) are converted via MCS using their respective standard errors to get a distribution range. The results are then calculated by means of 10,000 simulations via Palisade @Risk version 8.2.1 (Build 47).

Figure 3.2 Stochastic decision tree analysis model. Author



The results of the MLR and the SDTA were then presented to the expert panel for a second expert review session to discuss if the results were consistent with industry norm and to determine the use fit of the model to Portaal. After the discussions, a formula was proposed to predict the accurate budgets per year and as well five-year dPi forecast using the predicted time from the model. The formula for predicting the risk adjusted investment forecast can be summarized as follows:
can be expressed as follows:

$$\mathbf{D} = \frac{B}{t} \times n$$

Where:
D = risk adjusted investment forecast
B = Proposed construction budget
t = time predicted by the mathematical model given independent variables
n = Number of years desired in forecast

3.5 Data plan & ethical considerations

The data plan contains procedures taken when collecting and handling data during the research. The research has used several requirements according to the General data protection regulation (GDPR).

First, each interviewee received an Informed Form of Consent via email to ensure that they understood the nature of the research and agreed to participate in the in-depth interviews and the surveys. This form can be found in Appendices A and B. The emails sent contain five major agreements:

- The in-depth interviews are audio-recorded to facilitate data encoding and ensure the reliability of the data.
- the respondents and their HA's can choose to remain confidential.
- selected parts of the interview can be used as a quotation in the research outputs.
- the data collected, excluding personal information, is used for academic purposes, and the final graduation thesis is published in the educational repository of TU Delft.
- The IP addresses of the respondents was not collected.

Second, personal information is collected only where necessary. Names, email addresses and role in the organization was collected to allow for follow up interviews. This information is not shared beyond the research team and even so only upon request for specific purposes. In this case the participant will be informed to provide consent.

Survey content is anonymized except for expert interviews and interviews with oversight bodies. All participating HA's are replaced with codes. The original participation list is retained for one year after graduation but is not published according to the agreements for participation of the survey. The HA's characteristics including VHE's size, location, FTE and portfolio characteristics are however published as a comparison factor for respondents' data.

Third, the research also followed the FAIR requirements (Findability, Accessibility, Interoperability, and Reusability) according to Wilkinson et al. (2016). The research is therefore published in TU Delft's student repository and indexed with researchable keywords as per the abstract identifications. The research is conducted in English apart from specific terms that are published in Dutch including the survey. This is to avoid language translation errors since the terminologies in the survey are specific to the Dutch social housing context. All references are done in APA 7th edition.

The interviews were conducted via a secure Microsoft Teams channel from Ortec Finance where the internship is conducted, and the surveys were conducted via a TU Delft Qualtrics licence. The collected information is stored offline and deleted one year after graduation date; this information is only accessible via the graduation committee upon request.

4 Time affecting risks and appraisal processes

This section provides the time affecting risk perspectives of supervisory bodies and HA's from in-depth interviews, surveys and expert opinion sessions conducted. It further outlines gaps in the appraisal processes and solutions proposed for identified gaps.

The in-depth interviews were conducted among 5 supervisory bodies participants consisting of 3 policy managers (AW and BZK) and 2 data managers (WSW and AEDES). The survey was conducted among 29 Dutch HA's distributed across 12 provinces with rental units (VHEs) of more than 10,000. 19 HA'shad 10,000-25,000 VHEs and the remaining 10 above 25,000 VHEs. 16 HA's were located exclusively in urban areas with 13 in both rural and urban areas. All 29 HA's had homes as their main portfolio. Additional rental units included parking places (29), industrial property (29), public social buildings (29), garages (27), elderly homes (25), care homes (18) and student housing (14). The respondents job roles were distributed as asset managers (6), business controllers (6) and financial managers (6), real estate developers (5), and portfolio managers (5). The maximum full-time equivalent (FTE) of the HA's was 800 FTE and minimum 60 with a mean of 245 and standard deviation of 181. The expert opinion interviews were conducted among 3 experts (portfolio manager, project development manager and project controller from Portaal.

The results are laid out in three main segments as follows: The first part explores the findings on the main risks that affect delivery time of new build real estate development projects are outlined. The second part looks at current techniques used to appraise these risks and perceived mismatches as observed by participants and the third section reviews proposed remedies to mitigate the gaps found.

4.1 Risks affecting delivery time of HA's new build forecasts

4.1.1 Use of the Investment forecasts

To understand risks in the investment forecasts, the research first identified the uses of the forecasts from the perspective of both HA's and supervisory bodies.

The supervisory bodies use the new build forecasts for several reasons to collectively oversee or steer the behaviour of HA's forecasts. The bodies assess the investment forecasts via reviewing proposed financial ratios, the number of homes and subsequent financial budgets.

D-003

> *"The dPi thus "gives information about how much a housing association wants to invest in various categories like investment in new build, renovations, demolitions and sales".*

D-005

> *We also use them. HA's must fill in on the housing level, all kinds of internal information. So, when was the building built, what is the rent, the square meters and about 25 indicators per house? And we use that to do all kinds of analysis so the easiest one is just what is number of dwellings that association has what, what their age is and what the average rent is and what are the maintenance costs, what is the value, how many new built units they have made so also in the dVi they have of course to fill in what is new build houses and their characteristics"*

This data is collected to ensure oversight of financial and social goals of HA's and to ensure the predictions are achievable and within the set frameworks.

D-003 | *"We use it for supervision. Ok, you have these plans. You know a multiyear budget should be in accordance with your policy and what you really want to do in the next year. When you have plans let's say you want to build 100 homes in the third year but then you don't do more than 50 dwellings per single year then Aw can ask how realistic your policy plan is?"*

D-004 | *"So, we look at the ratios and cashflow plans and if our account managers have some need for additional information, they have more conversations (with housing associations and take some additional documentation. But our most important source to get an image of all those housing associations is through these data. We always look back three years so we can see what the associations have done in the past. For us, it's not so important how many new houses they build or houses they renovate. Uh, we're mostly here for our financial risks."*

D-003 | *"For the inspection, we use financial ratios but also mainly focus on financial continuity, performance agreements etc. So, now we only look at the track record for example if you said two years ago that this would be your plans and we know what you realized, we also have your track record on forecasts. A bad track record can give rise to a research into your policy and the reasons why you do not succeed in realizing it in time."*

The investment predictions are also connected to the local and national political agenda as governments use the predictions collected by the oversight bodies to form policy and drive the housing agenda.

D-003 | *"We use the data to make the reports on the state of the housing associations sector which is an annual publication also sent to the parliament and the minister for policymaking. We use a lot of dPi and dVi data for that."*

Investment forecasts are widely perceived as useful by 26 out of 29 HA's. Investment forecasts are mentioned as useful to better predict future policy plans and cashflows based on previous HA's performance.

HA5 | *"The forecasts show the extent to which the ambitions are achieved."*

HA3 | *"It is useful because of the determination of the degree of overprogramming to eventually arrive at the next expansion."*

HA16 | *"They provide insight into the extent to which the plans of recent years have been realized."*

HA's conduct risk assessment of investment forecasts to ensure their investment plans are realized as planned to largely avoid financial risks (29), followed by consequences for not achieving set goals (25), to avoid project delaying consequences (21) and finally to avoid reputational consequences.

4.1.2 Risks affecting accuracy of investment forecasts

Supervisory bodies mentioned several risks that caused investment forecasts to be inaccurate. These risks make the investment budgets, the time proposed for delivery of these intentions, resulting cashflow and financial ratios inaccurate.

The supervisory bodies suppose that three main risks delay projects which cause a deviation in the initial forecasts by HA's. The risks identified are lack of land positions followed by long permit procedures occasioned by permits taking too long to acquire and objections from local residents.

D-005 *"Currently there are two main things delaying projects that is permit plans and land availability. For permits that we did research on like what are the obstacles to increase or fast track new building permit granting, this was done by a taskforce on housing associations. There's a task force new building plans for housing associations and we both find the same problems. Access to land, that's the number one problem and permits taking way too long because of environmental issues or people making complaints for example."*

D-002 *"Then you have the neighbours who don't want a new building in in their neighbourhood. When they protest this also takes time to deliver projects."*

Top risks mentioned as causing the largest delays according to HA's were permit applications and land acquisition. This was followed by legal procedural risks, return requirements, buildings cost rise, objections by local communities, contractor delays and tendering delay risks. Lower to medium effect risks included interest rate changes, salaries and labor costs, permit requirements research, program of requirements, performance agreements, fiscal risks, presale percentages, flora/fauna, chance of getting subsidies, site preparation risks and heritage status as per figure 4.1.

Figure 4.1 Top risks causing delays as per HA's. Author

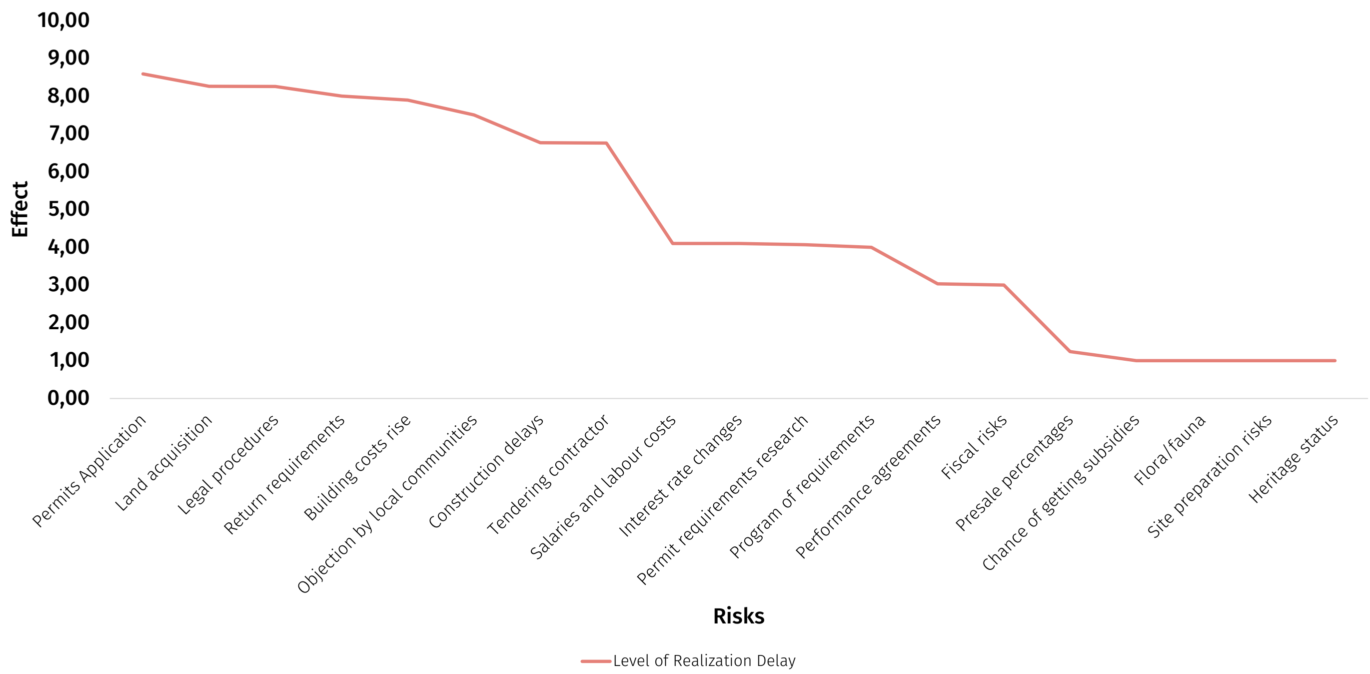
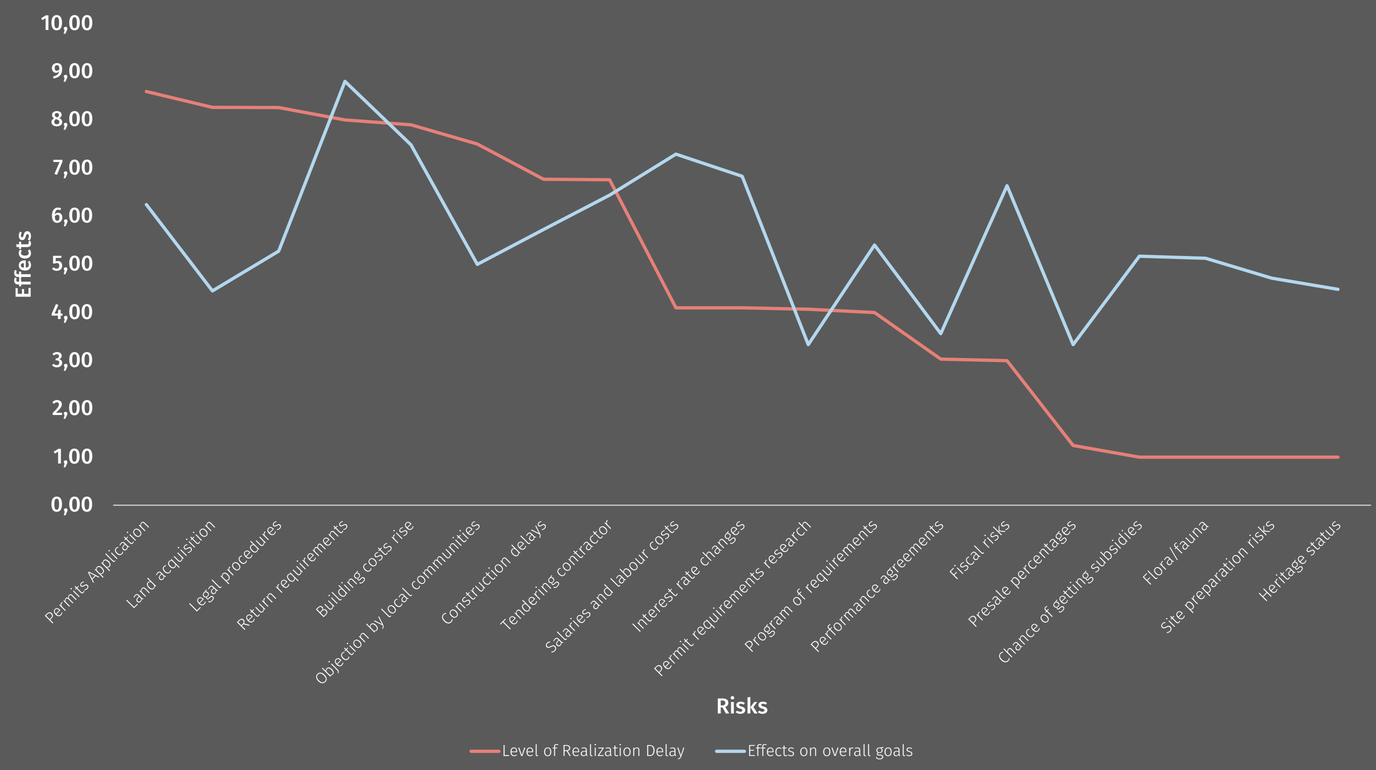


Figure 4.2 Top risks causing delays against top risks affecting overall goals. Author

The risks that affect social and financial goals are different from the ones observed to affect delay of projects. It was 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 as per figure 4.2.



It was noted that municipalities delayed projects when they took too long to approve permits, lacked land for building and also proper development teams.

D-005

"We also published the Actie agenda Wonen that is a document published by 34 stakeholders that all agreed on certain investments and appointments to increase the new builds, and that's the main thing we do. We can say we want to increase the amount, but we just can't do it alone by planning. We need land, we need builders to accelerate, we need municipalities to fast track permits, so that's what we do. So that's what we do. Yeah, just use that information and to make better agreements."

D-001

"You see that if you build in municipality A, you have a more chance of achieving your projects than municipality B because Municipality A will give you access to land or something so the risk of a project being realized in different municipalities is also different."

Additionally, municipal "hostility" was mentioned as one of the reasons delaying the realization of new build plans.

D-002

"Some local governments do not want to do anything with social housing associations, because they think that people living in the dwellings well, they are problematic people and are only costing a lot of money and they simply do not want these people in their community. It can be of course that this causes non delivery, but then if a housing association has a lot of money and financial power and we therefore wonder about their plans. Some municipalities have little interest in the realisation of new social housing, and/or there are few opportunities to build new houses. For housing associations in these municipalities, the result can be that they have very few opportunities to invest which can result in big financial reserves, if they do not find alternatives to spend it on like for example renovation."

4.1.3 Consequences of risks and inaccuracies in forecasts

The inadequacies in the new build investment predictions leads to several risk perceptions as identified by the oversight bodies. The ability of HA's to realize forecast plans is weakened resulting in under performance and therefore the future inability to realize their financial and social tasks.

D-004

"If an association does not for example get the right labels, then there would be a problem because they have a lot of houses. And they will not get any rent anymore if these homes deteriorate. So, we want to know what the policy is and what the risks are for the housing association and ultimately for us. We just want to know what the policy is, how they are doing or if the legislation would change and there are new risks. We want to know what they are doing and ultimately what the risks are for us."

Secondly, political and policy risks result from incorrect investment forecasts. Oversight bodies rely on the predictions to advise the housing minister and the parliament of the state of the housing sector.

D-001

"The minister is worried, and he is going to be here for three years. And he said, well in a year and a half or so, the Parliament will ask me as Minister, you have been here for a year and a half and spent a lot of money on the issue and we do not really see any new houses being built. So, what proof do you have that it will happen. So, there is not really any proof for it, so he is really looking and like so what have I got to show, and he is asking us, of course to have proof that show that it really helps that we are trying to push the tax away that increase the rate. So, predicting the realization rate or rather the dPi more accurately, it is very relevant if the government lowers €1.5 billion tax and they are kind of hoping that it has effects, but we do not have proof."

Additionally, several municipalities and political leaders are pushing the agenda for lesser social housing due to investment forecasts that are optimistic and rarely achieved which result to lower realization rates.

D-002

"Another reason is at a political level, and now we have a new Minister with a new coalition. There are several political parties, of course, and some parties are not convinced of the need to have housing associations or the need to grow social housing in cities. Liberal parties wanted the social housing stock to decrease, which has resulted to some extent in the extension of policies minister Blok from 2012 to 2018."

Inaccuracies in the prediction of project delivery are mentioned to cause long waiting lists for potential tenants especially within the affordable segment and special needs groups.

AW

> *"How accessible is social housing? Here there is a problem, because each year fewer social house come available for new renters through mutation. Furthermore, the number of newly built social houses has been fixed on a level around 15.000 per year. This almost half of the number of new built social houses needed each year till 2030, as calculated from the projections in "Opgave en middelen". The result is long waiting lists. Furthermore, accessibility for regular candidates is made more difficult by a growing group of candidates with urgency because of medical and social-psychological reasons. And finally there are less alternatives for people with low incomes, because rents in the private sector and housing prices have increased a lot the last few years. There is political consensus now, that housing associations need to build more to meet the demand and invest in sustainability. Therefore, the government now is considering revoking the tax law (Verhuurdersheffing) for housing associations that was introduced in 2014, so housing associations can invest enough to meet the demand (according to Opgave en middelen)."*

HA's observed that inaccurate predictions result in cautious planning of future predictions. For some HA's it was observed that less projects were planned in anticipation of not realizing the plans. Other HA's were observed to overplan their forecasts to cover unachieved plans thereby resulting in over optimism.

HA02

> *"A lower realization rate (less than 100%) results in a more cautious estimate for future years."*

HA03

> *"The planning volume of projects (pipeline) is always greater in number and cash flow than will be spent and delivered. This is related to risks and delays in projects. So, to get a desired number, you need to plan more. To know how much, you need insight into the degree of realization. So, you know how much to plan for individual projects. For example, if your realization rate is historically on average 70%, then you must plan 130% to arrive at 100% realization. You can then include that 100% in the long-term budget, but you steer to 130% because you consider outages / delays."*

4.2 Risk appraisal techniques and perceived mismatches

4.2.1 Risk capturing techniques

The most used risk assessment methods is intuition and personal experience (26) of managers. This was followed by scenario analysis (24) and further valuation methods like cost and discounted cash flow approach (23). Additional methods identified were risk assessment checklist (19), sensitivity analysis (16), probabilistic methods (10) and others (2) as per figure 4.3.

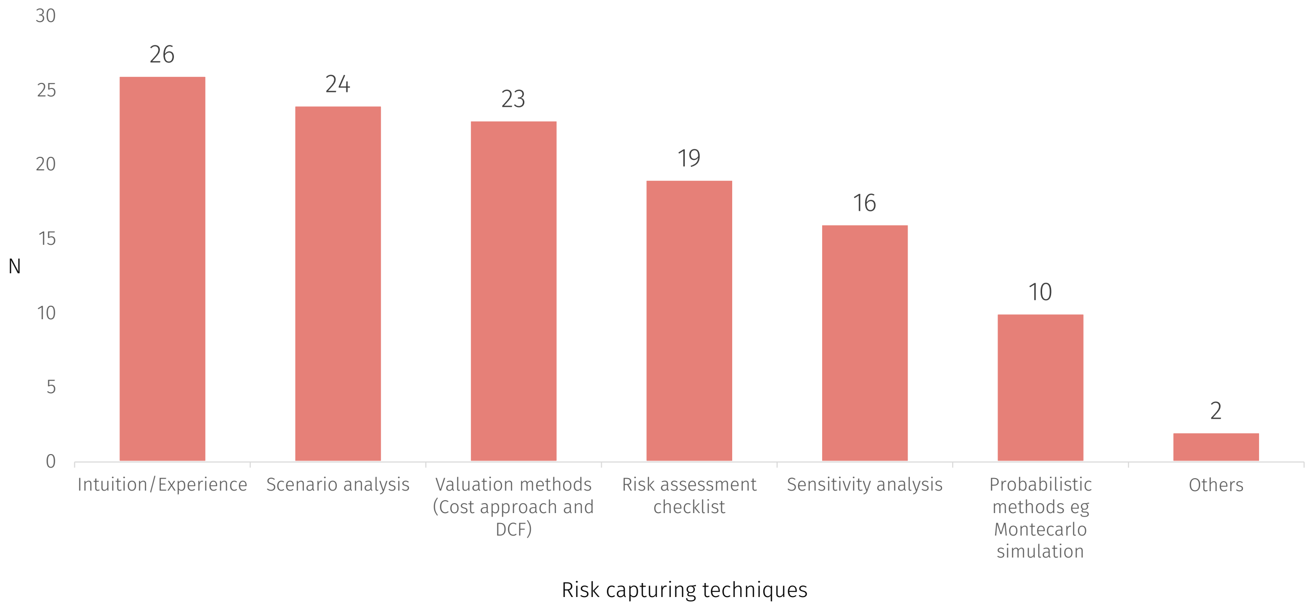


Figure 4.3 Most used risk assessment techniques. Author

The most likely combination of techniques used was the use of intuition in combination with valuation methods (19). All methods were used together by 7 of the 29 participants as per figure 4.4.

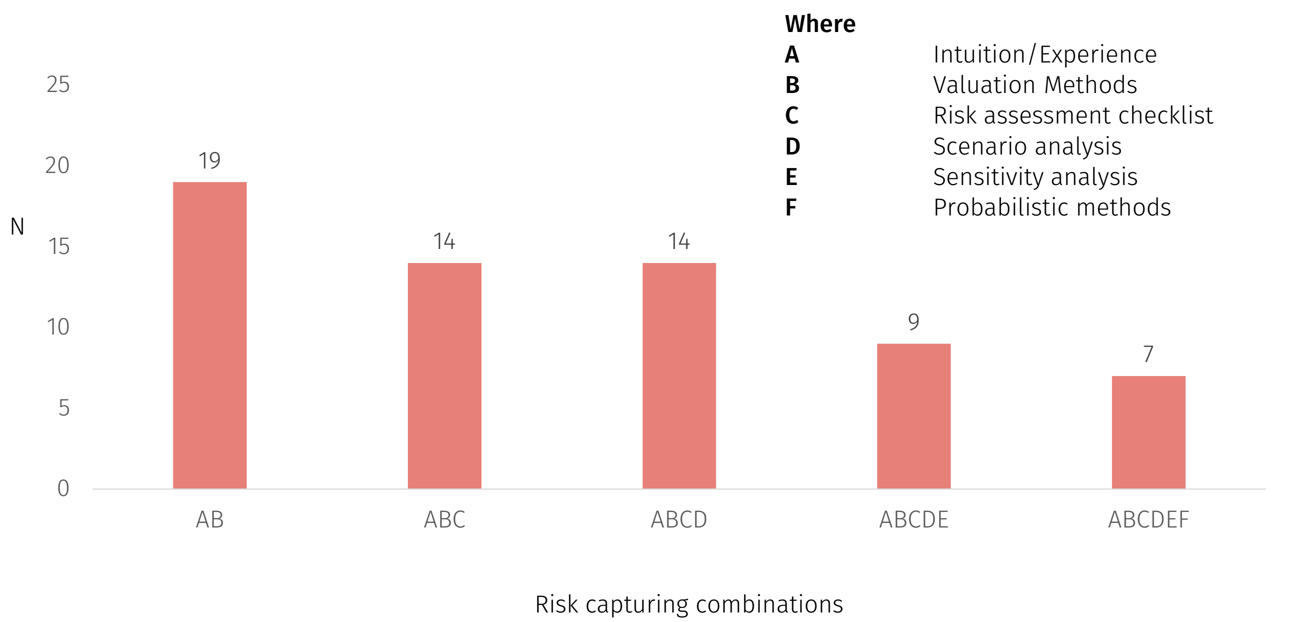


Figure 4.4 Most likely combination of techniques. Author

A large sample of participant HA's (18) observed not knowing whether an alternative method could be used to capture risks in investment forecasts. 5 participants mentioned that an alternative method was needed to capture gaps in the current methods used. The gaps identified related to such risks as land acquisition.

HA24 *"Risk assessment methods need to have weighting on the aspects of land acquisition, finance and feasibility."*

HA12 *"We map risks out in detail per project, but generally there is no direct relationship between risk and the required planning volume at portfolio level thus coarse plans are usually made based on the phase of the project and whether an environmental permit is granted."*

4.2.2 Gaps and mismatches in risks appraisal for investment forecasts

Supervisory bodies indicated that the investment forecasts lacked realism and investment predictions of new build plans by HA's as filled in the dPi are too optimistic.

D-005

> *"The plans of HA's are too ambitious. It's too optimistic and it's not realistic when they fill it in, so it becomes a bouw wave meaning they just keep postponing plans. Our observation (AEDES) is overprogramming is the cause, that's just planning too much because you already know some projects will be delayed. So, we are concerned that the dPi information are just plans and are not achieved. It's hard to address what is the reason behind it, but what we do know is that, like you see it in the last 5-6 years is that the numbers in the dPi are never realized, so if you take the numbers of the second year its almost always half of it and it's just a wave that is pushing forward it."*

It was also noted that overprogramming occurs because investment forecasting is conducted at a financial budgetary level and that two separate plans existed ie internal planning and external budgetary planning.

D-005

> *"And we already asked, you know, like a small group of housing associations, so how are you planning? What do you fill into the dPi? Is it realistic planning for your project or is it like another planning just for the dPi and so in a couple of housing associations said yeah, we have a couple of planning for our own internal planning, and we then plan for the dPi to ensure ratios and statements are okay? And they are different. Because the dPi is more budgeting financial forecast tool, and their internal planning is more project management."*

Additionally, it was noted that HA's make performance agreements with local and national governments which are in turn not connected to the internal planning activities of projects on the ground.

D-003

> *"The investment forecasts are part of the play of saying to the local government, I can do it. And hoping that the local government will deliver the land. But of course, the play is necessary for strategy planning, but you cannot do that play next to the multiyear budget because multiyear budget should be about what I am really going to realize. It's not about well when everything comes good and everything will be very lucky, so it feels a bit fictional these plans."*

D-004

> *"A taskforce also recently investigated that concluded that one of the problems is that yes, the housing associations should have put in only plans which had been approved by the municipality at a permitting level and not just at an agreement level."*

It was noted that all risks were included in the risk appraisal process of forecasts. The top risks (out of 10) prioritized by HA's DPIs forecasts for DPIs for inclusion in the DPI were found to be return requirements (9.26) and performance agreements (8.0). Fiscal risks (7.66), interest rate changes, salaries and labour costs followed, respectively. The medium resolved risks were permit applications, building cost rises (4.26), land acquisition (3.26) and objection by local communities (3.10) with the least being tendering for contractor (2.2), site preparation risks (2.07), presale percentages (1.46) and construction delays (1.36) as per figure 4.5.

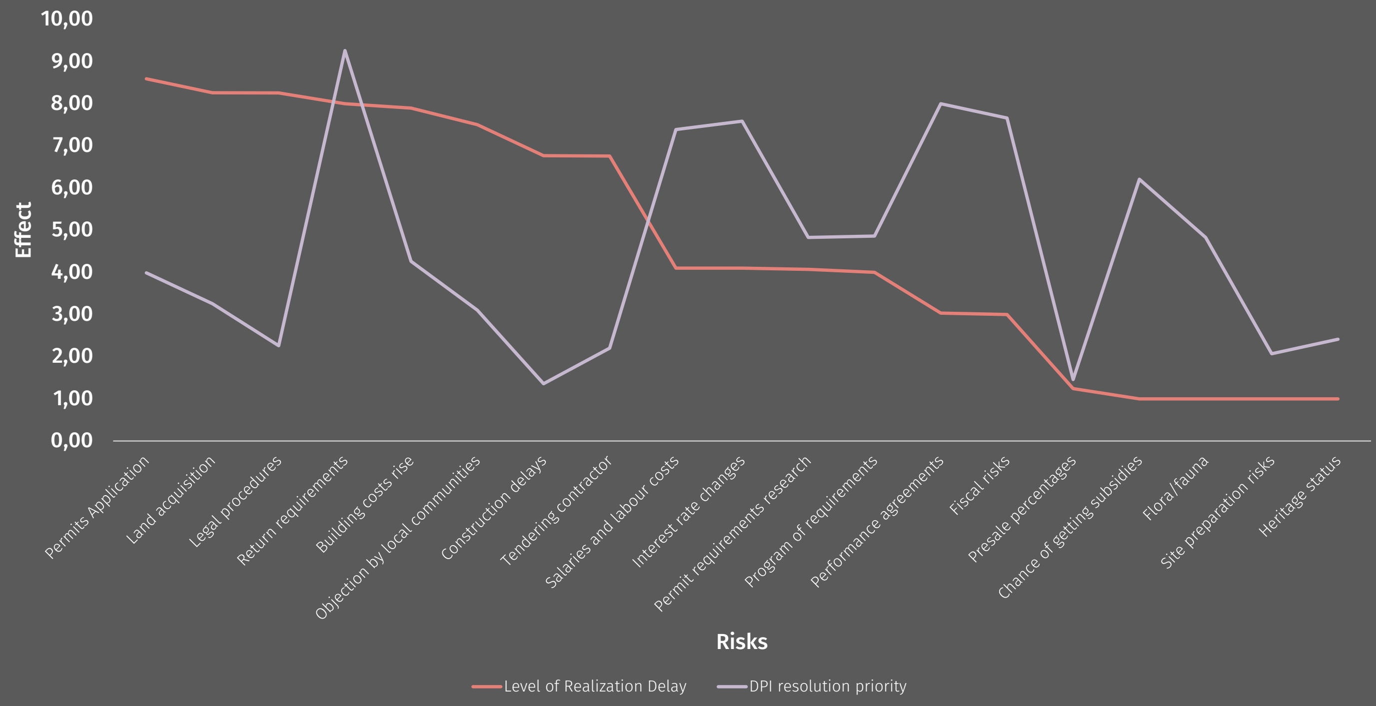


Figure 4.5 Top project delaying risks vs. priority of resolution for DPI. Author.

When the activities of HA's in the real estate development process are plotted against when they occur, HA's divide activities into two main phases i.e., phase 01 inclusive of initiation and feasibility and phase 02 inclusive of plan development and realization as per figure 4.6.

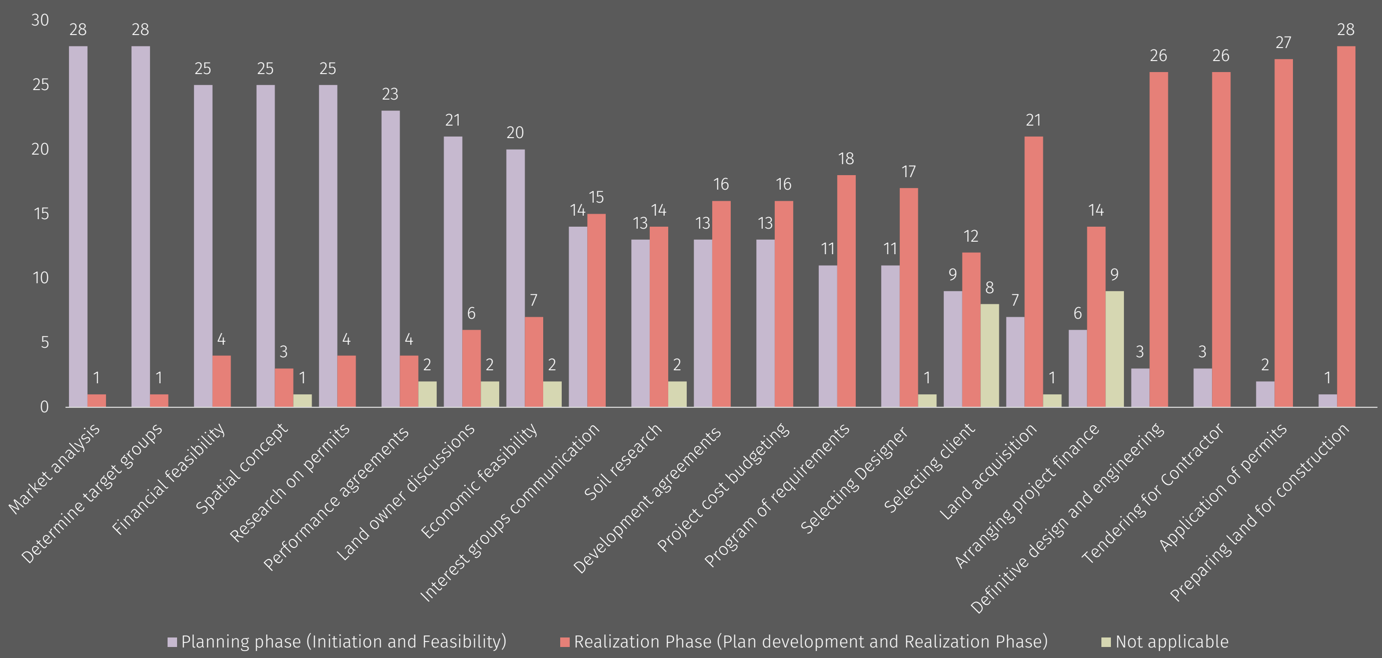
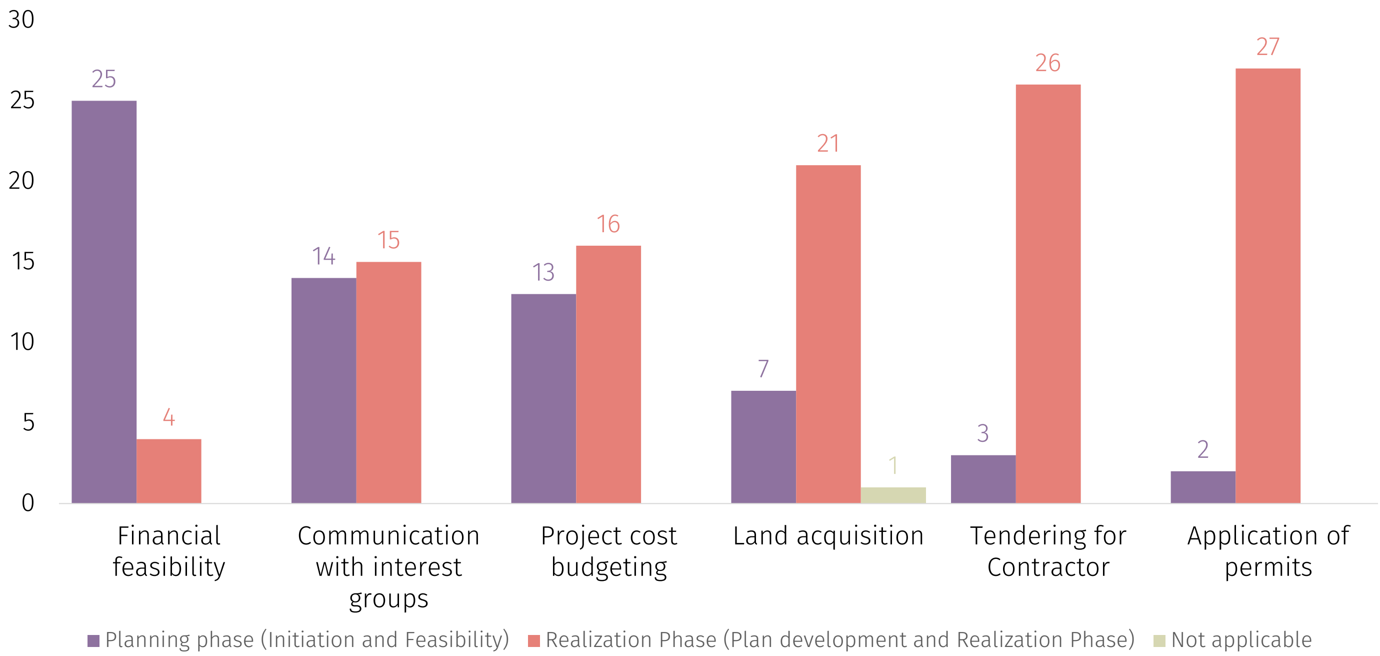


Figure 4.6 Timeline of activities of HA's in the real estate development process (N=29). Author

When the top delaying risks are isolated within the timeline, it is found that financial feasibility risks which are systematic risks occur almost exclusively in the first phase (25) of real estate development process. Unsystematic risks (land acquisition (21), tendering for contractor (26) and permit applications (27) occur mostly in the second realization phase. Building costs risks tend to occur in both first (13) and second phases (16). Communication with local communities also occurred in both first (14) and second phase (15). The results are summarized in figure 4.7.

Figure 4.7 Delaying risks placement in the investment delivery lifecycle. Author



4.3 Solutions to gaps in risk appraisal of investment forecasts

4.3.1 Supervisory Bodies perspective

The oversight bodies proposed several solutions for the current optimism and inaccuracies in new build investment forecasting. First, it was widely acknowledged that the dPi in its current form is sufficient to manage the financial activities of HA's at a sectoral level and to ensure they remain healthy. Supervisory bodies also make periodic inspections and soft interventions to steer the behaviour of HA's. It was also proposed that any solutions should carefully integrate the existing data as more information would create administrative burden which the oversight bodies and HA's have jointly worked to eliminate.

D-003

> *"So, I feel the DPI/DVI is sufficient to see if there's continuity in that aspect. It's not sufficient if you really want to know what's going on with the plans. But then as an authority, we have a risk-oriented oversight which means that we only dive into something in more detail if we think there is a potential risk. Otherwise, we would need more information which would cost more time to provide for the HA's and for us to manage. So, we always think about a lot of this when we ask for data. Also, the more information you ask the less accurate it gets."*

Oversight bodies desired interventions that would make the investment forecasts more realistic. Realism of investment forecasts is defined as planning that realistically looks at all the risks that limit production of homes and includes them in the prediction process to only propose plans that have a chance of realization within the time that they are planned.

D-005	*"I think housing associations should be more realistic because when you are realistic about what you can really do, it also makes it visible when there is a problem. Because if you say you want to build 30,000 a year, but only know you can realistically only build 20,000 then it is good to make that clear."*

Realism of investment forecasts is proposed by adding specific project related information to the dPi. This information will make plans feasible through adding information on permit status of projects, land ownership position, contractor appointments or possibilities of the same, status of local stakeholders' discussions, among others. Such realism in the prediction data is sort to go beyond the solitary perspective of financial capacity in the dPi as a performance measure to documenting and quantifying project related information and risks and how these can affect realization of plans.

D-002	*"We argue that the housing associations themselves should provide more realistic investment information in the dpi. That means that they stop with putting in all the plans they have. And instead provide their own estimation about what they expect to realize in the years of the multiyear budget. To get this estimation they must consider what is needed to get the ground position, the municipal permits, how many hours are needed, etcetera and also considering possible delay."*
D-005	*But the main question is whether they already have a permit or not, or how far in the process are with the plans, it will be very hard because if you still do not have a permit and you still must build the whole project. It is almost impossible to realize it in 2024 if it is planned in 2022. I think you can say you have to ask that in the dPi so that in the "activity overview" section to also do a field for example for permit status, if construction has started, if a contractor is available, land etc. That will really help, of course, to get a good insight in where we in the ambition in in the realization are."*

Other solutions proposed were that more research needed to be done at a sectoral level to for example see the impact of permits, land availability and other risks specifically to the prediction of social housing.

4.3.2 Using construction budgets to calculate time effect risks

The expert review session revealed that Portaal's project managers incorporate the effects of time delays in their forecasts. To tabulate the risk effects to the budget (for example a project that is likely to be delayed by 3 months) Portaal multiplies construction budgets by the number of delayed months and the indexed impacts of either fees, labour, or inflation rates. For this reason, the financial loss effects of delayed projects not delivered within the time proposed are measured using the indexed construction budgets.

Additionally, at a strategic level, Portaal also takes risk percentages for projects in early stages e.g., projects at the initiation phase are considered more risks than projects with more resolved project parameters. This captures the financial uncertainty of projects on the early stages and takes percentage of delay into account and this ensures Portaal reaches its original set forecasts.

4.3.3 Operationalizing qualitative risks to quantitative indicators

Table 4.1 Operationalization of qualitative risks to indicators. Author

The qualitative risks that cause delay in time were expressed as quantitative indicators to effectively quantify time effects of risks. The results of the expert review session are summarized in table 4.1.

Risk variables	Inclusion logic	Quantitative indicators
Permit procedures	*Multifamily apartments (MGW) vs single family apartments (EGW). Multifamily apartments are likely to take longer as they encounter resistance from local communities and municipal regulations due to requirements like parking, public space, views etc.*	**Property type: Multifamily Homes (MGW) vs Single family Homes (EGW). (X1)** **Number of Homes (X3)**
Land acquisition procedures	*Demolish and build projects were noted to be more complicated than building in empty land thus take longer time to acquire permits due to need to relocate existing tenants, apply for extra permits etc. Demolish and build projects were also likely to be already owned by Portaal and hence land was in possession without need for acquisition. New build projects required land acquisition in some form or land partnership agreement with a developer or municipality.*	**Construction type: New Build (1) vs Demolish and Build (0) (X2)**
Contractor processes (appointment and construction delay)	*Size of project determines the complexity of permit applications as big projects need environmental impact assessments etc.*	**Construction budget (X4)**
Municipal capacity	*Location of project by municipality lengthens or delays project time due to the capacity of the permit department, real estate development teams and policy of the municipality towards social housing production.*	**Municipality (1,2,3,4 ......n) (X5)**
Building costs changes	*Changes in construction costs affected the time it took for contractors to deliver projects. Rising costs made construction planning tight to mitigate labour and material costs and vice-versa.*	**Input price index (2000=0) (X6)**

It was hypothesised that a linear relationship existed between the indicators or risk factors that affected how long new build projects took. A multiple regression was constructed using the indicators provided in the data set to predict Total Project Time via Property type (x_1), construction type (x_2), Number of homes (x_3), construction budget (x_4), Municipal location (x_5) and input price index (x_6). The descriptive statistics of the data set provided by Portaal with a valid N value of 57 is summarized as per table 4.2.

Table 4.2 Descriptive statistics continuous variables. Author

	Variable type	Indicators	Freq. (n=57)	Relative frequency	Min	Max	Mean	Std. Dev
Total project time	Dependent				0.76	15.5	5.6	3.4
Number of Homes	Independent				4.0	255.1	67.1	49.9
input price index	Independent				31.9	76.9	46.8	10.6
Building cost/ mln	Independent				0.6	36.1	10.7	7.4
Municipality	Independent	Utrecht (1)	15	26.3				
		Leiden (2)	10	17.5				
		Arnhem (3)	7	12.3				
		Eemland (4)	8	14.0				
		Nijmegen (5)	17	29.8				
Property type	Independent	Single family home (EGW) (0)	20	35.1				
		Multifamily Unit (MGW) (1)	37	64.9				
Construction type	Independent	Demolish Build (0)	14	24.6				
		Newbuild (1)	43	75.4				

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, $p < 0.05$. Regression coefficients and standard errors can be found in table 4.3.

Table 4.3 Regression coefficients and results. Author

Model	**Total project time**	**B**	**SE B**	**Sig.**	**95% CI** LL	UL	**R^2**	***δR^2***
1							**0.421*** **	**0.310**
	(Constant)	7.837	2.509	0.003	2.790	12.884		
	Number of Homes	-0.020	0.015	0.200	-0.050	0.011		
	Input price index	-0.080	0.039	0.047	-0.158	-0.001		
	Construction type	-1.968	0.957	0.045	-3.893	-0.044		
	Building cost/mln	0.322	0.097	0.002	0.128	0.516		
	Property type	-0.291	0.867	0.739	-2.034	1.453		
	Municipality = 2.0 Leiden	2.796	1.273	0.033	0.235	5.356		
	Municipal = 3.0 Arnhem	-0.238	1.474	0.873	-3.203	2.728		
	Municipality = 4.0 Eemland	1.527	1.393	0.278	-1.275	4.329		
	Municipality = 5.0 Nijmegen	1.382	1.203	0.257	-1.039	3.803		

Note. *Model = "Enter" method in SPSS statistics; B =unstandardized regression coefficient; SE B = standard error of the coefficient; Sig = p value; 95% CI = 95% confidence interval for B; LL = Lower limit; UL = Upper limit; R^2 = coefficient of determination; δR^2 = Adjusted coefficient of determination; *p <0.05. **p<0.01. ***p<.001.*

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) + (β_3 x construction type) + (β_4 x municipality)

The stochastic decision model can be represented mathematically as:

Total project time (years) = 7.837 + (0.322 x construction cost) - (0.080 x input price index) – (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 can be represented in a stochastic decision tree model as per figure 4.8.

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

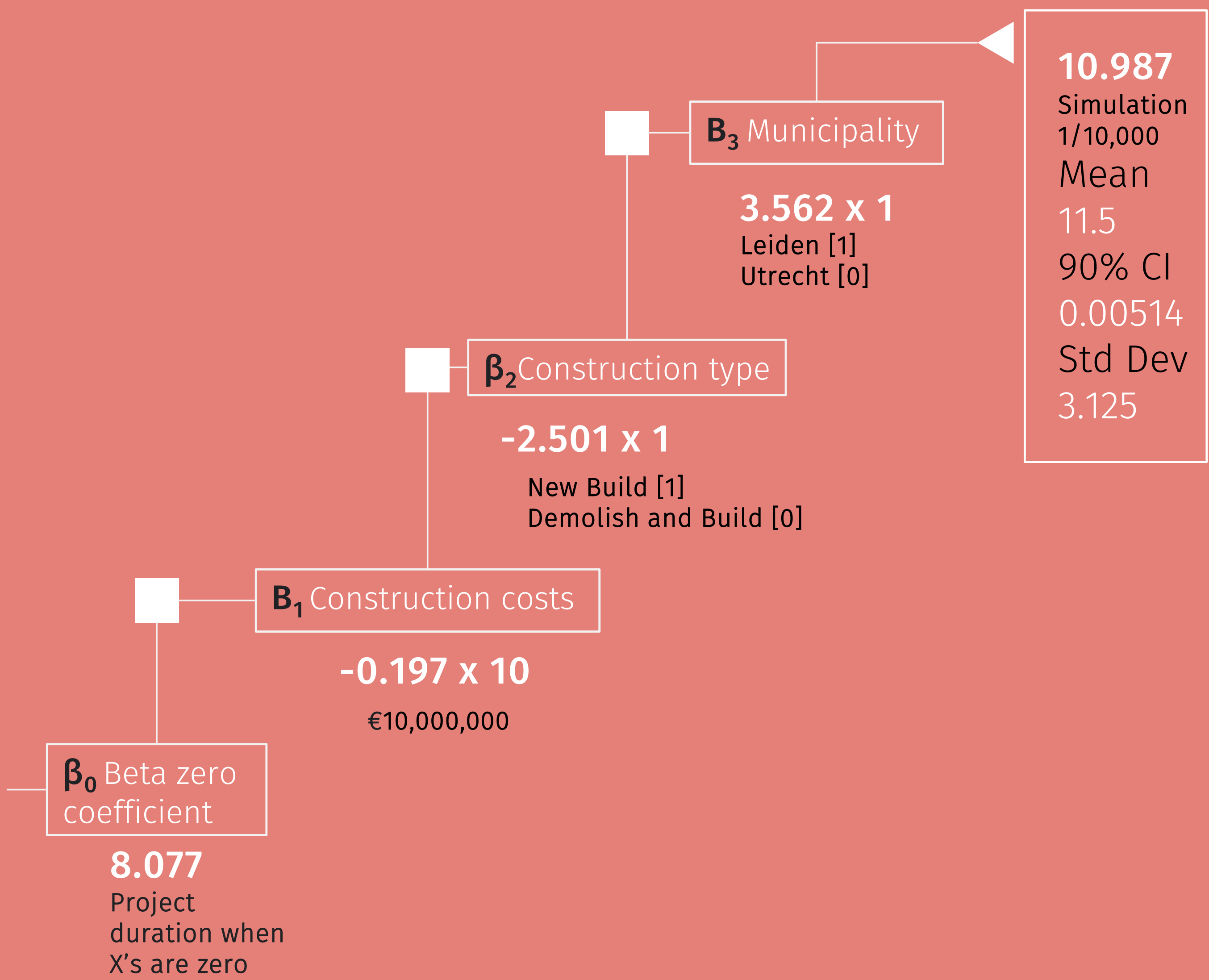


Figure 4.8 Stochastic decision tree model with regression results. Author

5 Discussion of findings

5.1 Restating the objectives

The purpose for this research was to explore how new build plans can be made more realistic by accurately predicting the delivery time of made forecasts. The following findings explore the discussion on risks that affect accurate prediction of delivery time by HA’s, how these risks are captured including gaps and available solutions and the observations of the alternative methods proposed.

New build investment forecasts of HA’s predominantly include financial budgets (operational, investment and financing cash flows), financial ratios, number of homes projected to be constructed. This information has been identified to be both financially and socially relevant to the goals of HA’s. Socially, the investment predictions are reviewed to ensure they meet standard set concerning affordability, availability, and quality frameworks. Financially, the predictions are used to establish what the available spending capacity of HA's is, what can be borrowed and how much investment a HA can undertake given its current financial performance. This is done by looking at past performance of a HA regarding the financial ratios, the cash flow and balance sheet position and the projected investment forecasts to determine current and future trends.

Investment forecasts therefore provide HA’s with insights into how certain the cash flows or predicted plans are when looking back at past performance. HA’s mention that this helps to measure plans against over or under programming and to see which new build investment priorities should be undertaken via feasibility studies. Supervisory bodies on the other hand mention that the forecasts help to ensure oversight of financial and social goals are achieved.

5.2 Perspectives of risk effects and appraisal

The research has signaled two perspectives of risks according to HA's.

The first perspective looks at the top risks causing delays in new build plans. The project delaying risks identified are complex 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. The opinion on these risks is shared by HA’s, supervisory bodies, and the experts.

The outcomes are also consistent with several authors in literature who have concluded similar results. Difficulties in acquiring land by HA’s from municipalities, developers or third parties often leads to cancellations in case land cannot be confirmed (Oudsten, 2021; van Os et al., 2021). Long permit obtaining procedures (including legal procedures, zoning changes, objection by residents) have been considered the leading causes of delays or abandonment of HA’s new build projects. Regarding rising building costs, financial requirements and long tendering procedures, AEDES (2019) 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 financial feasibility but also because tendering negotiations took longer because of the financial prerequisites.

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 by Gehner (2008), van Os et al. (2021) and Oudsten (2021). This research also indicated that municipalities lack resources like land, sufficient staff in permit approval and real estate development departments which tend to delay projects, a concern shared by Oudsten (2021) who indicates that 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 projects.

The second perspective is that HA's also perceive risks based on how they affect the social and financial goals of the HA's. Consequently, the top risks that affect financial and social goals include return requirements, building costs rise, salaries and labor costs, interest rate changes and fiscal risks. It is observed that the top risks on the financial and social goals risk appraisal focus on systematic risks but additionally are predominantly risks that directly relate to the financial component of new build plans. This effectively establishes a mismatch between time delaying risks (predominantly unsystematic risks like land acquisition and permit procedures) and risks that affect overall goals as perceived by HA's.

Forecast dPi information is perceived to be optimistic since it lacks specific project related information.

The mismatch is further compounded when risks appraisal techniques used by HA's to forecast new build plans are reviewed. It is observed that valuation methods in combination with personal experience is the most widely used method for capturing risks related to new build plans (figure 4.4). Supervisory bodies also observed that forecast information of HA's are meant to be "budgeting forecast tools" and lack information on whether projects are likely to be delayed by lack of land or permits. As a result, the forecast information is perceived to be optimistic since the forecast lacks the realism that comes with addition of specific project related information to the dPi.

This research also observed that HA's have a low priority when it comes to resolving the biggest new build delaying risks like building costs rise, permits procedures and land acquisition while risks associated to financial returns rank high on the priority list for resolution. This indicates that the focus lies on financial loss and not on time loss effects. Further, the results indicate that the forecast information can be made realistic by updating the status of investment forecasts with regards to such risks as permit status of projects, land ownership position, contractor appointments or possibilities of the same, status of local stakeholders' discussions, among others. Realism in the prediction data is proposed to avoid sole reliance on financial loss effects of risks towards also capturing the effects that time affecting risks could have. The results on adding realism to the forecast information matches the perspective of several authors (Park & Herath, 2000; Pless et al., 2016; Schachter & Mancarella, 2016) who indicated 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, they only capture financial loss effects of risks (Remøy et al., 2018).
The results indicate that the real estate development timeline includes several activities with two main stages i.e., 1st phase (initiation and feasibility), and 2nd phase (plan development and realization) with each possessing its own risks (figure 4.6). Risks that affect realization of new build projects for HA's are also found to belong to one of two phases in the real estate development cycle i.e., first or second phase. When the top delaying risks were isolated within the development timeline, it was found

that financial risks (systematic risk) occur almost exclusively in the first phase while unsystematic risks (long permit procedures, land acquisition, tendering delays, municipal incapacity, and contractor delays) occur 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 affect time which occur later in the development timeline. As a result, such risks are tackled in two separate phases. While financial requirements are calculated mostly in the first phase of the projects, time delaying risk like permit and land acquisition appear to be tackled in the second half of the project meaning that risks are tackled at static and separate moments in time. The results correspond with the perspective of several authors (Park & Herath, 2000; Pless et al., 2016; Schachter & Mancarella, 2016) who found that valuation methods when not combined with other methods assume that risks occur at a single point and assumes that projects are initiated and implemented as proposed. The result is that risk appraisal excludes risks that alter time to deliver projects leading to inaccurate predictions. Because predictions are inaccurate from the onset, the accuracy with which plans can be realized is also impacted leading to diminishing realization rates.

The findings have also suggested that inaccurate results weaken the ability of HA’s to realize set plans including decisions to increase new build homes matching the findings of Oudsten (2021) and Spelbos et al. (2020). This has been indicated to cause HA’s to reduce their plans. However, it is also noted that the opposite could happen where HA’s plan optimistically in anticipation of not realising their goals. This further causes HA's to reduce set plans leading to diminishing scope. A further consequence identified in the research of inaccurate plans is that because valuation forecasts rely on indexation of labour, fees or interest costs, inaccurate prediction of time could in turn affect the financial position of HA’s leading to unachieved social and financial goals.

In conclusion, it has been found that while all risks mentioned in the real estate development process are included, risks that affect the financial effects of new build projects are prioritized for resolution in dPi while time delaying risks are not systematically captured. The risk appraisal techniques also do not support time effects capture.

5.3 Quantifying time impacting risk effects

The addition of project level information to the calculation of investment forecast is proposed by this research to tackle the effects caused by the top identified time delayed risks. It is also noted that Portaal, an extra-large Dutch HA has been found to already have internal techniques in place of measuring the effects of risks on time delay of projects. By measuring the impact of interest rate, salary and indexations risks with the number of delays that occur in months, Portaal can qualitatively measure budgetary risks and therefore mitigate time delaying risks at a financial level. For this reason, it is observed that Portaal exhibits a relatively high build realization index of 92% on its new build forecasts. It was however noted in the sessions that while Portaal measure the impact of delay in projects, there exists no methodology to accurately measure duration of projects, thereby making the process of time appraisal quantitative and systematic.

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. This matches the perspective of Geuting & de Leve (2018) who noted that average lead time from start to sale of a home in the Netherlands was almost 10 years.

It was also found that when the input price index (when decision to tender was made) increased by one unit, meaning an increase in construction costs, the project time decreased by approximately a month (0.080 years). The reasons proposed for this were that real estate projects are generally accelerated at the construction stage when costs are high to achieve feasibility of labour and material costs. The opposite tends to occur in reducing costs where allowances in time are made to enable contractors and internal HA teams to spread their hours over multiple projects. The indicator provides HA's with the ability to review building costs as at time of decision to construct to explore time feasibility.

With every million euro increase in a project, the project time increases in the model by 0.32 years i.e., approximately 4 months. Because construction costs are usually a representation of the size of the project, larger projects with larger budgets tend to represent complex multifamily projects and vice versa. Subsequently, large projects tend to experience complex procedures associated with environmental assessments, complex local community discussions and area redevelopment processes which are likely to delay projects. It was however also noted that while increases in construction costs lead to increases in projects times, there is likely to be a tipping point where projects with larger budgets no longer have increase in projects times due to efficiency associated with large project organizations and systems. There is need thereof to review the tipping point to ensure accuracy of this variable across all construction cost points. The construction budget indicator is noted to be useful in determining the impact of budget to project time. The variable can assist portfolio managers to assess the budgets proposed by asset managers. This allows HA's to internally regulate for optimism in plans.

New build projects take off approximately 1.968 years off the total project time as compared to demolish and build projects. It was noted that projects involving demolition usually involve the relocation of tenants, applying for demolition permits and such extra regulatory requirements like asbestos research which tend to delay projects. The characteristics can therefore be used in weighing the delay time associated with empty or occupied land for building.

Projects in Leiden took 2.796 years longer than projects in Utrecht. It was indicated that projects in the municipality of Leiden are more complex to realize due to projects in Leiden being in inner city locations as opposed to outer locations in Utrecht. Building in inner-city areas is considered more complicated than developing extension locations. This is mainly due to its more central location. As a result, projects in inner cities like Leiden are seen to take longer. Further, it was indicated that Utrecht is a large municipality with well-developed municipal staff dedicated to real estate development projects in comparison to Leiden. The indicator for projects in Utrecht vs Leiden was noted as useful in differentiating time risks over the individual projects in different municipalities where projects in complex municipalities would get a standard delay when compared to plans in less complicated municipal locations.

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 model indicates that qualitative risks like land acquisition risks can be converted into qualitative indicators like Construction type. By finding the relevant project characteristics to quantitatively represent a qualitative risk, project time can be modeled to provide forecasts, thereby accurately representing the time it takes to deliver projects.

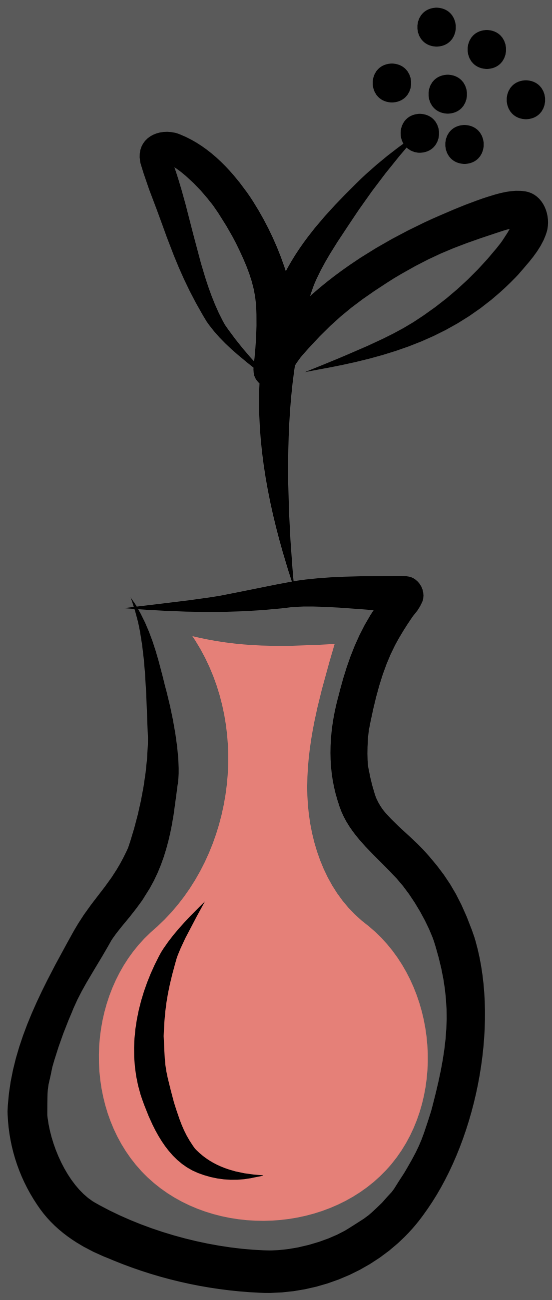
The experts noted that the model can help Portaal and other HA’s to determine the percentage of optimism in the budgets to counter-check against plans proposed by asset managers and financial controllers. By using the model, the number of years that a project with specific risk characteristics will take to realize can be determined.

Using the formula for risk adjusted investment forecast;

$$D = \frac{B}{t} \times n$$

Where:
D = risk adjusted investment forecast
B = Proposed construction budget
t = time predicted by the mathematical model given independent variables
n = Number of years desired in forecast

the time risk adjusted investment forecast budget D can be determined for the desired number of years. The model can assist in determining realistic projects times and budgets providing internal insight into the internal planning exercises of housing associations that are usually hinged on mostly financial loss effects. The model can also within the same spectrum, assist supervisory bodies to receive data that is time risk adjusted, which helps improve the quality of the dPi data received.



6 Conclusions & Recommendations

6.1 Conclusions

The purpose of the research was to explore how new build plans can be made more realistic by accurately predicting the delivery time of forecasts.

Dutch HA's new build investment forecasts have recently been declining in accuracy with projects proposed in the forecast plans (dPi) delivered later than they have been proposed. As such, investment forecasts suffer from inaccuracies which denote that HA's are struggling to make accurate forecasts and have diminishing prediction power of their forecast plans. As a result, tenants must contend with long waiting times when promises for homes delivery are not met. Tenant organizations, local and national government also contend with disappointments from unrealized plans and are unable to accurately plan housing agendas when promised HA's plans of delivery deviates from the actual realization. Financial return requirements also rely on accurate prediction of project duration and as such inaccurate prediction of project durations impact financial feasibility of projects. This in turn leads to loss of social capital and equity leakage. The purpose of the research was to explore how new build plans can be made more realistic by accurately predicting the delivery time of forecasts. For this one main research question was proposed: "How can time to deliver new build investments of Dutch HA's be accurately forecast?" To answer this main question; three sub-questions were formulated: [1] What are the main risks that affect the accuracy of new build investment forecasting for Dutch HA's? [2] What are the current gaps in how such risks are integrated in predicting the delivery times of new build investment forecasts? and thirdly [3] How can the current gaps be resolved to improve the accuracy of new build investment forecasting?

Firstly, this research aimed to investigate the main risks that affect the accuracy of new build investment forecasting for Housing association. The data suggests that there are two types of risks (systematic and unsystematic) that affect the proposed time that it takes to deliver new build projects and affecting the accuracy of investment forecasts. Systematic risks were identified as building costs increases and return requirements. Unsystematic risks include long and complicated land acquisition processes (including lack of land), elongated permit procedures (objection by local communities, legal procedures, and zoning change complexities), long tendering procedures and delays occasioned by contractors. Additionally, municipal capacity was identified as a risk where the municipality lacked resources relevant for delivering projects on time including efficient permit approvals, lack of land and inadequate staff dedicated to implementing projects.

Secondly, the research sort to explore the current gaps in how delaying risks were currently integrated into the investment forecasting process of Dutch HA's. It was identified that the investment predictions of new build plans by HA's as filled in the dPi are too optimistic. New build plans are over-programmed meaning that more investment budgets and homes are predicted than can be achieved within the time that is proposed. The plans struggle from lack of incorporation of elements like availability of land, permits and contractor appointments which are factors that could delay projects. Additionally, risk appraisal processes by HA's rely on valuation methods that are efficient at capturing financial loss effects but lack the ability to capture time. Moreover, systematic risks like financial feasibility are captured in a separate time frame (first phase) while unsystematic risks are captured mostly in the second phase meaning that the risks are not captured collectively when making forecasts.

Thirdly, the research sort to explore how the current gaps can be resolved to improve the accuracy of new build investment forecasting. It was found that the systematic and unsystematic risk effects on time need to be integrated into the investment forecasting process for the plans to retain accuracy of delivery. Aspects like whether projects have permits, access to land and confirmed building costs need to be captured or recorded to ensure oversight that projects remain accurate and realistic. Additionally, it was found that these risks manifest themselves as project characteristics. As such, time delaying risks can be represented as project indicators like municipal location, construction budget and property type (new build or demolish and build). These indicators exhibit a linear relationship with total project time to deliver new build projects and as such, linear modeling can be used to access the impact of specific risk factors and predict the time taken to deliver projects. Further, a stochastic decision tree model that incorporates the effect of risk derived from the linear model, using Monte Carlo Simulation, can be used to predict the risk adjusted time and investment budget forecasts. This approach fills the gap in the current valuation methods that lack the loss effect on time.

To accurately predict new build investment plans, risks techniques and processes need to acknowledge the role of both systematic and unsystematic risks and their impact on both financial and time loss effects. Additionally, financial return requirements also rely on accurate prediction of project duration and as such inaccurate prediction of project durations impact financial feasibility of projects and in turn the financial health of HA's.

6.2 Recommendations

6.2.1 Recommendations for implementation

The results of this research have multiple important implications for HA's and supervisory stakeholders. In general, the research brings new build time affecting indicators to the fore of investment forecasting. This is needed to be able to accurately predict time to deliver investment forecasts. The research indicated that total project time can be predicted by looking at project specific characteristics like number of homes, municipal location, construction type and construction budgets. Currently Dutch HA's struggle to plan new build investment forecasts accurately with the latest figures showing that 40% percent of investment forecasts' delivery times are incorrectly diagnosed (van Os et al., 2021).

Inaccurate prediction of delivery times has been noted in this research to cause higher uncertainty about the future predictions of new build investments proposed and makes the data in dPi inaccurate for oversight, policy making and sectoral management by oversight bodies (AW & WSW, 2018). Reduced investment forecasts also means that the earning capacity of HA's reduce which in turn leads to a loss of social capital and equity leakage (AW & WSW, 2018). Such impacts affect the amount of spending space for HA's and the guaranteed margins financial institutions are willing to offer when guarantee funds see that proposed past plans are never realized. The result is a perpetual reduction of scope and increasingly reduced investment forecasts due to diminishing liquidity (Spelbos et al., 2020). Inaccurate delivery time predictions for projects also lead to disappointments among tenant organizations, local and national government due to unachieved proposed investment forecasts while potential tenants also have to contend with inaccurate promises of uncertain waiting times for access to social housing (van Os et al., 2021).

Supervisory bodies including AW, WSW, AEDES and BZK can prioritize the collection of project specific information to better understand the intentions of HA's in their new build investment forecasts. For example, to understand the impacts of permit procedures, information as to whether planned projects need to go through zoning changes, have to be negotiated with local communities or need to go through environmental impact assessments is useful to determine project times. This information will at face value determine whether projects will take the longer or the shorter route of delivery. Information regarding land ownership (e.g., owned, or in the hands of third parties) could provide insights into the contribution of this variable to project duration. Plans in the dPi can also include information on whether the contractor has been appointed, if building costs are fixed or indexed and the municipal location of projects.

For HA's, the research provides alternative ways to assess risks in a quantitative way in addition to traditional valuation methods. The model that has been developed can be used for example by Portaal or HA's with similar portfolio and location make-up to determine potential project times during investment forecast prediction. While the developed linear regression model is not widely generalizable, it provides a framework to quantify risks and predict investment forecasts more accurately. The results of this research can be useful for HA's that are looking for means to quantify how risks like permit procedures and lack of access to land affect investment forecasts. Because only two municipalities in the Netherlands were statistically significant to the null hypothesis, the model could be especially as an advice for HA's with homes or projects in these regions to quantify investment forecasts.

The research also provides opportunities for Ortec Finance as a company that helps HA's to manage their investment decisions. Because Ortec Finance provides the technology and solutions for risk and return management for HA's, this research provides a starting point for data analysis and development. The research has indicated several included and excluded project specific characteristics that affect or could affect project time and the accuracy of investment forecasts. With additional analysis of project level data from large data sets that Ortec Finance has access to, the relationships between several project level information could be investigated to find definitive regression models that are more generalizable and can accurately predict project time within smaller standard deviations of error than exhibited in this research. The research therefore should be seen as a commencement to be further adapted and improved.

6.1.3 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 HA's as well. This can provide a holistic picture of investment forecast in the Dutch housing sector.

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, FTE of contracting company, Volume of production of construction company and Tendering method used. Future research should also explore whether the use of larger datasets at a sectoral level indicates linear relationships between the independent project characteristics and the dependent delivery time.

Future studies should consider the role of internal planning of HA's in delaying project delivery. For example, collecting data on projects that delayed in board approvals, that changed staff compositions or experienced delay in finance application process can be used to derive such relationships and correlations. While this research indicated that such risks are minimal and confined to less than three months, with regression models this can be effectively quantified to determine the impact to the overall process.

Finally, in relation to the methodology, this research is based on a qualitative survey based 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 risks that affect time at a more quantitative level. Such a study would facilitate the comparability between the sectoral perspectives of various HA's to tailor future models specifically to the characteristics of a HA including its portfolio and organizational makeup.

6.1.4 Summary of conclusions

In summary, the research explored how to capture unsystematic risks that cause delays in new build plans of Dutch housing associations and make their investment intentions inaccurate. First, the research indicated the key risks that affect HA’s in their planning process as permit procedures, lack of land positions to build, contractor appointment and in construction delay risks, rise in building costs and municipal incapacity exhibited by lack of land positions, efficient permit approval times and proper development teams at municipality level.

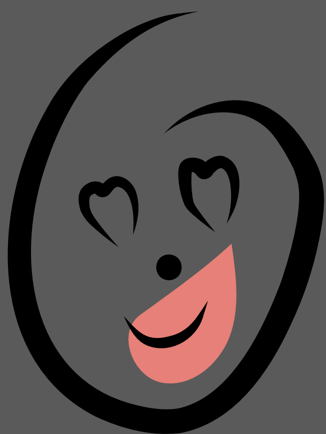
To accurately forecast new build investment plans, HA's risk appraisal processes must incorporate both time and financial loss effects in forecasts.

The gaps found out in the way housing associations plan their investment forecasts was first that while HA’s incorporate such risks on their assessment, they do not include the time risks and only calculate the financial impacts. 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 unsystematic risks that cause delay into project specific characteristics that can be quantified and used in a regression model to establish linear relationships between project time and the various characteristics indicated in the research as construction budget, municipality location, the input price index when decision to build was made and finally the construction type i.e. whether a project was on empty land or had to be demolished and rebuilt. 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 time frame 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, as a result, a HA's financial health.

7 Reflection



7.1 Research position within Master track

The research is undertaken as part of the Management in the Built Environment track of the MSc Architecture, Urbanism and Building Sciences program at TU Delft. The study is affiliated with the housing management department, which researches solutions for managing and redeveloping the housing stock to improve housing's socioeconomic and environmental sustainability. In this line, the research focuses on the risks that affect time it takes to develop new social housing in the Netherlands by Dutch HA's within the context of new build investment forecasts. The research provides information to support HA's and supervisory bodies in relation to their investment forecast and oversight tasks accordingly. This is with a goal to making investment activities more realistic.

7.2 Relevance

8.2.1 Academic relevance

Academically, the research is relevant in as it highlights the gaps that exist in valuation methods as a risk appraisal technique to plan new build investment forecast by HA's. The study adds to literature by highlighting that such methods, while strong at highlighting financial loss effects of risks, do not effectively capture time loss effects and therefore are inherently incomplete in their risk appraisal process. The research also contributes to knowledge that evidences the role of probabilistic techniques like stochastic decision tree analysis (resulting from DTA, MCS and MLR) can be used to predict time taken to deliver projects. This subsequently provides new insights into risks that affect delivery of new build projects within the Dutch housing sector and techniques available to resolve such risks.

8.2.1 Industry relevance

Additionally, the research has practical contributions regarding first, the overview of systematic and unsystematic risks that affect the delivery time of new build forecasts for Dutch HA's. This information helps to create awareness about the biggest qualitative risks that affect delivery of new build projects within the time they are forecast. The information can therefore be used by supervisory bodies and HA's to review and mitigate their impacts on time loss. The developed model also indicates that qualitative risks have quantitative indicators that have been proved to have linear relationships with project time. Supervisory bodies can use this information to closely monitor investment forecasts against such risk criteria. HA's can additionally pay attention to risk appraisal techniques to ensure they not only capture the financial loss effect of such risks but also to time loss effects as this has been indicated to cause inaccurate forecasts.

8.2.1 Corporate relevance

The study is also valuable for Ortec finance who are a company that creates software and decision models that help with investment forecasts. The research establishes a linear relationship between systematic and unsystematic risks and time taken to deliver projects. Such information is useful for the company since it is looking for a way to use project level data to make investment forecast predictions more realistic to combat overoptimism of forecast by HA's.

7.3 Research method and approach

8.3.1 Literature Review

The initial step of the research which incorporated a lot of existing literature research conducted on the strategic management and investment forecast processes of Dutch HA's was important in laying the basis for the empirical study. The literature review established the theoretical framework and expanded the notions of systematic and unsystematic risks and how they affect project delivery time which was the manifestation of new build investment forecasts. Additionally, techniques available in literature helped to identify ways in which the gaps in risk appraisal techniques could be resolved. The literature review included several scientific authors, government reports, journals, books, and website publications which were both private and governmental. Multiple iterations of the literature review were made with the initial draft as at P2 level containing the main authors that would be referred to for the most part of the research. By formulating main authors and concepts, further concepts were developed with time which, when aggregated, culminated in a theoretical framework model that reflects the conclusion of this research.

8.3.2 Mixed Method

The empirical research was planned as both a qualitative and quantitative process. For the qualitative part, starting the process of discussing with industry experts was beneficial to be able to understand the subject matter. The Dutch public housing is a highly specialist field with a lot of jargon, rules, accountability mechanisms and institutions and makes the field difficult to fathom, even for people who have experience with real estate development, investment, and spatial planning. Initial discussions with sectoral experts from BZK, Aw, WSW, AEDES and managers from HA's and Ortec Finance assisted in understanding the field better before commencing the research. The subsequent surveys and in-depth interviews built had been pre-discussed beforehand to ensure clarity. While this proved to be quite time consuming, it helped to resolve clarity of data collection and ensured that misinterpretations especially regarding terminologies that are natively inherent in the social housing sector, were correctly used.

The data collection of the survey was also initially intended to have a larger sample (70) but eventually due to non-response involved 29. This meant that the analysis of the data couldn't be conducted parametrically and as such a none-parametric method was used. While this method proved to be more time consuming than the initial method, it was useful to gather insights on systematic and unsystematic risks that affected delays in new build projects and further led to more in-depth discussions in the expert review stage and responses included text formats that also provided more insights. In retrospect, while a parametric analysis would have been initially desired, the non-parametric method provides in-depth insights about the identified concepts but also led to more concepts emerging beyond just identifying the risks. As such the results have been enriched by qualitative data that yielded significant information beyond the initial study's intended scope.

7.4 Research process and planning

Time planning was very important for this research. The most important step was finding a topic and a mentor early in advance. As such discussions with my first mentor, Ellen Geurts, began three months before the thesis research officially began. This allowed the research topic to develop in earnest before commencing. Further, the project planning was made always in conjunction with the methods and future dates set in advance with expectation for these dates laid out. This helped to keep output delivery clear and to guide towards a specific target.

The data collection proved especially challenging since most of the information was sensitive financial information and trade secrets. As such, several permissions had to be granted especially from Ortec Finance to access contact lists which proved to be time consuming. In this regard, contacting the prospective participants in the initial phases of the empirical research helped a lot to already establish rapport. Further, potential participants for the survey were given specific timelines within which to express interest of participation to avoid delays caused by waiting beyond response days. This helped to keep timelines clear and avoided delays.

The quantitative research required quite adaptations to the project level data that was required to run regressions. This was because the information was either not collected or could not be sourced in time. As such, to resolve the gap, alternative characteristics were discussed and incorporated into the model to keep the regression extensive and useful with the data that was available. It was also important to provide Portaal, who provided the dataset, with a prior excel spread sheet that listed headers of information required. This helped avoid a lot of errors that come with datasets that must be cleaned. In retrospect, this saved a lot of time.

Practically, a lot of material for the research, both literature review, interviews, expert opinion sessions and survey had to be conducted in Dutch language as this was the main working language of the sector. I was lucky to have undertaken a Dutch language course (Delftse methode) in TU Delft prior to the research. This helped me to conduct such discussions that would have otherwise been very difficult to conduct. While modern websites and software now possess the capability to translate documents to any language, the added advantage of speaking Dutch, even at a rudimentary A2 level, assisted a lot to get to speed with the aspects required for this research.

In conclusion, a masters research process requires patience, determination, and most of all motivation. For this, the recurrent biweekly first, second and company mentor meeting proved very useful to keep me motivated. These sessions helped to give guidance, and to develop the research in small components. This helped to keep the research very practical, and expectations were made on weekly or fortnight bite chunks. This has helped a lot to create an orientation between the initial goals and the result.

8 Appendices

Appendix A: Interview protocol with Oversight Bodies

Participating organizations:

Ministry of the Interior and Kingdom Relations of Netherlands (BZK).
Autoriteit woningcorporaties (Aw)- Inspectie Leefomgeving en Transport.
Waarborgfonds Sociale Woningbouw (WSW).
AEDES (Vereniging van woningcorporaties.

Participating professional roles:

Data managers
Policy managers

Good day,

My name is Edwin Seda, I am from Kenya and I am currently working on my graduation research for the Master Management in the Built Environment at TU Delft. The research is also carried out as part of a graduation internship at Ortec Finance. I would like to ask you to help me with my graduation research.

What is my research about?
The Aw writes in the most recent State of Public Housing "investment intentions do not provide insight into future performance."

My research focuses on the forecasting capacity of new construction plans of housing corporations. The study looks at the steps and risks of real estate development that are included in the new construction budget plans of housing corporations.
I do this by looking at how a decision tree model helps in predicting the delivery time for new construction. This can help corporations to gain more insight into the duration of new construction projects.

How can you help?

I would like to ask you if you are willing to do an in-depth interview. The information collected will help build a decision tree model for predicting delays in new construction plan and budget allocation in the modeled timeline. The in-depth interview lasts a maximum of 1hour and will be recorded and transcribed. Afterwards, the recordings will be deleted.

Thank you in advance for your time and participation.

What are the Questions I will ask?

1. What is your name?
2. What is your role at your organization?
3. What are the key responsibilities of your organization with regards to HA's?
4. Which section of the dVi and dPi do you use and for what specific purpose?
5. What does your organization use the realization rate metric for? Do you find it useful?
6. Are there methods that you have used for example to make sure that newbuild budgeting plans are more realistic?
7. Do you think the dVi and dPi information as you get is sufficient to oversee performance of HA's?
8. What do you think can be changed then in how the data is reported by housing associations?

Appendix B1: Survey correspondence to HA's

Afstudeeronderzoek | Voorspellingscapaciteit van nieuwbouwplannen van woningcorporaties.

Goededag,

Mijn naam is Edwin Seda, ik kom uit Kenia en ik werk momenteel aan mijn afstudeeronderzoek voor de master Management in the Built Environment aan de TU Delft. Het onderzoek wordt ook uitgevoerd als onderdeel van een afstudeerstage bij Ortec Finance. Ik wil u vragen mij te helpen met mijn afstudeeronderzoek.

Waar gaat mijn onderzoek over?
De Aw schrijft in de meest recente Staat van de Volkshuisvesting "investeringsvoornemens geven geen inzicht in toekomstige prestaties." Mijn onderzoek richt zich op de voorspellingscapaciteit van nieuwbouwplannen van woningcorporaties.

In het onderzoek wordt gekeken naar de stappen en risico's van vastgoedontwikkeling die zijn opgenomen in de nieuwbouwbegrotingsplannen van woningcorporaties.
Dit doe ik door te kijken hoe een beslisboommodel helpt in het voorspellen van de oplevertermijn voor nieuwbouw. Dit kan corporaties helpen om meer inzicht te krijgen in de looptijd van nieuwbouwprojecten.

Hoe kunt u helpen?
Graag wil ik u vragen of u bereid bent om een online enquête in te vullen. De verzamelde informatie zal helpen bij het bouwen van een beslisboommodel voor het voorspellen van vertragingen in nieuwbouwplan en budgettoewijzing in de gemodelleerde tijdlijn.

Ter ondersteuning van dit onderzoek is een enquête ontwikkeld die 6 delen bevat en maximaal 10 minuten duurt.

Wanneer u wil helpen:
Wanneer u via deze link aangeeft dat ik u mag benaderen voor deelname, ontvangt u een link waarmee u de enquête kunt invullen:

Voornaam:
Achternaam:
Woningcorporatie:

E-mailadres:

Ik wil wel/niet deelnemen aan het afstudeeronderzoek:
Wel
Niet

Deadline voor bevestiging van interesse deelname: **14 maart 2022**
Deadline voor voltooiing van de enquête: **22 maart 2022**

Alvast hartelijk dank voor uw tijd en deelname.

Met vriendelijke groet,
Edwin Seda

https://nl.linkedin.com/in/edwinseda

Appendix B2: Survey protocol - HA's

1a Wat is uw naam?

1b Wat is de naam van uw woningcorporatie?

1c Wat is uw rol in de woningcorporatie?

1d Wat is het aantal fte's dat uw woningcorporatie had in 2021?

1e Hoeveel verhuureenheden (vhe's) heeft uw organisatie in bezit?

- ☐ < 1.000 vhe's
- ☐ 1.001-2.500 vhe's
- ☐ 2.501-5.000 vhe's
- ☐ 5.001-10.000 vhe's
- ☐ 10.001-25.000 vhe's
- ☐ 25.000 vhe's

1f In welke provincies in Nederland bevinden uw woningen zich? (Meer dan één antwoord mogelijk)

- ☐ Noord Holland
- ☐ Zuid Holland
- ☐ Friesland
- ☐ Groningen
- ☐ Drenthe
- ☐ Overijssel
- ☐ Flevoland
- ☐ Utrecht
- ☐ Gelderland
- ☐ Zeeland
- ☐ Noord Brabant
- ☐ Limburg

1g Waar in de bovenstaande regio's staan uw woningen?

- ☐ landelijke gebieden
- ☐ stedelijke gebieden
- ☐ beide

1h Welke van de volgende vastgoedtypes bezit u? Meerdere antwoorden mogelijk.

- ☐ Woningen
- ☐ Parkeerplaatsen
- ☐ bedrijfsonroerend goed (BOG)
- ☐ Maatschappelijk vastgoed (MOG)
- ☐ verzorgingshuizen
- ☐ garages
- ☐ wooneenheden voor ouderen
- ☐ Studentenhuisvesting

2a Is de berekening van het realisatiegraad nuttig in het meerjarenbegroting proces?
Ja
Nee

2b Hoe is de berekening van het realisatiegraad nuttig in het meerjarenbegroting proces?

2c Waarom is de berekening van de realisatiegraad niet nuttig in het meerjarenbegroting proces?

3a Welke van de volgende technieken gebruikt u voor risicoanalyse? Meerdere antwoorden mogelijk.

- ▯ Intuïtie/Ervaring
- ▯ Disconteringsvoet op basis van DCF Methode
- ▯ Checklist voor risicobeoordeling
- ▯ Probability Impact Matrix (PIM)
- ▯ Gevoeligheidsanalyse
- ▯ Scenario analyse
- ▯ Beslissingsboom analyse
- ▯ Verwachte monetaire waarde methode (EMV)
- ▯ Probabilistische methode, bijv. Montecarlo-simulatie
- ▯ Real Options Aanpak (ROA)
- ▯ Geen techniek gebruikt
- ▯ Ik weet het niet
- ▯ Onze methode staat er niet bij

3b Welke andere methode (niet genoemd in de vorige vraag) gebruikt u voor risicoanalyse?

3c Denkt u dat een andere risicoanalyse methode(s) nuttig kan/kunnen zijn voor risico analyse naast de methodes zoals gebruikt in uw organisatie?

- ▯ Ja
- ▯ Nee
- ▯ Ik weet het niet

3d Welke andere methode(s) denkt u dat nuttig kan/kunnen zijn voor risico analyse naast de methodes zoals gebruikt in uw organisatie?

3e Waarom voert uw organisatie risicoanalyse en -beheer? Meerdere antwoorden mogelijk.

- ▯ Financiële gevolgen
- ▯ Project Vertragende gevolgen
- ▯ Reputatie gevolgen
- ▯ Veiligheid gevolgen
- ▯ Gevolgen voor het niet behalen van gestelde doelen

4a Wat is uw perceptie van de effecten van de volgende risico's en neemt u deze mee in uw nieuwbouw budget berekeningen?

	Hoe beoordeelt u het risico Impactcapaciteit?			Neemt u het risico mee in uw budgetberekeningen?	
	Laag effect	Midden effect	Hoog effect	Ja	Nee
bouwkosten (stijging/daling)	☐	☐	☐	☐	☐
onderhoudkosten (stijging/daling)	☐	☐	☐	☐	☐
flora/fauna	☐	☐	☐	☐	☐
asbest	☐	☐	☐	☐	☐
juridische procedures	☐	☐	☐	☐	☐
vergunningen (bestemmingsplan, bouwvergunning)	☐	☐	☐	☐	☐
rente	☐	☐	☐	☐	☐
loon- en salaris inflatie	☐	☐	☐	☐	☐
vereisten marktwaarde en rendementen	☐	☐	☐	☐	☐
fiscale risico's	☐	☐	☐	☐	☐
belanghebbenden bezwaar	☐	☐	☐	☐	☐
bouwrijpmaken	☐	☐	☐	☐	☐
grondeigendom/erfpacht/lasten en bezwaren/grondvervuiling	☐	☐	☐	☐	☐
nutsvoorzieningen verbinding	☐	☐	☐	☐	☐
monumentale status	☐	☐	☐	☐	☐
programma van eisen (PvE)	☐	☐	☐	☐	☐
veiligheid en gezondheid	☐	☐	☐	☐	☐
contractering bouwer	☐	☐	☐	☐	☐
subsidiekans	☐	☐	☐	☐	☐
vertraging in bouwtijd	☐	☐	☐	☐	☐

4b Hoe gaat u om met de risico's die worden beschouwd als "hoog" risico maar niet zijn opgenomen in uw risicoanalyse (gebaseerd op vraag 4a)?

	Besluit inzake risicobeheer			
	Vermindering of eliminatie	Overdragen of delen	Vermijden	Aanvaarding
bouwkosten (stijging/daling)	☐	☐	☐	☐
onderhoudkosten (stijging/daling)	☐	☐	☐	☐
flora/fauna	☐	☐	☐	☐
asbest	☐	☐	☐	☐
juridische procedures	☐	☐	☐	☐
vergunningen (bestemmingsplan, bouwvergunning)	☐	☐	☐	☐
rente	☐	☐	☐	☐
loon- en salaris inflatie	☐	☐	☐	☐
vereisten marktwaarde en rendementen	☐	☐	☐	☐
fiscale risico's	☐	☐	☐	☐
belanghebbenden bezwaar	☐	☐	☐	☐
bouwrijpmaken	☐	☐	☐	☐
grondeigendom/erfpacht/lasten en bezwaren/grondvervuiling	☐	☐	☐	☐
nutsvoorzieningen verbinding	☐	☐	☐	☐
monumentale status	☐	☐	☐	☐
programma van eisen (PvE)	☐	☐	☐	☐
veiligheid en gezondheid	☐	☐	☐	☐
contractering bouwer	☐	☐	☐	☐
subsidiekans	☐	☐	☐	☐
vertraging in bouwtijd	☐	☐	☐	☐

5a Sleep de woorden in de volgende fasen en volgorde zoals gebruikt in uw woningcorporatie. Sleep naar "niet van toepassing" als u niet deelneemt aan de activiteit.

Fasen:

- Stap 01: Initiatiefase
- Stap 02:Haalbaarheidfase
- Stap 03:Planontwikkelingsfase
- Stap 04: Realisatiefase
- Niet van toepassing

Activiteiten

- Prestatieafspraken met bijv. Gemeente
- Financiele haalbaarheid
- Marktanalyse en haalbaarheidsstudies
- Grondverweving
- Ruimtelijk concept
- Bekijk markttrends en bepaal doelgroepen
- Definitief ontwerp en engineering
- Grondonderzoek Grondeigenaar discussie aankoop, en onderzoek bouwrijpmaken
- Uitwerking van het woningbouwplan (Ontwikkeling programma van Eisen)
- Selectie van ontwerper
- Aannemer selectie en contracten
- Selectie van opdrachtgever
- Onderzoek bestemmingsplan en vergunningen
- Aanvraag omgevingsvergunning
- Communicatie met belangengroepen
- Projectfinanciering regelen
- Samenwerkingscontracten bijv. ontwikkelaars, gemeente
- Analyse van de economische haalbaarheid
- Bouwkostenberekening

5b In welke mate leiden de volgende fasen tot vertraging en knelpunten in de procedure nieuwbouwontwikkeling?

	geen knelpunt	zeer laag knelpunt	laag knelpunt	gemiddeld knelpunt	groot knelpunt	zeer groot knelpunt
	0	1	2	3	4	5
Vaststellen beleidsdocument met daarin opgenomen dit nieuwbouwplan	☐	☐	☐	☐	☐	☐
Projectfinanciering regelen	☐	☐	☐	☐	☐	☐
Grondonderzoek	☐	☐	☐	☐	☐	☐
Grondverwerving	☐	☐	☐	☐	☐	☐
Haalbaarheidsstudie als grond als grond al eigendom is	☐	☐	☐	☐	☐	☐
Haalbaarheidsstudie door ontwikkelaar, als grond in eigendom is van ontwikkelaar	☐	☐	☐	☐	☐	☐
Haalbaarheidsstudie door uw projectmanager, met gunning uit de hand	☐	☐	☐	☐	☐	☐
Haalbaarheidsstudie door externe ontwikkelaar, met gunning uit de hand	☐	☐	☐	☐	☐	☐
Haalbaarheidsstudie door ontwikkelaar, in geval van tenderprocedure	☐	☐	☐	☐	☐	☐
Selecteren van de ontwikkelende partij als grond als grond al eigendom is	☐	☐	☐	☐	☐	☐
Selecteren van de ontwikkelende partij, in geval de eigenaar van de grond niet	☐	☐	☐	☐	☐	☐
Uitwerking van het woningbouwplan (Ontwikkeling programma van Eisen)	☐	☐	☐	☐	☐	☐
Bestemmingswijziging naar functie wonen	☐	☐	☐	☐	☐	☐
Onderzoek bestemmingsplan en vergunningen	☐	☐	☐	☐	☐	☐
Verlenen omgevingsvergunning	☐	☐	☐	☐	☐	☐
Communicatie met belangengroepen	☐	☐	☐	☐	☐	☐
aanbestedingsprocedure (ontwerper, aannemer,opdrachtgever)	☐	☐	☐	☐	☐	☐
Behalen van benodigd percentage voorverkoop	☐	☐	☐	☐	☐	☐
Aanvang bouwwerkzaamheden tot oplevering laatste woning nieuwbouwproject	☐	☐	☐	☐	☐	☐

appendix

5c Aan welke van de volgende vereisten moet uw woningcorporatie voldoen om een nieuwbouwproject van een "zachte" naar een "harde plancapaciteit" te verplaatsen? Meerdere antwoorden mogelijk.

- [ ] Prestatieafspraken met bijv. gemeente of huurdersverenigingen
- [ ] Financiele haalbaarheid rapport
- [ ] Marktanalyse en haalbaarheidsstudies rapport
- [ ] Grond in bezit of grondovereenkomst
- [ ] aanwezigheid ruimtelijk concept
- [ ] bepaalde doelgroep
- [ ] Definitief ontwerp en engineering
- [ ] Grondonderzoek
- [ ] Bouwgerijpd grond
- [ ] aanwezigheid Programma van Eisen
- [ ] aanwezigheid ontwerper
- [ ] aanwezigheid aannemer
- [ ] aanwezigheid opdrachtgever
- [ ] Gereed onderzoek bestemmingsplan en vergunningen
- [ ] aanwezigheid omgevingsvergunning
- [ ] medewerking van belangengroepen
- [ ] aanwezigheid projectfinanciering
- [ ] Samenwerkingscontracten bijv. ontwikkelaars, gemeente
- [ ] Economische haalbaarheid rapport
- [ ] aanwezigheid Bouwkosten
- [ ] Ons vereisten staat niet bij

5d Welke aanvullende eisen (niet genoemd in de vorige vraag) wilt u noemen die nodig zijn om een nieuwbouwproject van een "zachte" naar een "harde plancapaciteit" te verplaatsen?

6a Welke software wordt er in uw organisatie gebruikt om de nieuwbouwbegroting op te stellen en risicoanalyses te integreren? Meerdere antwoorden mogelijk.

- [ ] Microsoft Excel
- [ ] Zelfgebouwd systeem
- [ ] Speciale projectontwikkelingssoftware
- [ ] Speciale risicobeheersingsoftware
- [ ] Geen software gebruikt
- [ ] Onze methode staat er niet bij

6b Welke aanvullende software's (niet genoemd in de vorige vraag) gebruikt uw corporatie voor uw risicobeheer proces?

Appendix C: Sample survey List data

Number	Housing Association	Province	Size	Homes
1	Stichting Zayaz	Noord-Brabant	L	10.001-25.000 vhe's
2	Woningstichting Rochdale	Noord-Holland	XL	> 25.000 vhe's
3	Stichting Intermaris	Noord-Holland	L	10.001-25.000 vhe's
4	Stichting deltaWonen	Overijssel	L	10.001-25.000 vhe's
5	Domesta	Drenthe	L	10.001-25.000 vhe's
6	Stichting Parteon	Noord-Holland	L	10.001-25.000 vhe's
7	Stichting Volkshuisvesting Arnhem	Gelderland	L	10.001-25.000 vhe's
8	Woonstad Rotterdam	Zuid-Holland	XL	> 25.000 vhe's
9	Wonen Zuid	Limburg	L	10.001-25.000 vhe's
10	Woningstichting Eigen Haard	Noord-Holland	XL	> 25.000 vhe's
11	Stichting Portaal	Utrecht	XL	> 25.000 vhe's
12	Stadgenoot	Noord-Holland	XL	> 25.000 vhe's
13	Woningstichting 'thuis	Noord-Brabant	L	10.001-25.000 vhe's
14	Woningstichting Stek	Zuid-Holland	L	10.001-25.000 vhe's
15	BrabantWonen	Noord-Brabant	L	10.001-25.000 vhe's
16	HEEMwonen	Limburg	L	10.001-25.000 vhe's
17	Stichting Mozaïek Wonen	Zuid-Holland	L	10.001-25.000 vhe's
18	Woonwaarts	Gelderland	L	10.001-25.000 vhe's
19	Trivire	Zuid-Holland	L	10.001-25.000 vhe's
20	ZOWonen	Limburg	L	10.001-25.000 vhe's
21	Stichting KleurrijkWonen	Gelderland	L	10.001-25.000 vhe's
22	Stichting Woonconcept	Drenthe	L	10.001-25.000 vhe's
23	Stichting Havensteder	Zuid-Holland	XL	> 25.000 vhe's
24	Haag Wonen	Zuid-Holland	L	10.001-25.000 vhe's
25	Wooncompagnie	Noord-Holland	L	10.001-25.000 vhe's
26	Stichting Alwel	Noord-Brabant	L	10.001-25.000 vhe's
27	Stichting Elkien	Friesland	L	10.001-25.000 vhe's
28	Stichting Woonforte	Zuid-Holland	L	10.001-25.000 vhe's
29	Stichting Woonpunt	Limburg	L	10.001-25.000 vhe's
30	Stichting Actium	Drenthe	L	10.001-25.000 vhe's
31	Woningstichting Kennemer Wonen	Noord-Holland	L	10.001-25.000 vhe's
32	Pré Wonen	Noord-Holland	L	10.001-25.000 vhe's
33	Vivare	Gelderland	L	10.001-25.000 vhe's
34	Woonbron	Zuid-Holland	XL	> 25.000 vhe's
35	Stichting WoonCompas + Woonvisie	Zuid-Holland	L	10.001-25.000 vhe's
36	HW Wonen	Zuid-Holland	L	10.001-25.000 vhe's
37	GroenWest	Utrecht	L	10.001-25.000 vhe's
38	Casade Woonstichting	Noord-Brabant	L	10.001-25.000 vhe's
39	Welbions	Overijssel	L	10.001-25.000 vhe's
40	Vidomes	Zuid-Holland	L	10.001-25.000 vhe's
41	Stichting Nijestee	Groningen	L	10.001-25.000 vhe's
42	Woonwaard	Noord-Holland	L	10.001-25.000 vhe's
43	Stichting Woonbedrijf ieder1	Overijssel	L	10.001-25.000 vhe's
44	Woningcorporatie Domijn	Overijssel	L	10.001-25.000 vhe's
45	Stichting Woonbedrijf SWS.Hhvl	Noord-Brabant	XL	> 25.000 vhe's
46	Stichting Talis	Gelderland	L	10.001-25.000 vhe's
47	Stichting Wooninc.	Noord-Brabant	L	10.001-25.000 vhe's
48	Stichting Lefier	Groningen	XL	> 25.000 vhe's
49	Stichting Accolade	Friesland	L	10.001-25.000 vhe's
50	Woonzorg Nederland	Noord-Holland	XL	> 25.000 vhe's
51	WoonFriesland	Friesland	L	10.001-25.000 vhe's
52	Stichting Habion	Zuid-Holland	L	10.001-25.000 vhe's
53	Wonen Limburg	Limburg	XL	> 25.000 vhe's
54	Staedion	Zuid-Holland	XL	> 25.000 vhe's
55	Stichting Thuisvester	Noord-Brabant	L	10.001-25.000 vhe's
56	Stadlander	Noord-Brabant	L	10.001-25.000 vhe's
57	Woonstichting Leystromen	Noord-Brabant	L	10.001-25.000 vhe's
58	Stichting Acantus Groep	Groningen	L	10.001-25.000 vhe's
59	Stichting Mooiland	Noord-Brabant	L	10.001-25.000 vhe's
60	De Woonplaats	Overijssel	L	10.001-25.000 vhe's
61	Stichting Maasdelta Groep	Zuid-Holland	L	10.001-25.000 vhe's
62	Beveland Wonen	Zeeland	L	10.001-25.000 vhe's
63	Stichting WonenBreburg	Noord-Brabant	XL	> 25.000 vhe's
64	Stichting de Alliantie	Noord-Holland	XL	> 25.000 vhe's
65	Woonkracht10	Zuid-Holland	L	10.001-25.000 vhe's
66	Stichting Woonstede	Gelderland	L	10.001-25.000 vhe's
67	Mitros	Utrecht	XL	> 25.000 vhe's
68	Stichting Ymere	Noord-Holland	XL	> 25.000 vhe's
69	Waterweg Wonen	Zuid-Holland	L	10.001-25.000 vhe's
70	Stichting Woonplus Schiedam	Zuid-Holland	L	10.001-25.000 vhe's
71	Woonstichting De Key	Noord-Holland	XL	> 25.000 vhe's

Appendix D: List of oversight bodies in-depth interviews

Oversight bodies interviews conducted with the four main stakeholders (Ministry of Internal affairs and kingdom relations (BZK), Autoriteit woningcorporaties (Aw), Waarborgfonds Sociale Woningbouw (WSW) and AEDES Vereniging van woningcorporaties). These stakeholders oversee and lobby for housing associations. These organizations are responsible for the financial and social continuity of housing associations and lobbying and advice activities.

	Participant Code	Title	Role Description	Interview
D	D-001	Senior Policy advisor	Policy officer at the Ministry of the Interior at the Housing Market Department.	Online video call
	D-002	Coordinator and specialist advisor	Sectoral analyses and risk-based thematic reviews of housing corporations, instrument development for individual supervision, policy advice	Online video call
	D-003	Coordinator and specialist advisor	Sectoral analyses and risk-based thematic reviews of housing corporations, instrument development for individual supervision, policy advice	Online video call
	D-004	Data manager	Responsible for dPi and dVi data management and coordination of risk management	Online video call
	D-005	Advisor data and benchmarking	Data manager and benchmarking manager responsible for dPi content in the joint data organization SBR-Wonen	Online video call

appendix

Appendix E: List of members of expert opinion

The following members formed part of the expert opinions team from Portaal Housing association that was organized.

	Organization	Interviewee	Title	Role Description	Interview
E	Portaal	Ivo de Lijster	Portfolio manager	Responsible for the portfolio strategy and steering the development and management of the project portfolio and the multi-year planning through asset management. Part of the investment committee at Portaal, to advise the board on their investment decisions.	In person meeting at Portaal Offices
E	Portaal	Bert Bredewold	Project controller	Project controller at Portaal housing association with 10 years of work experience at the intersection of real estate, processes, and finance. He specializes in project control, valuation calculations of real estate assets, feasibility study, scenario analysis, liquidity forecasts and general project organization for housing association.	In person meeting at Portaal Offices
E	Portaal	Robert Hendriks	Project development manager	Real estate development manager specializing in strategic cooperation with municipalities and housing associations. He has more than 17 years' experience as a real estate developer and has helped contribute to acquisition of new development assignments in the medium to long term.	Online via Teams

appendix

Appendix F: Atlas.ti code co-occurrence tables for Supervisory

	AEDES Gr=5	AW Gr=12	BZK Gr=6	WSW Gr=6
Contents of the investment predictions in the dPi				
Policy Plans Numbers Gr=10	5	1	1	3
Building characteristics Gr=3	2			1
Financial ratios Gr=3		2		1
Valuation and Budgets Gr=5	2			3
Uses of investment forecast information in the dPi				
Financial continuity oversight Gr=10		2	2	6
Sectoral policy and communication Gr=1		1		
Social governance oversight Gr=15	4	8	2	1
Political responsibility Gr=1		1		
Past and future expectation management Gr=7		2		5
Policy decision making Gr=5	2	1	2	
Gaps in the investment forecast information				
dPi fit for purpose Gr=5	1	3		1
Precedence of financial over social targets Gr=6	1	1		4
Optimistic or non-realistic dPi data Gr=35	11	12	8	4
Causes of inaccuracies in the investment forecasts				
Underdeveloped performance agreements Gr=2	1	1		
Insufficient municipal capacity Gr=2	1	1		
Hostile municipality policies Gr=1		1		
Lack of means to control accuracy of plans Gr=2		1		1
Land availability Gr=6		5		
Local neighbours' opposition to plans Gr=3	1	1	1	
Long permit procedures Gr=4	2	1	1	
Risks resulting from inaccurate forecast (dPi) Plans				
Political risks for unrealized plans Gr=5	1	2	2	
Jeopardizing of HA's policy abilities Gr=9	1	1	4	3
Financial performance risks Gr=3	1		1	1
Resolutions for inaccuracies in the investment forecasts				
Reduction of administrative burdens Gr=6	2	4		
Target problem specific research Gr=7	3	4		
Project specific information needed Gr=10	5	3	2	
Realistic planning Gr=7	2	4	1	
Oversight bodies pressure Gr=5	4			1
Cross administrative collaboration Gr=2		2		
Inability to steer solutions Gr=8	4	3	1	
No solutions needed Gr=1				1
Intervening at a national policy level Gr=9	1	6	1	1

Appendix G: List of dataset variables

Code	Data provided	Example (Example randomized data for privacy)	Source
1	Project	P001	Portaal
2	Project Name	Name of project (case identifier)	Portaal
3	Municipality	For example, Utrecht Municipality	Portaal
4	Project construction type	New build or Demolished and Build	Portaal
5	Number of Homes	10	Portaal
6	Construction cost	5 x mln (1.000.000)	Portaal
7	Cost per home (calculated from 5 and 6)	0.14 x mln (1.000.000)	Portaal
8	Start of project idea	15-1-2010	Portaal
9	Initiation decision date	17-3-2010	Portaal
10	Development decision date	13-4-2011	Portaal
11	Realization decision date	5-3-2014	Portaal
12	Start of construction	1-9-2014	Portaal
13	End of construction	15-6-2015	Portaal
15	End of evaluation period after construction	7-3-2016	Portaal
16	Building type	EGW or MGW	Portaal
17	Input price index*	1.5 (above or below index as of 1-1-2000)	(CBS, 2022)

**Realization decision date*

appendix

Appendix H: Focus group interview protocols

Focus group session 01

1. Do you agree with the following perspectives of risks that delay projects as the most important?

   a) Permit processes e.g., objections from neighbouring community or zoning procedures.
   b) Land acquisition processes
   c) Building costs rising
   d) Delays in finding contractor and contractor delays during construction
   e) Risks of return requirements

2. Are there any risks in the list that you feel is important but has been omitted?
3. How are these risks currently incorporated in the investment forecasting process?
4. Is time modelled in the investment forecasting process?
5. Which indicators can be used for the risks mentioned as project delaying?
6. How is the total project time in Portaal calculated?

Focus group session 02

1. Results of the regression presented to expert review
2. Each variable and resulting coefficients in the multiple regression presented.
3. Discussion to be conducted per variable
4. Potential use of the model in Portaal discussed.

appendix

Appendix I: Linear Regression SPSS Results

Correlations												
		Total project time	Number of Homes	input price index	Construction Type	Building cost per million	Property type	Location=1.0 Utrecht	Location=2.0 Leiden	Location=3.0 Arnhem	Location=4.0 Eemland	Location=5.0 Nijmegen
Pearson Correlation	Total project time	1,000	,177	-,185	-,309	,366	-,002	-,063	,310	-,241	-,011	-,016
	Homes	,177	1,000	-,052	,110	,828	,247	,498	-,034	-,095	-,143	-,275
	input price index	-,185	-,052	1,000	-,168	,065	-,030	,113	-,055	,096	,160	-,254
	Construction Type	-,309	,110	-,168	1,000	-,013	,178	-,029	-,165	,213	-,004	,016
	Building cost per million	,366	,828	,065	-,013	1,000	,220	,420	,024	-,057	-,090	-,314
	Property type	-,002	,247	-,030	,178	,220	1,000	-,062	,049	,163	,085	-,164
	Location=1.0 Utrecht	-,063	,498	,113	-,029	,420	-,062	1,000	-,276	-,224	-,241	-,390
	Location=2.0 Leiden	,310	-,034	-,055	-,165	,024	,049	-,276	1,000	-,173	-,186	-,301
	Location=3.0 Arnhem	-,241	-,095	,096	,213	-,057	,163	-,224	-,173	1,000	-,151	-,244
	Location=4.0 Eemland	-,011	-,143	,160	-,004	-,090	,085	-,241	-,186	-,151	1,000	-,263
	Location=5.0 Nijmegen	-,016	-,275	-,254	,016	-,314	-,164	-,390	-,301	-,244	-,263	1,000
Sig. (1-tailed)	Total project time	.	,094	,084	,010	,003	,493	,321	,010	,035	,469	,453
	Number of Homes	,094	.	,350	,208	,000	,032	,000	,400	,242	,145	,019
	input price index	,084	,350	.	,106	,316	,413	,201	,341	,238	,117	,028
	Construction Type	,010	,208	,106	.	,461	,092	,415	,109	,055	,488	,454
	Building cost per million	,003	,000	,316	,461	.	,050	,001	,431	,336	,253	,009
	Property type	,493	,032	,413	,092	,050	.	,325	,358	,113	,264	,112
	Location=1.0 Utrecht	,321	,000	,201	,415	,001	,325	.	,019	,047	,035	,001
	Location=2.0 Leiden	,010	,400	,341	,109	,431	,358	,019	.	,100	,083	,012
	Location=3.0 Arnhem	,035	,242	,238	,055	,336	,113	,047	,100	.	,131	,034
	Location=4.0 Eemland	,469	,145	,117	,488	,253	,264	,035	,083	,131	.	,024
	Location=5.0 Nijmegen	,453	,019	,028	,454	,009	,112	,001	,012	,034	,024	.

Correlations												
		Total project time	Number of Homes	input price index	Construction Type	Building cost per million	Property type	Location=1.0 Utrecht	Location=2.0 Leiden	Location=3.0 Arnhem	Location=4.0 Eemland	Location=5.0 Nijmegen
N	Total project time	57	57	57	57	57	57	57	57	57	57	57
	Number of Homes	57	57	57	57	57	57	57	57	57	57	57
	input price index	57	57	57	57	57	57	57	57	57	57	57
	Construction Type	57	57	57	57	57	57	57	57	57	57	57
	Building cost per million	57	57	57	57	57	57	57	57	57	57	57
	Property type	57	57	57	57	57	57	57	57	57	57	57
	Location=1.0 Utrecht	57	57	57	57	57	57	57	57	57	57	57
	Location=2.0 Leiden	57	57	57	57	57	57	57	57	57	57	57
	Location=3.0 Arnhem	57	57	57	57	57	57	57	57	57	57	57
	Location=4.0 Eemland	57	57	57	57	57	57	57	57	57	57	57
	Location=5.0 Nijmegen	57	57	57	57	57	57	57	57	57	57	57

Variables Entered/Removed[a]			
Model	Variables Entered	Variables Removed	Method
1	Location=5.0 Nijmegen, Construction Type, Property type, Location=4.0 Eemland, input price index, Building cost per million, Location=3.0 Arnhem, Location=2.0 Leiden, Number of Homes[b]	.	Enter

a. Dependent Variable: Total project time
b. Tolerance = ,000 limit reached.

Model Summary[b]					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,649[a]	,421	,310	2,85983	1,847

a. Predictors: (Constant), Location=5.0 Nijmegen, Construction Type, Property type, Location=4.0 Eemland, input price index, Building cost per million, Location=3.0 Arnhem, Location=2.0 Leiden, Number of Homes
b. Dependent Variable: Total project time

Excluded Variables[a]								
						Collinearity Statistics		
Model		Beta In	t	Sig.	Partial Correlation	Tolerance	VIF	Minimum Tolerance
1	Location=1.0 Utrecht	.[b]	.	.	.	,000	.	,000

a. Dependent Variable: Total project time
b. Predictors in the Model: (Constant), Location=5.0 Nijmegen, Construction Type, Property type, Location=4.0 Eemland, input price index, Building cost per million, Location=3.0 Arnhem, Location=2.0 Leiden, Number of Homes

Casewise Diagnostics[a]				
Case Number	Std. Residual	Total project time	Predicted Value	Residual
27	3,072	15,46	6,6732	8,78470

a. Dependent Variable: Total project time

Residuals Statistics[a]					
	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	,9614	11,1559	5,6305	2,23334	57
Std. Predicted Value	-2,091	2,474	,000	1,000	57
Standard Error of Predicted Value	,859	2,538	1,172	,248	57
Adjusted Predicted Value	1,7230	11,9400	5,6543	2,29471	57
Residual	-5,02234	8,78470	,00000	2,61997	57
Std. Residual	-1,756	3,072	,000	,916	57
Stud. Residual	-1,976	3,475	-,003	1,009	57
Deleted Residual	-6,35571	11,24198	-,02384	3,18428	57
Stud. Deleted Residual	-2,041	3,988	,007	1,052	57
Mahal. Distance	4,076	43,106	8,842	5,368	57
Cook's Distance	,000	,338	,022	,047	57
Centered Leverage Value	,073	,770	,158	,096	57

a. Dependent Variable: Total project time

Collinearity Diagnostics[a]

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions (Constant)	Number of Homes	input price index	Construction Type	Building cost per million	Property type	Location=2.0 Leiden	Location=3.0 Arnhem	Location=4.0 Eemland	Location=5.0 Nijmegen
1	1	5,694	1,000	,00	,00	,00	,01	,00	,01	,00	,00	,00	,00
	2	1,035	2,345	,00	,00	,00	,00	,00	,00	,29	,05	,00	,08
	3	1,013	2,371	,00	,00	,00	,00	,00	,00	,01	,28	,02	,13
	4	1,003	2,383	,00	,00	,00	,00	,00	,00	,02	,09	,40	,01
	5	,605	3,068	,00	,04	,00	,00	,03	,00	,20	,05	,05	,04
	6	,264	4,645	,00	,00	,01	,01	,01	,92	,01	,03	,01	,00
	7	,207	5,242	,00	,00	,01	,78	,02	,01	,00	,12	,03	,09
	8	,113	7,098	,02	,05	,14	,01	,05	,05	,32	,32	,42	,41
	9	,050	10,627	,01	,83	,00	,10	,88	,01	,01	,04	,02	,00
	10	,015	19,287	,97	,07	,84	,09	,01	,00	,14	,03	,04	,23

a. Dependent Variable: Total project time

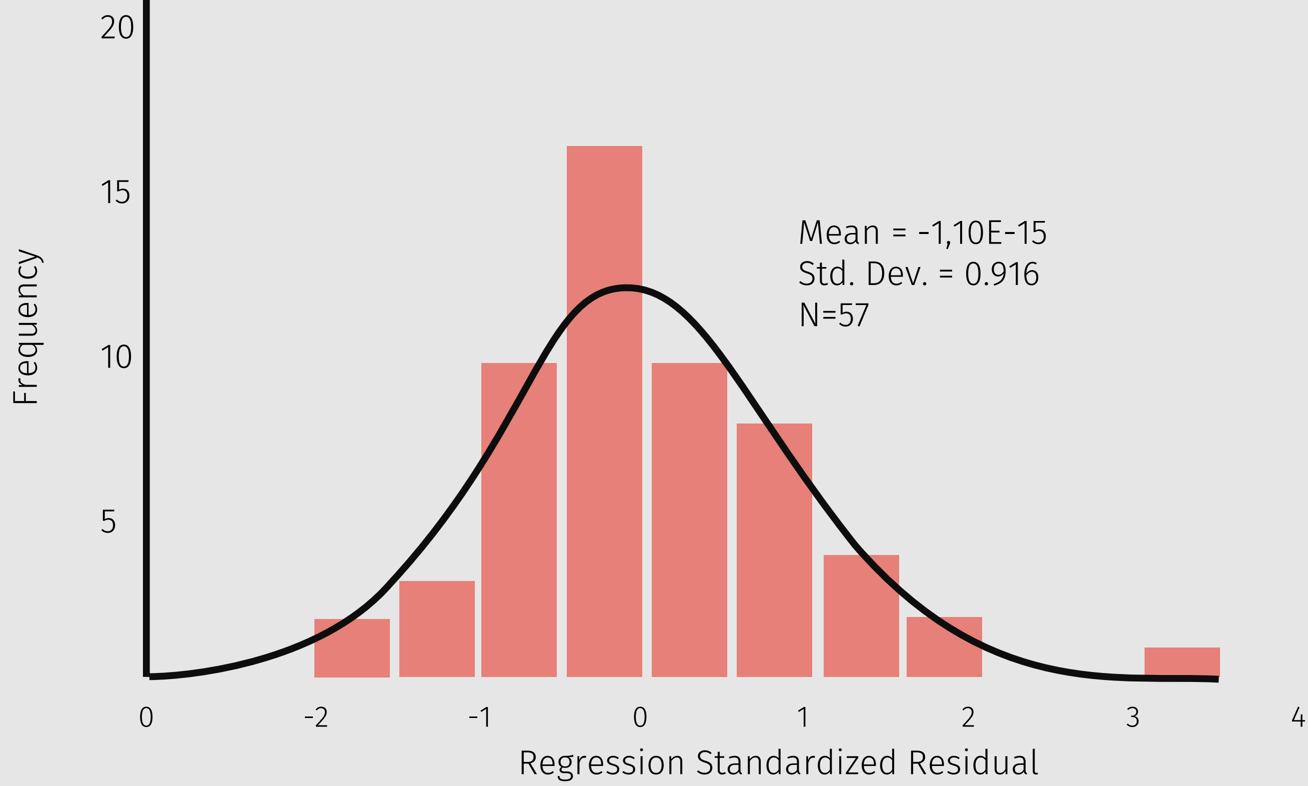
Coefficients[a]

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.	95,0% Confidence Interval for B Lower Bound	Upper Bound	Correlations Zero-order	Partial	Part	Collinearity Statistics Tolerance	VIF
1	(Constant)	7,837	2,509		3,124	,003	2,790	12,884					
	Number of Homes	-,020	,015	-,287	-1,301	,200	-,050	,011	,177	-,186	-,144	,253	3,959
	input price index	-,080	,039	-,246	-2,041	,047	-,158	-,001	-,185	-,285	-,227	,847	1,180
	Construction Type	-1,968	,957	-,248	-2,057	,045	-3,893	-,044	-,309	-,287	-,228	,846	1,182
	Building cost per million	,322	,097	,689	3,334	,002	,128	,516	,366	,437	,370	,289	3,464
	Property type	-,291	,867	-,041	-,335	,739	-2,034	1,453	-,002	-,049	-,037	,839	1,192
	Location=2.0 Leiden	2,796	1,273	,312	2,196	,033	,235	5,356	,310	,305	,244	,612	1,633
	Location=3.0 Arnhem	-,238	1,474	-,023	-,161	,873	-3,203	2,728	-,241	-,024	-,018	,613	1,631
	Location=4.0 Eemland	1,527	1,393	,155	1,097	,278	-1,275	4,329	-,011	,158	,122	,613	1,631
	Location=5.0 Nijmegen	1,382	1,203	,185	1,149	,257	-1,039	3,803	-,016	,165	,128	,473	2,112

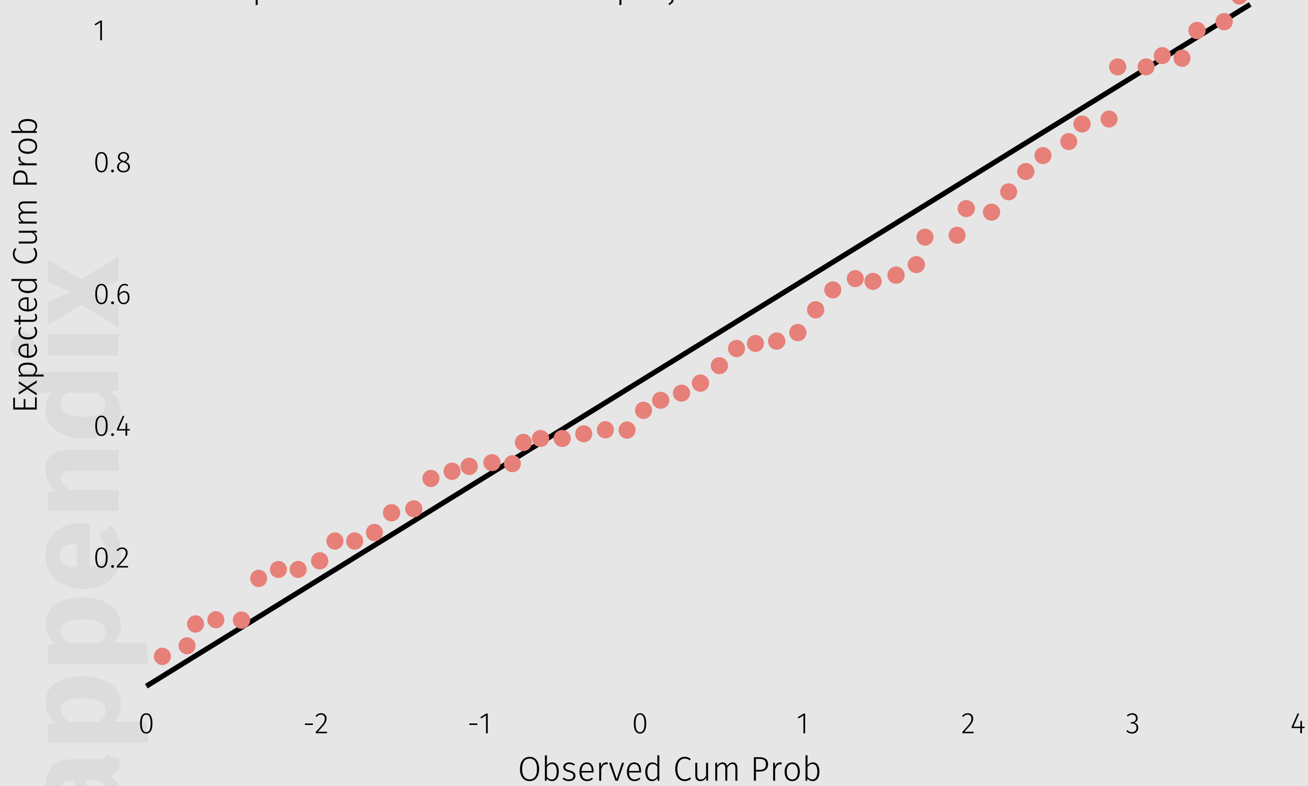
a. Dependent Variable: Total project time

appendix

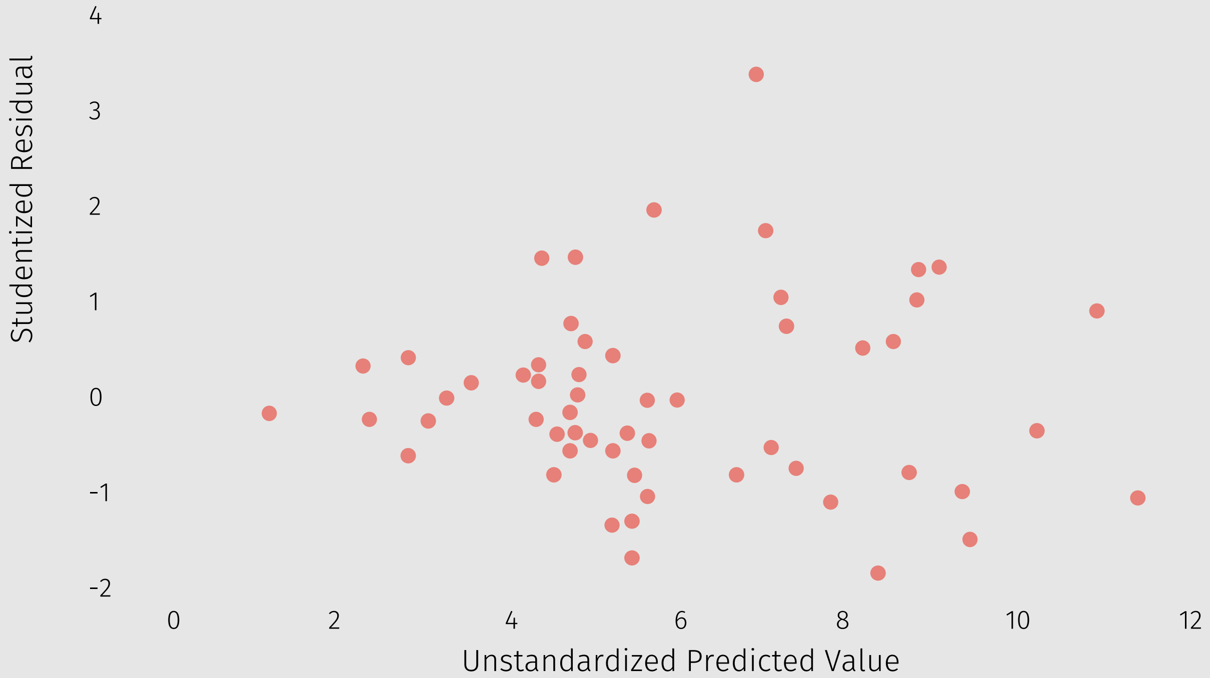
Histogram
Dependent variable: Total project time



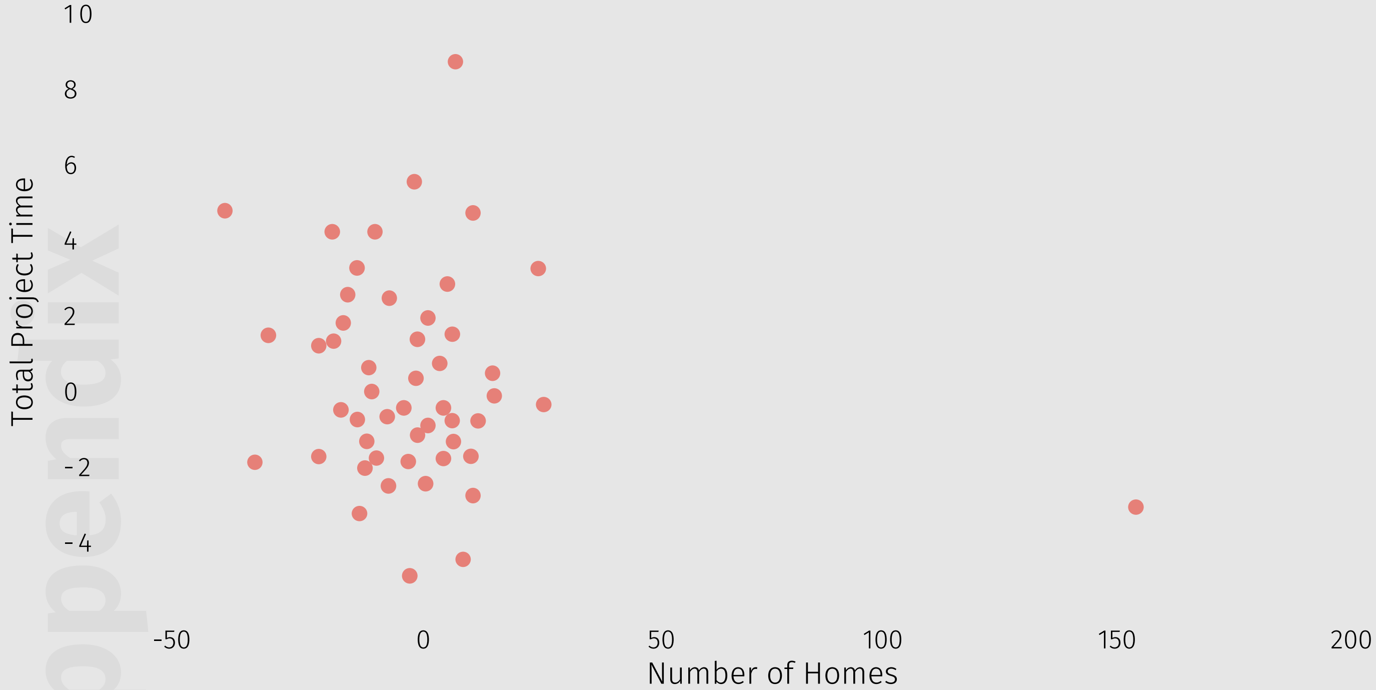
Normal P-P Plot of Regression Standardized Residual
Dependent variable: Total project time



Scatter plot of Studentized Residual by Unstandardized Predicted Value

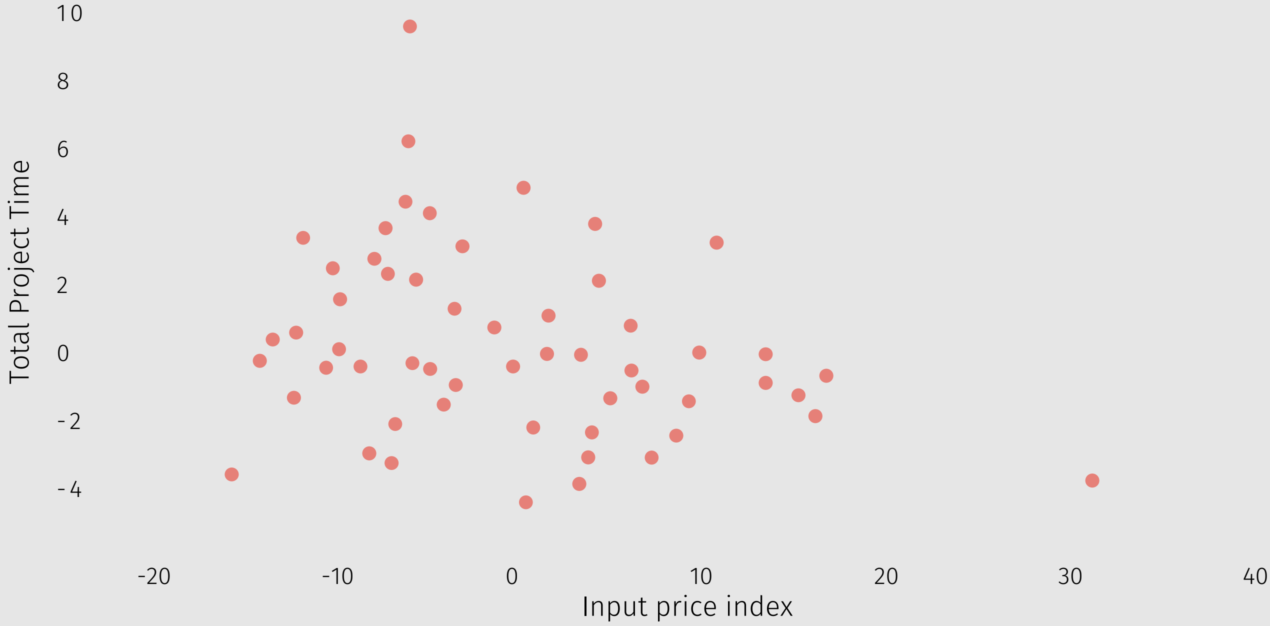


Partial Regression plot
Dependent variable: Total Time



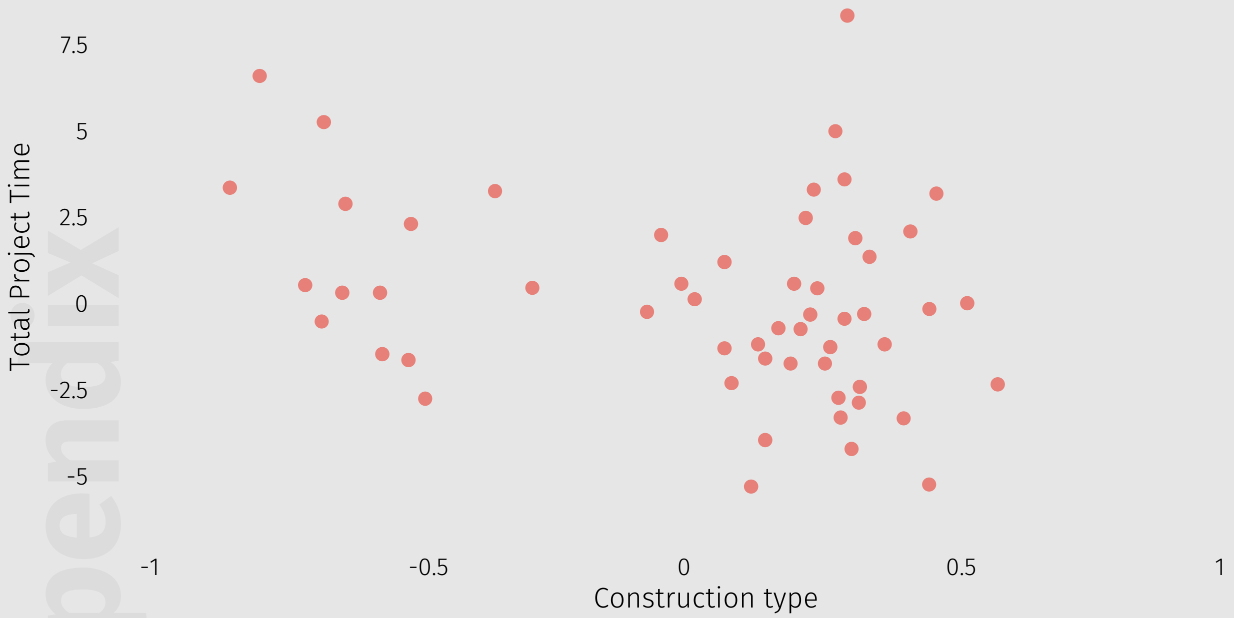
Partial Regression plot

Dependent variable: Total Time



Partial Regression plot

Dependent variable: Total Time



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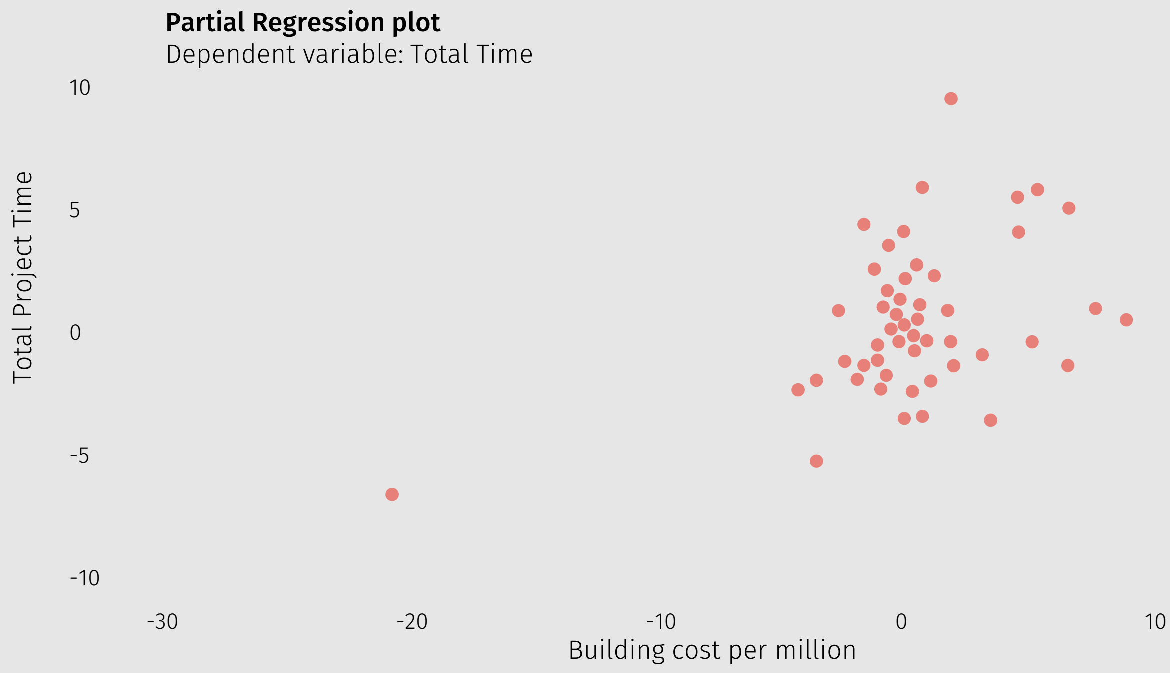
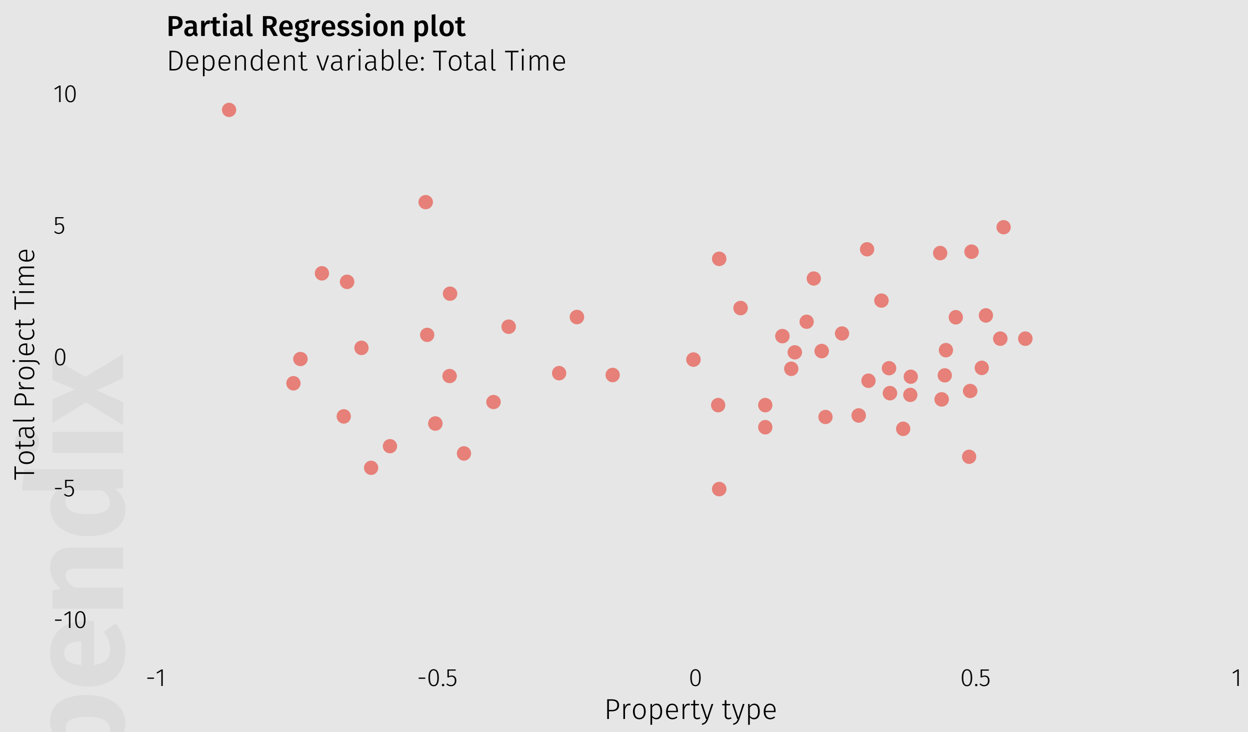
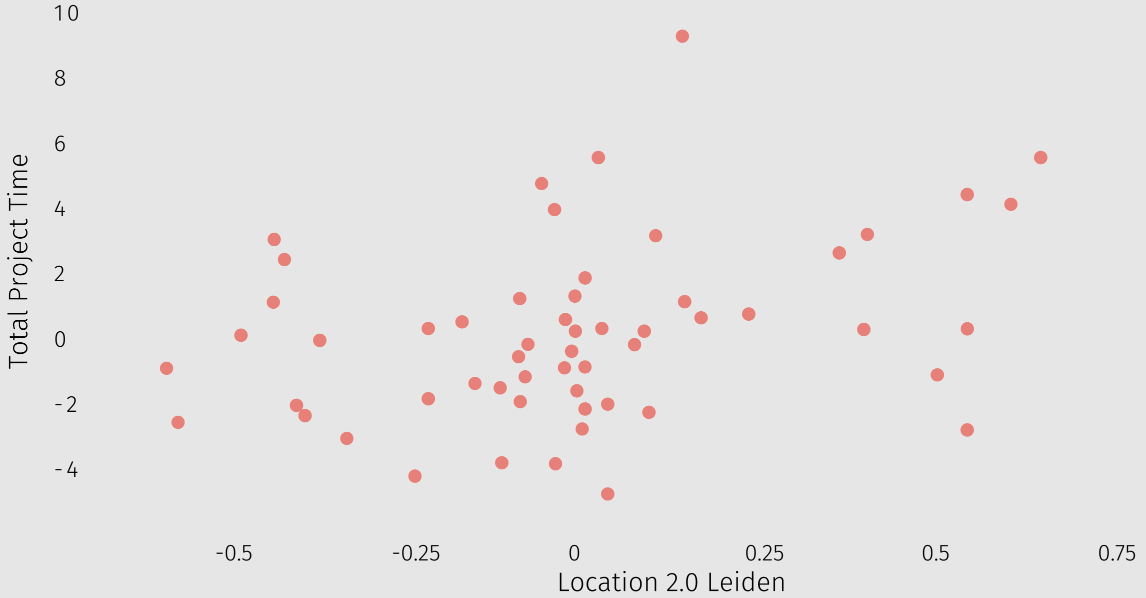

Partial Regression plot
Dependent variable: Total Time
Total Project Time
10
5
0
-5
-10
-30
-20
-10
0
10
Building cost per million

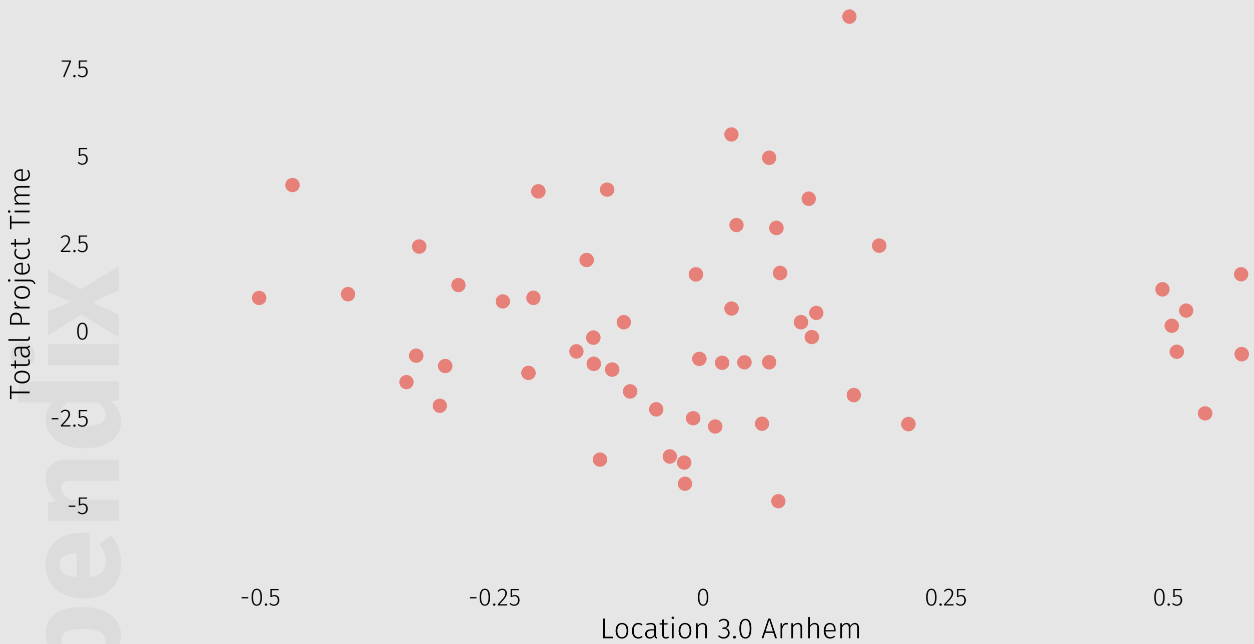

Partial Regression plot
Dependent variable: Total Time
Total Project Time
10
5
0
-5
-10
-1
-0.5
0
0.5
1
Property type

appendix

Partial Regression plot
Dependent variable: Total Time

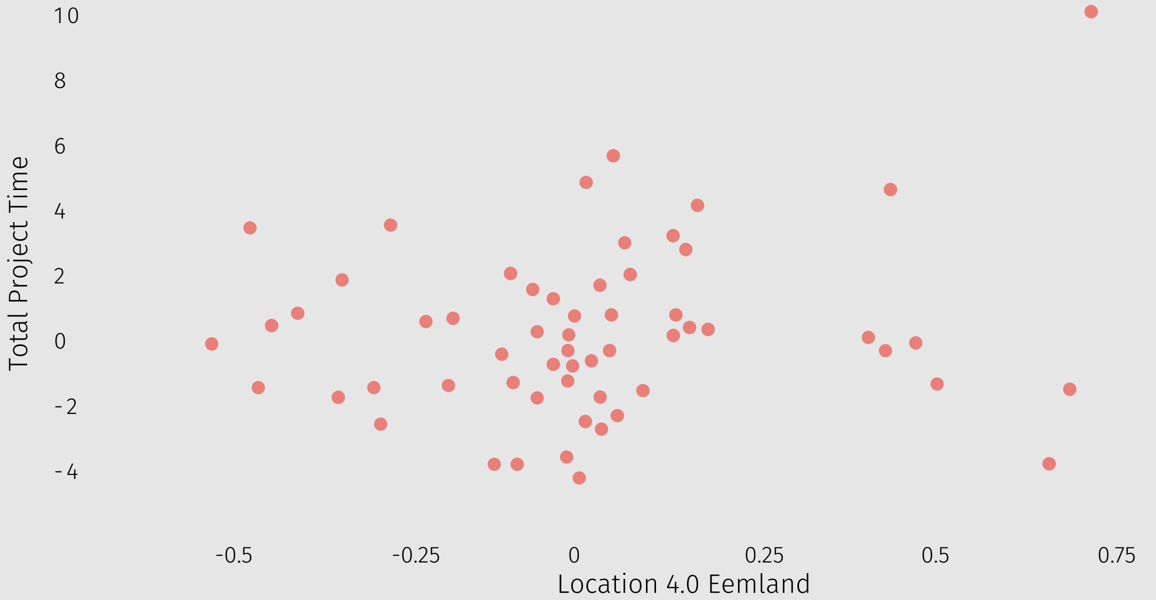


Partial Regression plot
Dependent variable: Total Time

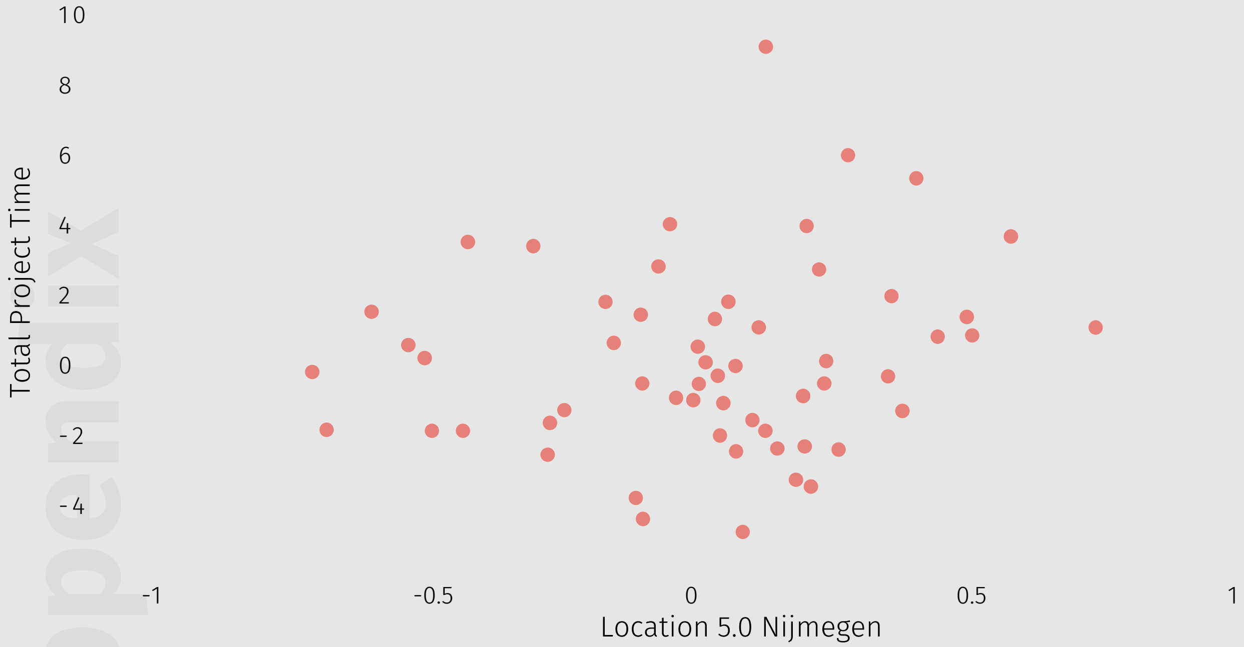


appendix

Partial Regression plot
Dependent variable: Total Time



Partial Regression plot
Dependent variable: Total Time



appendix

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2022