AN OFFICE THAT FEELS LIKE HOME

The influence of the home work environment on perceived productivity

MSc graduation thesis
B.B.T. Kieft

An office that feels like home

The influence of the home work environment on perceived productivity

A thesis submitted to the Delft University of Technology in partial fulfillment of the requirements for the degree of

Master of Science in Architecture, Urbanism and Building Sciences

by

B.B.T. (Bernice) Kieft

COLOPHON

An office that feels like home
The influence of the home work environment on perceived productivity

MSc graduation thesis
P5 Report – June 2021

Author

Name	B.B.T. (Bernice) Kieft
Student number	4368932
Contact address	

Educational institution

University	Delft University of Technology
Faculty	Architecture and the Built Environment
Master	Architecture, Urbanism and Building Sciences
Master track	Management in the Built Environment
Graduation laboratory	Real Estate Management

Supervision

First mentor	dr. ir. M.H. (Monique) Arkesteijn MBA – TU Delft
Second mentor	dr. S.J.T. (Sylvia) Jansen – TU Delft
Third mentor	dr. ir. H.A.J.A. (Rianne) Appel-Meulenbroek – TU/e
Delegate of the Board of Examiners	Prof. ir. E.A.J. (Eric) Luiten – TU Delft

Graduation Company

Graduation organization	Aestate /ontrafelexperts
Graduation mentor	dr. ir. P. (Pity) Jongens

TU Delft BK Bouwkunde — Department of Management in the Built Environment

aestate /ontrafel experts

PREFACE

This report is the result of one-year research conducted in the academic year 2020-2021. The research is focused on the influence of the home working environment on perceived productivity. This MSc thesis was written in the middle of the Covid-19 pandemic, which was the inspiration of the research topic. Because we had to work from home all of the sudden, it got me thinking about my experience of homeworking, the suitability of the home work environment, and the future of the office.

Because most people had to work from home, a unique opportunity arose to research mass homeworking and how this affects employees' productivity. This 'new way of working' is a phenomenon that is already researched since the 1980s, but working from home has never been applied so quickly and massively ever. I had the chance to participate in the research 'We Werken Thuis' (We Work from home; WWH), executed by a consortium of Aestate/ontrafelexpers, Center for People and Buildings, Eindhoven University of Technology, and the Delft University of Technology. WWH collected a large dataset on the experience of homeworking during Covid-19. Because of this, I had the resources to research specific aspects of the home work environment and to what extend this influences productivity.

I would like to thank my mentors from the Delft University of Technology. First, Monique Arkesteijn, thank you for the enthusiasm on the topic from the start and for involving me in the WWH research project. Without this project and your guidance, this thesis would have looked a lot differently. Secondly, for the support and extensive help on the statistical analysis, I would like to thank Sylvia Jansen. You were always available for questions and took the time to learn the ins and outs of statistics. From the Eindhoven University of Technology, I would like to thank Rianne Appel-Meulenbroek for looking critically at my thesis throughout this academic year. Furthermore, I would like to thank my graduation company Aestate/ontrafelexperts, and in particular Pity Jongens for providing me new insights on the results, especially for practical use in the future. Despite Covid-19 and the many hours working at home, I felt welcome at the organization from the start and I look back on a successful internship.

Having said that, there are also some important people in my personal life that I would like to thank. First, my friends with whom I have had an unforgettable and wonderful student time. Just like for every student it has not always been easy, but you always supported me and listened when I needed it. Secondly, my parents for their unconditional love, support and belief in me. Because of you, I learned to dream big and I was able to do everything I wanted over the past seven years. Last, I would like to dedicate this thesis to my grandmothers, Oma and Omilou. Sadly you are no longer in this world but you are probably the strongest women I will ever meet inspiring me every day to become the best version of myself.

Met vrandelijke greuten,

Bernice Kieft

Rotterdam, June 2021

EXECUTIVE SUMMARY

Introduction

Working from home can have both advantages and challenges from an organizational, individual, and societal perspective (Kurland & Bailey, 2000). The most commonly known advantage, from an organizational perspective, is that it can increase the productivity of its employees. However, it is harder for managers to monitor and measure the performance of their employees. For the employee, it can provide a better work-life balance, but it can also blur the line between working and non-working activities. Then from a societal perspective, it can reduce traffic congestions, as employees are less likely to commute every day.

Because of the rise of information and communication technologies (ICTs) and the advantages of homeworking, already studies since the 1980s, it was predicted that homeworking arrangements would become massively popular. However, throughout the years, these arrangements were not implemented by organizations as much as predicted (Martin & MacDonnell, 2012). This is also shown by the office use, as, for example, since the financial crisis of 2008 offices only increased in m2 (CBRE Netherlands, 2020).

As employees are the most 'valuable assets of organizations' (Appel-Meulenbroek et al., p. 280), the influence of the work environment on employees' productivity has been researched extensively. However, these studies were mostly focused on the office work environment (e.g. Croon et al, 2005; Haynes, 2008), instead of the home work environment. Furthermore, homeworking was only researched as a phenomenon in itself, where it was assumed that the home work environment was appropriate to work in. So, a research gap was found between the work environment, homeworking, and productivity.

Because of Covid-19, it was recommended to work from home as much as possible. So, since 13 March 2020, (Dutch) employees are massively homeworking. These employees reported both positive and negative experiences with homeworking, as, for example, not every home work environment is suitable to conduct their work. Therefore, a unique opportunity arose to research (the experiences of) homeworking more extensively with the focus on what aspects of the home work environment influence employees' productivity.

Hence, the main research question of this thesis is:

What is the influence of the home work environment during telehomeworking on perceived productivity?

This main research question is supported by three sub-questions:

SQ1. *Which theories that revolve around homeworking and productivity can be distinguished?*

SQ2. *What aspects of the home work environment during homeworking can influence employees' productivity?*

SQ3. *What effect do aspects of the home work environment have on employees' productivity?*

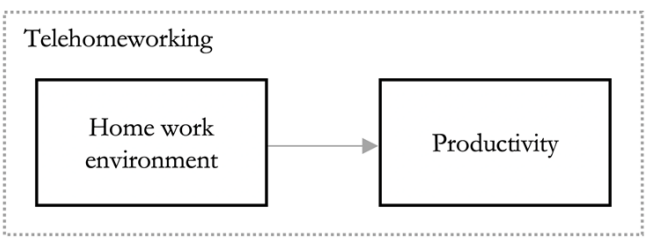

Figure 0.1 Conceptual framework

Methodology

The research can be split into two phases. The first phase entails desk research. In this phase, a literature review is conducted to answer the first two sub-questions. From this literature study, a theoretical model is made including all aspects of the home work environment and how they relate to productivity. The second

phase is the empirical study in which statistical analyses are conducted to see if and how aspects of the home work environment affect productivity. This is done by testing multiple (null) hypotheses with the use of bivariate analyses, regressions analyses, and combining all aspects in an integral path model.

The data that is used for the second phase is gathered by the research project 'We Werken Thuis' (We Work from Home; WWH). This research project is a collaboration between Aestate/ontrafelexpers, a real estate consultancy firm, Center for People and Buildings, a knowledge center focused on the built environment, and the universities Eindhoven University of Technology and Delft University of Technology. For nine weeks, employees of mostly public organizations were asked to fill in questionnaires every week. For this thesis, the data of the second week (N = 36,102) has been used.

The focus in the second week questionnaire was the physical home work environment related to productivity. This questionnaire was compared to the variables within the theoretical model. With the input of both the theoretical model and the questionnaire a conceptual model was made to be used for the statistical analysis (see also Figure 0.2)

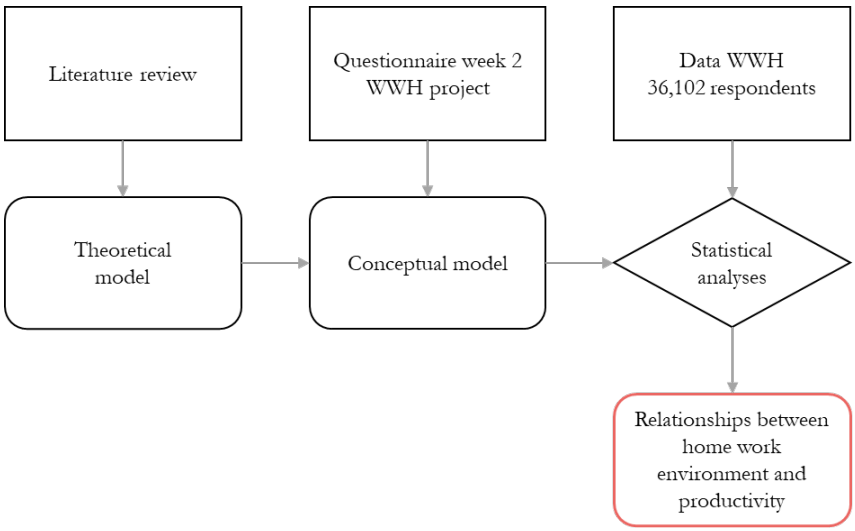

Figure 0.2 Research framework

Theoretical model

From the literature review it was found that homeworking was directly related to multiple advantages and challenges in relation to productivity. These were autonomy, commuting, managerial support, physical home work environment, strain and motivation, and work life balance. From these advantages and challenges multiple aspects of homeworking influences productivity were identified.

First, the home work environment can be split into the physical home work environment and the social environment. Aspects influencing productivity of the physical home work environment include the function of the room, the use of the room, size of the workplace, ICT facilities, ambient factors, view, and furniture. The social environment contains the level of autonomy and managerial support.

Secondly, not only the home work environment itself (objectively), but also the satisfaction with this home work environment (subjectively) influences productivity. The satisfaction with the home work environment is determined by the satisfaction with the comfort, facilities, furniture, light, overall suitability, possibility of concentrated work, privacy level, size, temperature, ventilation, and view.

Last, as every respondent reacts differently towards homeworking individual control variables were included in the theoretical model. These are the household composition, age, education level, gender, job function, personality, level of motivation, and level of strain.

From the theories that revolve around homeworking or can e applied to the homeworking context, it was found that these three groups of variables not only affect productivity directly but also indirectly via the

home work environment and the satisfaction with the home work environment. All the aspects and relations are summarized in Figure 0.3.

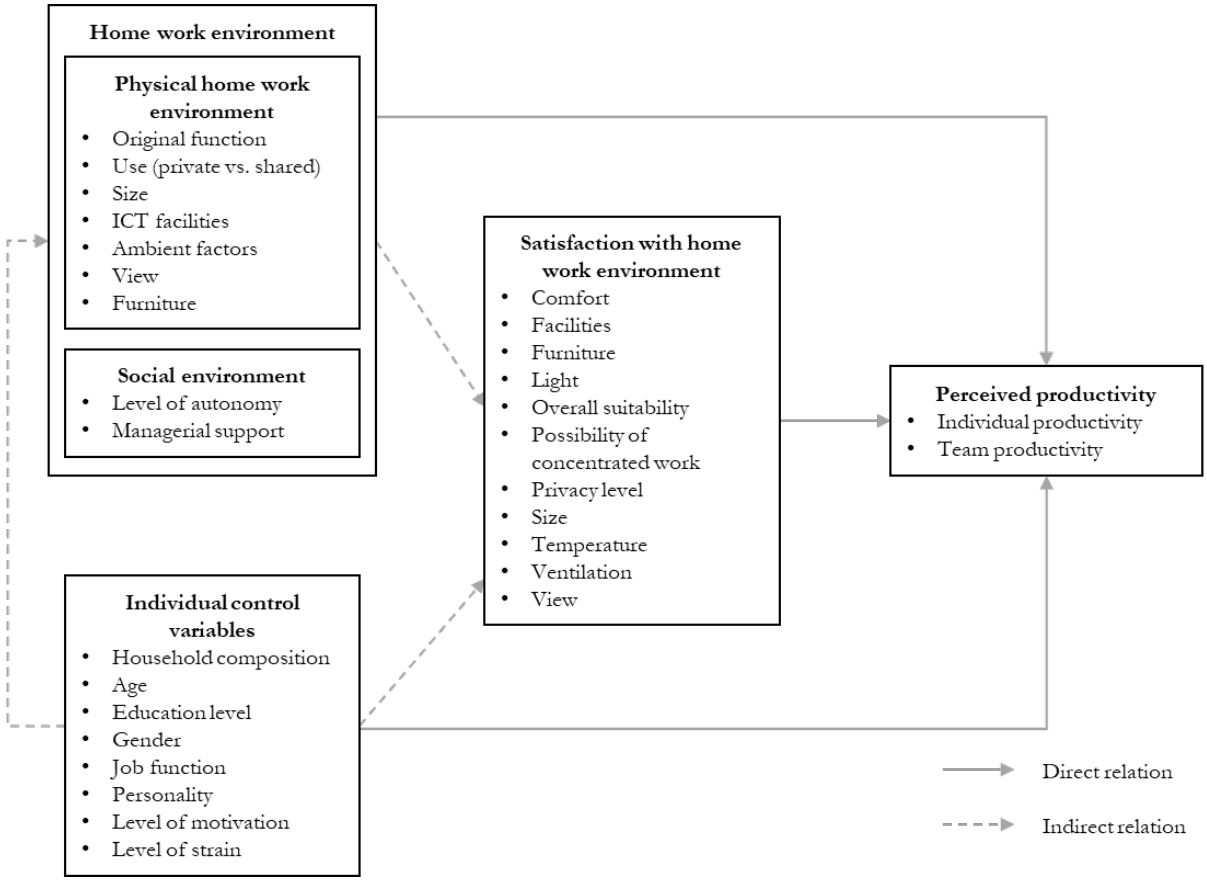

Figure 0.3 Theoretical model

Conceptual model

Comparing the theoretical model with the questionnaire of week 2 of the WWH project, a conceptual model including hypotheses was made (see Figure 0.4). No questions were asked on the social environment, and for the individual control variables personality traits, level of motivation, and level of strain were not included in the questionnaire. Some extra satisfaction variables were added to the model, being the green available, and the regulation of indoor climate. The overall suitability has been disregarded for the conceptual model.

To make the model more compact, factor analysis was conducted between the satisfaction variables. This resulted in four combinations of satisfaction variables for the conceptual model. The first factor is the satisfaction with ambiance, including green, view, atmosphere and appearance, daylight, size of the workplace, and lighting on the worksurface. The second factor is the satisfaction with privacy and concentration. This factor included the level of privacy, and the availability to work concentrated. The regulation of indoor climate, temperature, and ventilation, was combined in the third satisfaction factor, namely the satisfaction with indoor climate. The last satisfaction factor, satisfaction with functionality entails the comfort of the (desk)chair, available facilities, and the surface of the worktop.

Within the conceptual model, several relationships are included, both directly and indirectly, with productivity. From the theoretical model, the direct relationships with productivity predicted include all three groups of variables, being the physical home work environment, satisfaction with the home work environment, and the individual control variables. This is supported by the first three hypotheses:

H1. *The physical home work environment affects perceived productivity*

H2. *Satisfaction with the home work environment affects perceived productivity positively*

H3. *Individual control variables affect perceived productivity*

Also, indirect relationships with individual productivity were found in the literature. First, the physical home work environment is likely to affect the satisfaction with this home work environment. Secondly, the same was predicted for the individual control variables influencing the satisfaction with the home work environment. The last indirect relation with productivity was found by the individual control variables influencing the physical home work environment, and therefore affect the satisfaction with the home work environment. These indirect relationships are assisted by hypotheses 4 – 6:

H4. *The physical home work environment has an indirect effect on perceived productivity, via satisfaction with the home work environment*

H5. *The individual control variables indirectly affect perceived productivity, via the physical home work environment and the satisfaction with the home work environment*

H6. *The individual control variables indirectly affect perceived productivity, via the satisfaction with the home work environment*

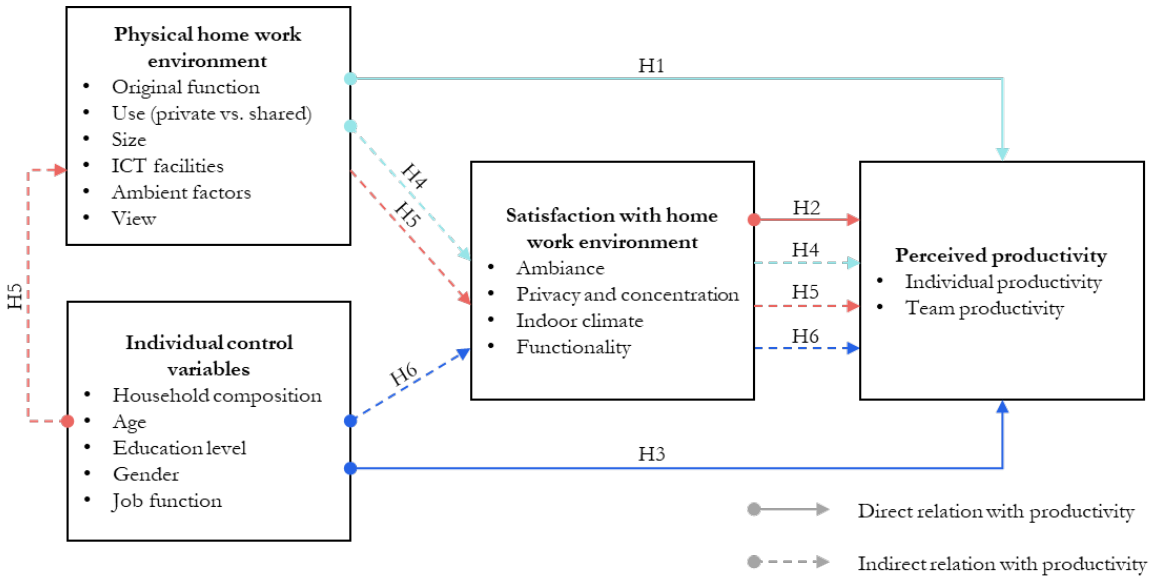

Figure 0.4 Conceptual model

Results

For the scope of the research, it was decided to focus on individual productivity, instead of both individual and team productivity. Individual and team productivity correlated highly. So, this indicates that the results from the statistical analyses on individual productivity are likely to occur (to some extend) in the same way on team productivity.

From the bivariate analyses, it was shown that all the variables of the physical home work environment influence productivity. For the original function, the highest reported individual productivity was found for the work room. All the other types of rooms, i.e. the living room, kitchen, bedroom, multiple rooms, and other room, had (significantly) lower means in productivity. When looking at the use of the room, it is most preferable to work privately compared to working shared or both private and shared use. For the size, the analysis showed that the larger the work room, the higher the mean in productivity. For the other variables, the individual productivity was significantly higher in mean having plants, art, color, and a view in your home work environment.

The regression analysis on the physical home work environment variables and the individual productivity showed that the large size workplace compared to the small size workplace had the highest positive influence on productivity. The highest negative influence on productivity was found for working in the living room compared to working in a work room.

All satisfaction factors correlated significantly with individual productivity. The highest correlation was found with the satisfaction with privacy and concentration, followed by the satisfaction with ambiance. The lowest correlation was found with the satisfaction with indoor climate. The results of the correlation analysis were supported by the regression analysis, where the highest (positive) influence on individual productivity was found for the satisfaction with privacy and concentration.

For all the individual control variables it was found that they influence individual productivity to some extend. First, for the household composition, the one-way anova analysis showed that it is most preferable to be a couple without children (living at home). The lowest individual productivity mean was found for the household composition 'otherwise'. Secondly, for age, it was found that the older the employee is, the higher individual productivity would be. The education level was categorized from low to high education level. The medium education level scored the highest individual productivity mean. Fourthly, on the variable gender, it was found that females perceive their productivity significantly higher in mean than male and other. Last, managers find their productivity higher than regular employees.

When comparing the effects all the individual control variables have on individual productivity, the regression analysis showed that couples with children and single households have the highest negative influence on productivity compared to the household type of couples without children. The highest positive influence on productivity was having the age 51 – 60 compared to < 30 years old.

All the aspects and posed hypotheses were combined in an integral path model. This model tests both direct and indirect effects on individual productivity. First, it showed that the physical home work environment affects individual productivity via the satisfaction factors. The variables size, number of ICT facilities, ambient factors, had a positive influence on all satisfaction factors. For the variable original function, only the kitchen compared to the work room had a positive coefficient with the satisfaction with the indoor climate. All other alternative categories compared to the work room had a negative coefficient with the satisfaction factors, indicating that the work room is the most preferable place to work at home when looking at the satisfaction. For the variable use, the shared use had a negative coefficient with all satisfaction factors. This suggests that shared use compared to private use negatively affects satisfaction.

Also, the individual control variables affected the satisfaction factors and, therefore, influences productivity. The variables education level (low and other, and medium education level compared to high education level), age (> 30 year compared to < 30 year), and gender (female compared to male and other) had positive relationships with satisfaction. The job function (manager compared to employee) negatively influence satisfaction with ambiance. The household composition shows various results.

Furthermore, the last hypothesis posed was the influence individual control variables have on the physical home work environment and therefore, influence individual productivity. Also, this relationship was found in the integral path model. Because of all the categorical variables, these relationships differed per variable and within the variable.

Discussion and conclusion

The dataset used for the statistical analysis was gathered during the Covid-19 crisis. Therefore, the findings have to be read in this particular context. Within the questionnaire, no questions were asked particularly about the experiences with the Covid-19 crisis. However, the results are likely influenced by Covid-19. Also, the theoretical model and the questionnaire did not match fully. Therefore, not all aspects found in literature could be tested by statistical analyses. This can explain why the R squares of all three regression analyses were relatively low, indicating that not all variances could be explained by the aspects analyzed.

Furthermore, the dataset was not comparable to the population of the Netherlands, and, therefore, it is hard to generalize all the findings. On top of that, the participating organizations were mostly public, which does not give the full picture of the experiences of homeworking.

Overall, all the null hypotheses can be rejected and, therefore, the statistical analyses showed that the physical home work environment, the satisfaction with the home work environment, and individual control variables all influence the perceived productivity. This influence is both directly and indirectly via the physical home work environment and the satisfaction with the home work environment. From these three groups of variables, the satisfaction with the home work environment affects productivity the most, comparing the R-squares.

When looking at all variables individually, the satisfaction with ambiance and the satisfaction with privacy and concentration have the biggest positive effect on productivity. The highest negative effect on productivity is working in the living room compared to working in a determined work room at home.

Recommendations

Overall the average score on individual perceived productivity was a 7.7 on a 10-point scale. This suggests that working from home is a feasible alternative for working at the office. Therefore, it could be interesting for organizations to expand their homeworking arrangements with their employees. Working productively is mostly associated with having privacy and working concentrated. With a hybrid form of working (working both at the office and home), it is, therefore, best to carry out concentrated work at home and the emphasis on collaboration can be placed in the office. However, it still has to be possible for employees to (for some extend) conduct concentrated work at the office, because their home work environment is not suitable enough to carry out their work.

Additionally, as the results show that the home work environment influences productivity it is recommended for employers to assist the employee in optimizing the home work environment to enhance their productivity if necessary. This can be done in multiple ways, such as financial support, but also by providing guidelines for the employee for their home work environment. It should be taken into account that some studied variables are easier to adapt to the home work environment than others. For example, adding plants and art to the home work environment is easier than increasing the size of the workplace.

For further research, two types of approaches can be used. First, a broader scope can be implemented. This means that extra variables of the home work environment can be researched, or extra outcome variables, such as well-being, can be added to the conceptual framework. Some of these variables can already be found in the research data of WWH (e.g. commuting time), but some need to be gathered extensively. On the other hand, more detailed research can be conducted on specific variables, such as what type of view positively influences productivity or to what extend the age of children affects the productivity of the employee.

Furthermore, the developments of hybrid working can be monitored and researched for the coming years to see why this way of working is or is not chosen by employers and employees, especially after Covid-19 where homeworking arrangements had to be implemented at a rapid pace.

ABSTRACT

Homeworking can have benefits both for employees and employers, such as a productivity increase and a better work-life balance. Still, homeworking arrangements were less implemented than expected throughout the years. Now, due to Covid-19, every office worker is highly recommended to work from home as much as possible. Therefore, everybody works at home with either a suitable or an unsuitable home work environment. During this 'mass experiment' new insights can be gathered on the experience of homeworking and the influence the home work environment has on productivity. Employees are sometimes forced to carry out certain work activities at home that were considered unsuitable beforehand. So, prejudices about homeworking can be confirmed or invalidated and specific aspects of the home work environment that influence productivity can be determined.

For this study quantitative data of the research project, 'We Werken Thuis' (We Work at Home; WWH) are used. First, a literature review is conducted to have a clear overview of what already has been researched on the topic of homeworking and the work environment related to productivity. From the literature study, a theoretical model is developed. This theoretical model includes the home work environment, divided into the physical home work environment and the social environment, the satisfaction with the home work environment, and individual control variables being of influence on the perceived productivity. It was predicted that all these elements affect productivity, both directly and indirectly.

The findings from the literature review are tested by statistical analyses (N = 36,102). Bivariate and regression analyses were performed, followed by integral path analysis. These analyses showed that the physical home work environment, satisfaction with the home work environment, and individual control variables directly affect productivity. Also, the physical home work environment indirectly affects productivity via satisfaction with the home work environment. The same was found for the individual control variables. Furthermore, the individual control variables influence the physical home work environment itself as well, which indirectly affects the perceived productivity via the satisfaction with the home work environment.

The outcomes of this research can be used by practitioners to revise their current corporate real estate strategy or by real estate consultants to advise companies about their office use in the future. It fills the gap in research on the influence specific aspects of the home work environment have on productivity during homeworking.

Keywords: Homeworking, Productivity, Home work environment, Satisfaction, Covid-19

TABLE OF CONTENT

Preface **5**

Executive summary **6**

Abstract **13**

List of tables **16**

List of figures **17**

1 Introduction **20**

1.1 Research gap 20

1.2 Research aim 21

1.3 Research scope 21

1.4 Research questions 22

2 Research methodology **26**

2.1 Research framework 26

2.1.1 Phase 1: Desk research 27

2.1.2 Phase 2: Empirical research 28

2.2 Data plan 29

2.3 Ethical considerations 29

3 Literature review **32**

3.1 Physical home work environment 34

3.1.1 Commuting 36

3.2 Social environment 37

3.2.1 Level of autonomy 37

3.2.2 Managerial support 38

3.3 Individual control variables 39

3.3.1 Strain and motivation 40

3.3.2 Work-life balance 42

3.4 Theoretical model 43

3.5 Sub conclusion 44

4 Empirical Study **48**

4.1 Questionnaire WWH project 48

4.2 Data preparation 49

4.2.1 Missing values 49

4.2.2 Recoding 50

4.3 Conceptual model 54

5 Results **58**

5.1 Representativeness sample 58

5.1.1 Household composition 58

5.1.2 Education level 59

5.1.3 Age 60
5.1.4 Gender 61
5.1.5 Job function 61
5.1.6 Sub conclusion 62
5.2 Per cohort 62
5.3 Physical home work environment 63
5.3.1 Original function of the room 63
5.3.2 Private vs. shared use of the room 64
5.3.3 Size of the workplace 65
5.3.4 ICT facilities 65
5.3.5 Ambiance 67
5.3.6 View 68
5.3.7 Regression analysis 68
5.3.8 Interrelations physical home work environment 70
5.3.9 Sub conclusion 70
5.4 Satisfaction with the home work environment 71
5.4.1 Regression analysis 71
5.4.2 Sub conclusion 72
5.5 Individual control variables 72
5.5.1 Household composition 73
5.5.2 Education level 73
5.5.3 Age 74
5.5.4 Gender 74
5.5.5 Job function 75
5.5.6 Regression analysis 75
5.5.7 Interrelations individual control variables 76
5.5.8 Sub conclusion 77
5.6 Integral path model analysis 77
5.6.1 Physical home work environment 77
5.6.2 Individual control variables 79
5.6.3 Sub conclusion 81
6 Discussion 84
6.1 Limitations of the research 84
6.2 Reliability and validity 84
7 Conclusion 88
8 Recommendations 92
8.1 Practice 92
8.2 Further research 93
References 96
Appendix A Survey 100
A.1 Quantitative operationalization table 100
A.2 Missing values before and after exclusion of cases 100
Appendix B Statistical analysis 101
B.1 Decision tree – bivariate analysis 101

B.2 Descriptives per cohort 102
B.3 Results statistical analysis – Physical home work environment 105
B.4 Results statistical analysis – Satisfaction with the physical home work environment 115
B.5 Results statistical analysis – Individual control variables 116
B.6 Integral path analysis 121

Appendix C Reflection 134

C.1 Relevance 134
C.2 Methodology 134
C.3 Personal reflection 135

LIST OF TABLES

Table 2.1 Research overview 26
Table 2.2 Inclusion and exclusion criteria used in the selection of papers 28
Table 3.1 Papers addressing team productivity 32
Table 3.2 Literature related to type of direct factor within homeworking on productivity 33
Table 3.3 Papers addressing home work environment and homeworking productivity 36
Table 3.4 Papers addressing commuting and homeworking productivity 37
Table 3.5 Papers addressing autonomy and homeworking productivity 38
Table 3.6 Papers addressing managerial support and homeworking productivity 39
Table 3.7 Papers addressing strain and/or motivation, and homeworking productivity 41
Table 3.8 Papers addressing work-life balance and homeworking productivity 42
Table 4.1 Summary of exploratory factor analysis (N = 24128) 52
Table 4.2 Recoding individual control variables 53
Table 5.1 Distribution of household composition in the research sample compared to the population of the Netherlands 59
Table 5.2 Distribution of education level in the research sample compared to the population of the Netherlands 60
Table 5.3 Distribution of age in the research sample compared to the population of the Netherlands 61
Table 5.4 Distribution of gender in the research sample compared to the population of the Netherlands 61
Table 5.5 Distribution of job functions in the research sample 62
Table 5.6 Descriptives individual productivity and satisfaction with the home work environment per cohort 63
Table 5.7 Summary results one-way ANOVA test (post hoc Games-Howell) original function of the room and individual productivity 64
Table 5.8 Summary results one-way ANOVA test (post hoc Games-Howell) private vs. shared use of the room and individual productivity 65
Table 5.9 Summary results one-way ANOVA test (post hoc Games-Howell) size of the workplace and individual productivity 65
Table 5.10 Summary results one-way ANOVA test (post hoc Games-Howell) number of ICT facilities and individual productivity 66
Table 5.11 Summary results independent samples t-tests plants, art, color, and the individual productivity 67

Table 5.12 Summary results one-way ANOVA test (post hoc Games-Howell) combinations of ambient factors and individual productivity 68
Table 5.13 Summary results independent samples t-test on view and individual productivity 68
Table 5.14 Linear model of predictors the physical home work environment of individual productivity .. 69
Table 5.15 Results Pearson correlation analysis satisfaction with the home work environment and individual productivity 71
Table 5.16 Linear model of predictors satisfaction with the home work environment of individual productivity 72
Table 5.17 Results one-way ANOVA test (post hoc Games-Howell) household composition and individual productivity 73
Table 5.18 Results one-way ANOVA test (post hoc Games-Howell) education level and individual productivity 74
Table 5.19 Results one-way ANOVA test (post hoc Games-Howell) age range and individual productivity 74
Table 5.20 Results independent samples t-test on gender and individual productivity 74
Table 5.21 Results independent samples t-test on job function and individual productivity 75
Table 5.22 Linear model of predictors the physical home work environment of individual productivity .. 76
Table 5.23 Standardized direct effect integral path model function of the room on satisfaction factors ... 78
Table 5.24 Standardized direct effect integral path model size of the workplace on satisfaction factors ... 78
Table 5.25 Standardized direct effect integral path model use of the room on satisfaction factors 78
Table 5.26 Standardized direct effect integral path model facilities, ambient factors, and view on satisfaction factors 79
Table 5.27 Standardized direct effect integral path model household composition on satisfaction factors 79
Table 5.28 Standardized direct effect integral path model age on satisfaction factors 80
Table 5.29 Standardized direct effect integral path model education level on satisfaction factors 80
Table 5.30 Standardized direct effect integral path model gender and job function on satisfaction factors 80

LIST OF FIGURES

Figure 0.1 Conceptual framework 6
Figure 0.2 Research framework 7
Figure 0.3 Theoretical model 8
Figure 0.4 Conceptual model 9
Figure 1.1 Research gap 21
Figure 1.2 Summary of the concepts remote working, teleworking, and homeworking 22
Figure 2.1 Starting point literature review 27
Figure 2.2 Search strategy 27
Figure 3.1 Direct advantages and challenges of productivity during working at home 33
Figure 3.2 The Job Demands-Resources model (Bakker & Demerouti, 2007, p. 313) 40
Figure 3.3 Theoretical model 44
Figure 4.1 Theoretical model compared to the questionnaire of week 2 WWH project 49
Figure 4.2 Conceptual model 54
Figure 5.1 Pie chart distribution of household composition in research sample (N = 31,301) 59
Figure 5.2 Pie chart distribution of education level in research sample (N = 31,301) 60
Figure 5.3 Pie chart distribution of age in research sample (N = 31,301) 61
Figure 5.4 Bar graph ICT facilities respondents have at home 66
Figure 5.5 Outcomes significant relationships integral path model 82

Chapter 01

INTRODUCTION

1 INTRODUCTION

Already since the 80s of the twentieth century, research has been conducted on working from other places than the office itself, due to the rise of information and communication technologies (ICTs) (Pratt, 1984). It was predicted that with the developments in ICTs, it would become simply possible to work remotely in the future and therefore, also work from home. Homeworking is known for multiple challenges and advantages from an organizational, individual, and societal perspective (Kurland & Bailey, 2000). From an organizational level, on the one hand, it can increase the productivity of the employees, but on the other hand, it is harder for managers to monitor and measure performance. For the employees, their job satisfaction can increase or a better work-life balance can be established. However, informal interaction with colleagues becomes less easy which can, for example, result in social and professional isolation. From a societal perspective, it can help reduce traffic congestions and pollution, as fewer people travel to and from work every day (Kurland & Bailey, 2000). Because of all the advantages and the rise of ICTs, such as the laptop, the world wide web, and the mobile telephone, it was predicted that homeworking would become a popular, highly implemented arrangement (Martin & MacDonnell, 2012; Nakrošienė et al., 2019).

Nonetheless, offices have been far from disappeared from the face of the earth. In 2019, the demand for office space in the Netherlands was around 1,259,000 m2 (NVM Business, 2020) and since the financial crisis of 2008, it reached a record number of m2 in Rotterdam, Utrecht, and The Hague (CBRE Netherlands, 2020). Throughout the years, homeworking arrangements were adopted, but less than predicted (Martin & MacDonnell, 2012). There are multiple explanations for this phenomenon, such as lower career prospects for homeworking employees because these employees are literally not seen at the office (Nakrošienė et al., 2019). However, the most found explanation is the attitude (or hesitance) of managers to implement homeworking arrangements (Martin & MacDonnell, 2012; Steward, 2000).

Due to the Covid-19 crisis, people are told to stay at home as much as possible. From 13 March 2020, all (Dutch) employees, employers, and managers are challenged by this 'mass experiment' of many people working from home. Also, previous research on homeworking and productivity should be (re)viewed in light of this Covid-19 crisis. The use of ICTs has increased because most meetings are held online and communication is done via either telephone or computer. Employees have both positive and negative experiences with homeworking during Covid-19. Some people prefer not to go back to the office at all. For example, VodafoneZiggo, a Dutch telecommunications service provider, decided that homeworking would become their norm in the future (NOS, 2020). Others like to go back to the office because they miss social interaction with their colleagues and their workplace at home is not suitable enough for long-term homeworking. So, it can change the perception of assumptions around homeworking and it raises the question of what the future of the office should look like and to what extent people will be working from home after Covid-19.

1.1 RESEARCH GAP

As employees are known as "the most valuable assets of the organization" (Appel-Meulenbroek et al., 2020, p. 280) the productivity gains that homeworking can generate, or the productivity loss due to an unsuitable home work environment, are of high importance for organizations. Therefore, a lot of research has been conducted on productivity related to homeworking. However, in former research on homeworking and productivity, the respondents were mostly studied from a voluntary perspective, which resulted in only a part of the employees working from home some days of the week. Because it is recommended to work at home as much as possible during Covid-19, almost every knowledge worker now works at home, most days of the week.

Furthermore, the role the office work environment can have on employee behavior is researched extensively. These studies were mostly focused on how different types of offices and elements in the office influence productivity (e.g. Croon et al. (2005)). However, almost no research has been carried out on the influence the home office, i.e. the home work environment, has on productivity because in previous research it was assumed that the home worker had a suitable working environment at home. Recent research on homeworking during Covid-19 shows different results on the effect on productivity, as both increases

and decreases of productivity have been reported (Mihai et al., 2020; Moretti et al., 2020; Toscano & Zappalà, 2020). So, there is a research gap on the influence of the home work environment on productivity (see Figure 1.1).

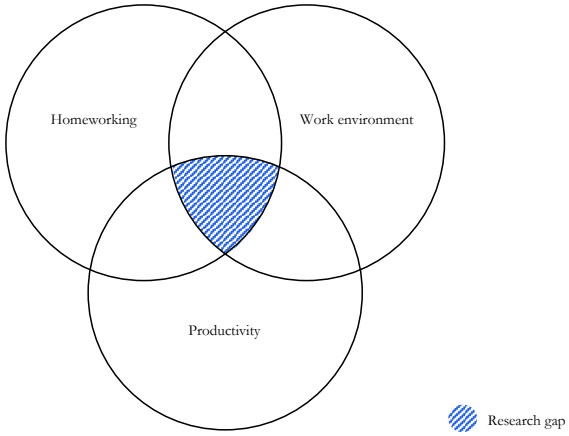

Figure 1.1 Research gap

1.2 RESEARCH AIM

Due to Covid-19, a unique opportunity arose to research what the experiences are of homeworking as most people work from home now. This forces employees to carry out certain work activities at home that were considered unsuitable beforehand. A lot of activities and processes are reconsidered due to mass homeworking. It can give new insights on the influence of the home work environment on productivity and it may have a big effect on post-Covid corporate real estate strategies and human resources.

This research aims to identify the aspects of the home work environment that influence employees' productivity to fill the research gap as defined in the previous section. Moreover, it can highlight the aspects that significantly influence productivity in the home work environment. Based on the outcome, a more people-based strategy can be developed to the extent that people work from home. Besides, multiple organizations have invested in improving the home work environment of their employees, by providing ICT facilities for example. Therefore, outlining the experiences of homeworking by looking at the influence of the home work environment on productivity, could provide organizations with more insights on how new corporate real estate and human resources strategies can look like.

1.3 RESEARCH SCOPE

Several concepts, such as homeworking, teleworking, remote working, and telecommuting are used interchangeably (Nakrošienė et al., 2019), but there are differences between them. To define the scope of this research, first, the concepts of working at home and productivity, the two focal points of this research, are defined.

Homeworking means that your home is used as a base to perform your work duties. A homeworker performs his work from home at least one day a week (Sullivan, 2003). Remote working can be defined as not working from a traditional office space. Remote workers can work from anywhere (Felstead & Henseke, 2017), such as in a coffee shop, co-working space, or during travel time in a train or car. This means that remote workers do not automatically work from home. A teleworker can be defined as "[…] someone who works at a place other than where the results of work are needed using ICTs" (Stanworth, 1998, p. 53). So, a teleworker is a remote worker, but a remote worker is not necessarily a teleworker (see also Figure 1.2). However, most of the time ICTs are used to enable employees to work from home (Halford, 2005). Employees using ICTs, such as a telephone and computer, and working from home are defined as telehomeworkers (Sullivan, 2003).

To summarize, when an employee is not working in the office, but somewhere else, it is called remote working (dotted line in Figure 1.2). When this employee works at home, he is called a homeworker (square 'home' within the dotted line of homeworking in Figure 1.2). When the homeworker is using ICTs, he is called a homeworker (see also Figure 1.2). The use of ICTs during homeworking is crucial for communicating, especially when every employee is likely to work from home as is the case in this research. So, when in this research the terms homeworking or homeworker are used, it refers to the more accurate terms of telehomeworking and telehomeworker.

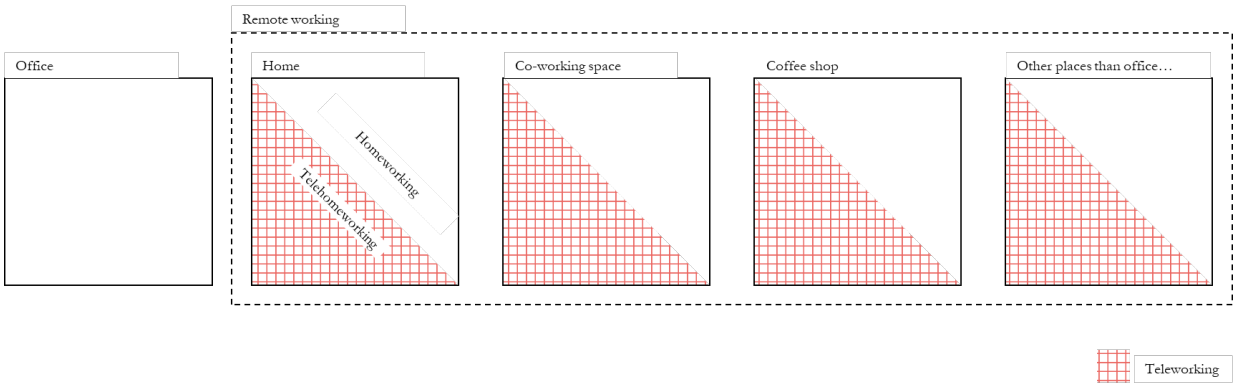

Figure 1.2 Summary of the concepts remote working, teleworking, and homeworking

The second concept in the research is productivity. Productivity is defined as the ratio of input and output (Neufeld & Fang, 2005). Productivity is of high importance for organizations, as the profit and loss depend on the productivity of the employees, also known as labor productivity. This is both the case for commercial and public organizations, as overall costs are essential for every organization (Maarleveld & de Been, 2011).

In this study, the emphasis is on the productivity of knowledge workers. The productivity of knowledge workers is hard to measure, as it is difficult to quantify and there are multiple ways of executing the work. Therefore, the outcomes of knowledge workers are mostly not comparable (Bosch-Sijtsema et al., 2009). For this reason, productivity measurements of knowledge workers are mostly perceived. It has to be noted that, due to Covid-19, people not only voluntarily work from home. Some employees felt working at home was only tolerated by their employer before Covid-19 and they would like to continue working at home in the future. Others may want to work at the office again as soon as possible. Both attitudes can influence their perceived productivity, as they may be more optimistic or pessimistic about the influence homeworking has on their productivity.

Productivity can be divided into individual, team, and organizational productivity (Maarleveld & de Been, 2011; Neufeld & Fang, 2005). Individual productivity is affected by the support of the work environment, where the team and organizational productivity are less influenced by this (Maarleveld & de Been, 2011). As productivity is measured by the employee's perception, the focus in this study is on individual and team productivity. This can subsequently show how the home work environment of employees indirectly can increase or decrease organizational productivity.

1.4 RESEARCH QUESTIONS

Based on the research gap, aim, and scope, the following research question is posed:

What is the influence of the home work environment during telehomeworking on perceived productivity?

To answer the main research question, three sub-questions are formulated. To identify the factors of homeworking that can influence productivity, it is important to first research existing theories revolving around homeworking. These theories can show whether, but more importantly how, productivity can be influenced by homeworking. Therefore, the first sub-question is:

SQ1 – *Which theories that revolve around homeworking and productivity can be distinguished?*

When these theories are identified, the specific work environment of homeworkers can be researched. The second sub-question looks into the aspects of the home work environment, that may influence productivity during homeworking. Hence, the second sub-question is:

SQ2 – *What aspects of the home work environment during homeworking can influence employees' productivity?*

The first two sub-questions form the theoretical framework. As a result, several hypotheses are posed from these distinguished theories and the identified aspects of the home work environment. To see if and how these hypotheses emerge, the following sub-question is posed:

SQ3 – *What effect do aspects of the home work environment have on employees' productivity?*

The outcome of this research question shows the influence of these aspects on productivity and a comparison can be made to see what aspects have the biggest effect. By researching these three sub-questions, the main research question can be answered.

Chapter 02

RESEARCH METHODOLOGY

2 RESEARCH METHODOLOGY

The study is part of a research project called 'We Werken Thuis' (We Work at Home; WWH). For this study, the data of WWH are used to conduct quantitative research on the influence homeworking has on productivity. Quantitative research allows studying multiple subjects at the same time that, in this case, influence productivity. In addition, the results can be studied objectively and, to some extent, be generalized.

WWH aims to collect experiences with and insights in mass and obliged homeworking to firstly offer organizations and employees practical tools on how to work from home, now and in the future, and secondly provide insights into starting points for policy and management after Covid-19. The WWH research can be divided into seven main themes, namely (1) organization, (2) home work environment, (3) health and vitality, (4) social cohesion, (5) collaboration, (6) leadership, and (7) future. The focus of this thesis is on the second theme: the home work environment.

WWH is a collaboration of four organizations, namely Aestate / ontrafelexperts, Center for People and Buildings, the University of Technology Delft, and the University of Technology Eindhoven. Aestate is a consulting firm based in Odijk, the Netherlands, specialized in housing, real estate advice, and healthcare real estate. Their clients are mostly operating in the public sector, such as Rijksvastgoedbedrijf (*Central Government Real Estate Agency*), the Municipality of Utrecht, and the Erasmus University Rotterdam (Aestate, n.d.). From Aestate the point of contact for this research is the director and senior advisor dr. ir. P. (Pity) Jongens. The Center for People and Buildings is a knowledge center based in Delft, Netherlands. This center is founded in 2001 to conduct knowledge about people, work, and the working environment applicable to companies and governments. It tends to do applied research based on scientific methods, mostly in the office and education sector (Center for People and Buildings, n.d.). From the Center for People and Buildings, the lead researcher is ir. W. (Wim) Pullen. Last, the lead researchers from Delft University of Technology and Eindhoven University of Technology are dr. ir. M. H. (Monique) Arkesteijn, MBA (TU Delft) and dr. ir. H.A.J.A. (Rianne) Appel-Meulenbroek (TU Eindhoven).

2.1 RESEARCH FRAMEWORK

First, a literature review is conducted on relevant theories of homeworking and the aspects that can influence productivity are distinguished. With this literature review, the first two sub-questions are answered. Then, with the input of the literature and the questionnaire of WWH, hypotheses are formulated on the influence of the home work environment on productivity. These hypotheses are researched in the third sub-question. This is done by quantitative data analyses using SPSS. With all information gathered from the literature review and the statistical analyses, a conclusion can be drawn to answer the main research question. The research is divided into two phases, i.e. Phase 1: Desk research, Phase 2: Empirical research. Each phase uses different methods and has a different output (see Table 2.1).

Table 2.1 Research overview

	Phase 1		**Phase 2**
Type	Desk Research		Empirical research
Research questions	Which theories that revolve around homeworking and productivity can be distinguished?	What aspects of the home work environment during homeworking, found in literature, can influence employees' productivity?	To what extent is there a relationship between aspects of the home work environment and employees' productivity?
Methods	Literature review		Statistical analyses
Output	Relevant theories on homeworking	List of aspects of the home work environment	Rejected or fail to rejected null hypotheses

2.1.1 Phase 1: Desk research

A literature review is conducted on the effect of homeworking on productivity. It aims to distinguish theories and independent variables that revolve around homeworking concerning productivity. So, the starting point of this literature review is the effect homeworking has on productivity as shown in Figure 2.1.

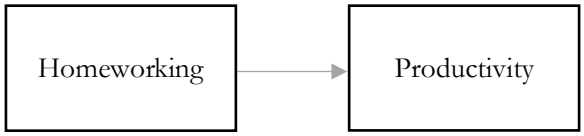

Figure 2.1 Starting point literature review

To collect all relevant papers, three search engines are used. These are the multi-disciplinary search engines of Scopus and Web of Science Core Collection, and a more specific database of life sciences PubMed. As discussed in Section 1.3, the concepts homeworking, remote working, teleworking, and telecommuting are often used interchangeably. Therefore, all these terms are used for the systematic literature review and how these concepts are related to the term productivity. So, the input for the search engines was: "homework*" OR "home work*" OR "remote work*" OR "telework*" OR "telecommute*" AND "productivity" (see Figure 2.2). The same search terms were used in all three databases in November 2020, with the results of 223 papers.

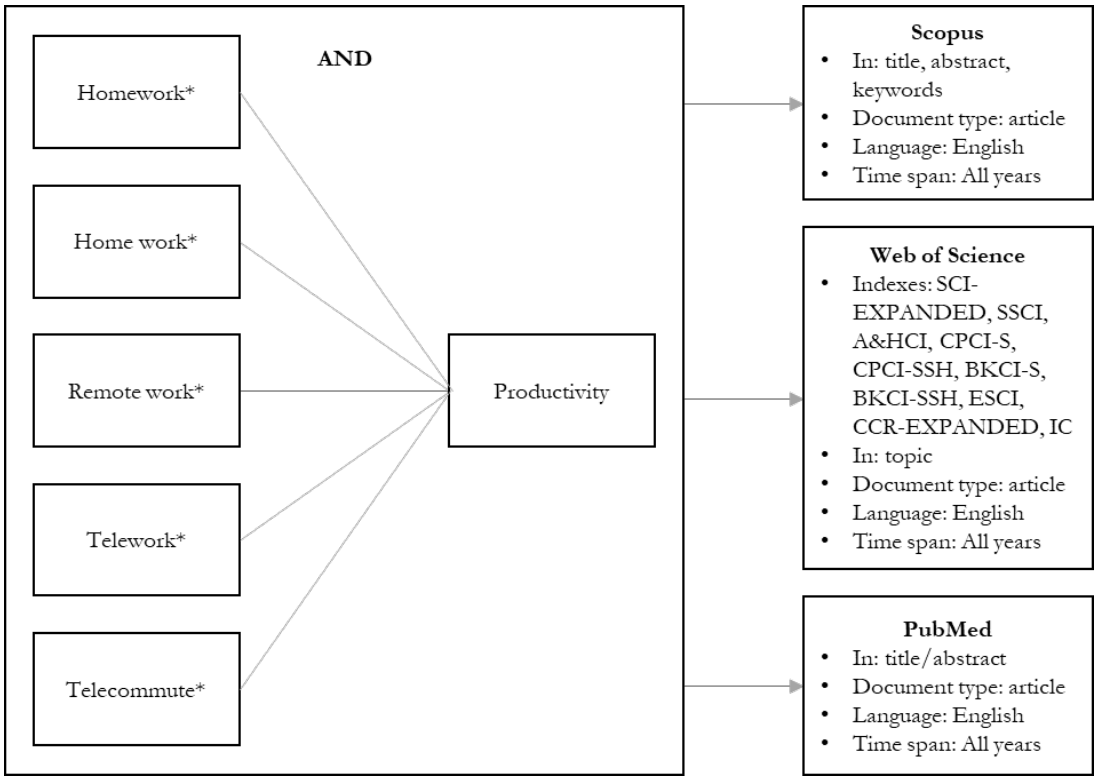

Figure 2.2 Search strategy

These articles form the initial database of the literature review. The database is screened three times to exclude all irrelevant papers. First, the title of the papers was scanned, followed by a scan of the abstract. The remaining papers were read fully. The papers were tested against the inclusion criteria described in Table 2.2 on the following page. This resulted in 38 papers for the analysis. The results are discussed in Chapter 3 Literature review and gives the answers to the first two sub-questions, followed by a theoretical model.

Table 2.2 Inclusion and exclusion criteria used in the selection of papers

Inclusion criteria	Exclusion criteria
- Setting: home work environment	- Setting: other environments, such as co-working spaces
- Type of research: empirical studies and systematic reviews	- Type of research: theoretical papers, position papers, etc.
- Dependent variable: directly measuring productivity	- Dependent variable: not directly measuring productivity
- Subject: knowledge workers in Western countries	- Subject: knowledge workers in non-Western countries, special needs groups (e.g. disabled people), etc.

2.1.2 Phase 2: Empirical research

To answer the third sub-question, quantitative data are used collected by the research consortium WWH. For this dataset, the participating companies are all ministries of the Dutch government, Belastingdienst (*Tax and Customs Administration*), De Nederlandsche Bank (*The Dutch Bank*), province South-Holland, DCMR Milieudienst Rijnmond (*DCMR environmental service Rijnmond*), the Police of the Netherlands, and Uitvoeringsinstituut Werknemersverzekeringen (UWV) (*Employee Insurance Agency*). The employees of these organizations received one questionnaire per week, for nine weeks. It took about 15 minutes to fill in the first questionnaire. Each subsequent questionnaire took 3 to 5 minutes to complete.

These questionnaires have been conducted in three different periods, so-called cohorts. For this thesis, the questionnaire of the second week is used. In total, data are gathered of 36,102 respondents, distributed over the following cohorts:

1. April till June 2020 with 7,933 respondents;
2. July till September 2020 with 14,478 respondents;
3. October till December 2020 with 13,691 respondents.

First, the data had to be prepared. Preparing means that missing values had to be detected and variables were recoded to be used properly in the statistical analysis. It has to be noted that this questionnaire was already set up and distributed to respondents before the literature study was conducted. Therefore, when the variables were mapped out, a comparison had been made between the theoretical model from the literature review and the variables from the questionnaire, to see what dependent and independent variables match. This matching process forms the conceptual model. From the conceptual model, hypotheses were formulated to test in the statistical analysis.

The hypotheses are being tested with the use of the program IBM® SPSS®. This is done with various analysis methods, such as an independent samples t-test, one-way ANOVA, and parametric Pearson correlation tests. First bivariate analyses are conducted to see what the relationships are between the independent variables and the dependent variable productivity. This is followed by a regression analysis to see to what extent these variables influence productivity. The type of variable, i.e. ordinal vs. categorical, determine what type of bivariate analyses is conducted. This is explained by a decision tree found in Appendix B.1. It was decided to use parametric analysis methods instead of non-parametric because the sample size was large enough, it allows to analyze groups with unequal variances, and it has greater statistical power.

The whole sample is tested as one homogeneous group followed by a heterogeneous analysis of the individual control variables. This heterogeneous analysis is conducted to compare different types of groups based on individual control variables, such as gender and age, to see how different types of employees respond to working from home and their productivity. Last, all elements are put together in an integrated analysis to see what indirect relationships, next to direct relationships can be found. Therefore, path analysis is executed with the use of the plugin program IBM® SPSS® Amos.

2.2 DATA PLAN

For the data used in this research and the data from this research, the FAIR guidance principles have been applied. The FAIR guidance principles are an abbreviation of Findable, Accessible, Interoperable, and Reusable (Wilkinson et al., 2016).

To be findable and accessible, the final research thesis will be published on the educational repository of the Delft University of Technology. This repository can be found by using the following link: https://repository.tudelft.nl. Besides, data that are not included in the final published thesis, can be retrieved upon request by sending an email to the email address mentioned in the colophon at the beginning of this report. To be easily interoperable, the language used in this thesis is English. This is seen as a 'broadly applicable language for knowledge representation' (Wilkinson et al., 2016, p. 4). Also, Dutch data are translated to English, and if necessary include the Dutch term in brackets. Last, the methodology of the analyzed data is explained in detail for the reusability of the research. All data are referenced or cited in APA style. The full references can be found in the reference chapter at the end of this report.

2.3 ETHICAL CONSIDERATIONS

Diener and Crandall (1978, as cited in Bryman, (2012, p. 135)) summarized ethical considerations in social research fourfold. First, the participant may not be harmed by the research. For this research, participation in the research is voluntary and a participant is by no means obliged to give answers to a question. This means that there were no mandatory questions in the questionnaire. However, when the data is prepared for analysis, respondents that did not fill in certain questions, such as their perceived productivity, had to be excluded from the analysis.

Secondly, there should be no lack of informed consent (Diener and Crandall, 1978, as cited in Bryman, 2012). This is guaranteed by informing participants about the goal of the research beforehand with the invitation to participate. This is done by the consortium of WWH during the three cohorts as discussed in Section 2.1.2.

Thirdly, there should be no invasion of privacy. For the data collection of WWH, the questionnaires are anonymous.

Last, there must be no deception included (Diener and Crandall, 1978, as cited in Bryman, 2012). This is ensured by reporting every step of the research with full honesty so nothing is masqueraded as another matter.

Chapter 03

LITERATURE REVIEW

3 LITERATURE REVIEW

Throughout the years, research shows that homeworking increases productivity (Giovanis, 2018; Martin & MacDonnell, 2012). However, homeworking is mostly studied as a phenomenon in itself, which means that no specific elements of homeworking were researched more in detail. An exception is Hoornweg et al. (2016), which discusses the role telework intensity has on productivity. Telework intensity is the number of hours working from home compared to the total number of hours worked. When the telework intensity is too high, it was found that productivity decreased (Hoornweg et al., 2016). As the employees during Covid-19 are likely to work at home every day, the telework intensity is of a high level. This implies that the productivity of the homeworker during Covid-19 would decrease instead of increase.

Recent research on homeworking and productivity during Covid-19, however, shows various results. According to Moretti et al. (2020) respondents were less productive and less stressed. Toscano and Zappalá (2020) record a high level of strain and, because of that, low productivity, whereas Mihai et al. (2020) show higher productivity during Covid-19.

Table 3.1 Papers addressing team productivity

Paper	Studied variables of homeworking	Type of study	Major findings related to team productivity
(Bosch-Sijtsema et al., 2009)	n/a	Literature review	Five aspects are identified from literature that influences the productivity of knowledge workers in distributed teams: (1) the time spent of knowledge workers in different work modes and on different tasks, (2) team structure and composition, (3) team processes, (4) physical, virtual and social workspace, and (5) organizational context. However, it is not studied to what extent these elements influence the team productivity of knowledge workers.
(Belanger et al., 2001)	- Availability of information system technology - Availability of communication technologies - Communication patterns of telecommuters	Cross-sectional (n = unknown)	Technology variables have a positive influence on productivity and the interaction between the technology variables is significant for perceived productivity. However, workgroup communication has a negative effect on perceived productivity. This means that it is hard to establish adequate group communication within virtual teams.
(Hill et al., 1998)	- Mobile teleworker vs. traditional office worker - Mobility	Cross-sectional (n = 399)	From qualitative data, a negative relation is mentioned generally between homeworking and working in a team. However, quantitative data did not support nor rejected this negative relation. The negative influence of homeworking on teamwork was probably overestimated in previous research.

Most studies looked at how homeworking impacted the employee's perceived individual productivity, such as Bosua et al. (2013), Nakrošienė et al. (2019), and Singh et al. (2013). Only some studies researched the effect on team productivity (Belanger et al., 2001; Bosch-Sijtsema et al., 2009; Hill et al., 1998). Virtual teams, meaning that every team member works from a different place remotely, were researched (see Table 3.1). Homeworkers during Covid-19 that work in a team, work consequently in a virtual team, as everybody is likely to work from home.

Hill et al. (1998), found a negative relation between teamwork and productivity but discuss that this negative influence was overrated in previous research. Belanger et al. (2001) looked into several aspects of virtual teamwork and how this influences productivity. They discuss the importance of technology for interaction between several team members, and how this can positively influence team productivity. However, it was still noticed that group communication is hard to establish and negatively influences productivity (Belanger et al., 2001). Other aspects that influence virtual team productivity are (1) the time

spent of knowledge workers in different work modes and on different tasks, (2) team structure and composition, (3) team processes, (4) physical, virtual and social workspace, and (5) organizational context (Bosch-Sijtsema et al., 2009). However, to what extent these aspects influence team productivity was not found in the literature.

Table 3.2 Literature related to type of direct factor within homeworking on productivity

Type of direct factor	Literature
Autonomy	Bosua et al., 2013; Nakrošienė et al., 2019; Singh et al., 2013; Steward, 2000
Commuting	Bosua et al., 2013; Hill et al., 1998; Singh et al., 2013
Managerial support	Baker et al., 2006; Bosua et al., 2013; Nakrošienė et al., 2019; Neufeld & Fang, 2005
Physical home work environment	Moretti et al., 2020; Nakrošienė et al., 2019; Ralph et al., 2020; Tunyaplin et al., 1998
Strain and motivation	Bosua et al., 2013; Hoornweg et al., 2016; Martin & MacDonnell, 2012; Mihai et al., 2020; Moretti et al., 2020
Work-life balance	Bosua et al., 2013; Giovanis, 2018; Hill et al., 1998; Nakrošienė et al., 2019; Neufeld & Fang, 2005; Singh et al., 2013

A productivity increase is one of the major advantages for organizations when looking at homeworking, but other advantages and challenges are found in literature as well. A productivity gain is related to some of these advantages and challenges, both direct and indirect. The literature study showed the importance of the following direct factors: autonomy, commuting, managerial support, physical home work environment, strain and motivation, and work-life balance (see also Table 3.2).

These direct factors are categorized by organizational, individual, and societal advantages and challenges (Kurland & Bailey, 2000) (see Figure 3.1). Most factors can be both a challenge and an advantage, for example, the work-life balance can be positively or negatively influenced, or the physical work environment can be suitable or unsuitable for homeworking.

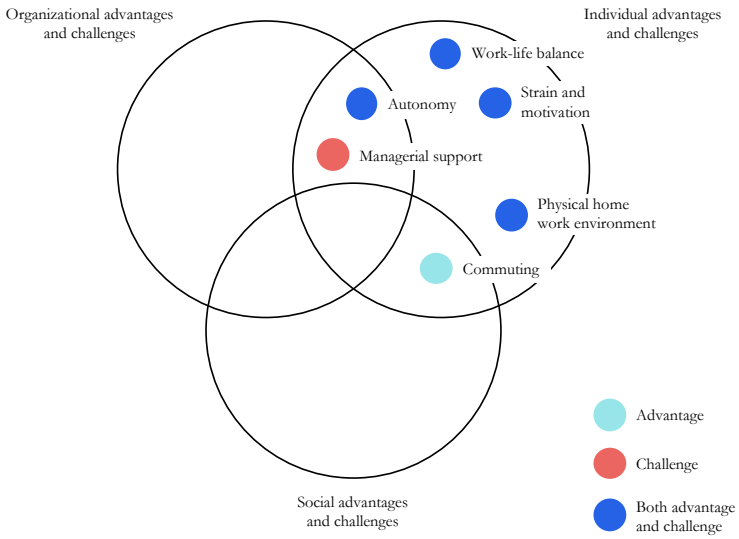

Figure 3.1 Direct advantages and challenges of productivity during working at home

The following subsections discuss these direct advantages and challenges and how they are related to productivity. The studies are organized into three research dimensions, being:

1. The physical home work environment,
2. The social environment,
3. Individual control variables.

First, the physical home work environment is discussed, including both the objective home work environment (e.g. the size of the workplace) and the subjective home work environment (e.g. satisfaction with the home work environment). Besides, the advantage of saving commuting time is discussed as well. This is followed by the social environment, i.e. autonomy and managerial support. The aspects of the physical home work environment and the social environment together form the overall home work environment. Thirdly, the individual control variables are introduced, such as age and gender. It also includes theories on strain and motivation and the work-life balance. Last, all the theories and aspects are combined and summarized in a theoretical model. Throughout the chapter, parts of the theoretical model are explained one by one (red outline text frame).

3.1 PHYSICAL HOME WORK ENVIRONMENT

So far, studies on productivity and the work environment are mostly focused on the office work environment, instead of the home work environment, such as the literature study by de Croon et al. (2005). An exception being Ng (2010), which adjusted the conceptual framework of Croon et al. (2005) to fit into the context of the home work environment. However, Ng (2010) did not research the effect these aspects of the home work environment have on productivity.

According to Croon et al. (2005), aspects of the office work environment that influence employee performance, in this case, productivity can be categorized by (1) office location, (2) office lay-out, and (3) office use. The office location can be the telework office or the conventional office (de Croon et al., 2005). For the study of this thesis, the office location is at home, i.e. the telehomework office. So, the focus is on the latter two.

When the framework of layout and use is converted to the home work environment, a distinction can be made between the physical environment and the behavioral environment. The physical environmental variables identified by Ng (2010) are the spatial requirements, lay-out and use, ambient factors, and job equipment.

First, the work environment has to fulfill some spatial requirements. The size of the dwelling influences the size of the home work environment. Having extra space at home to fulfill work duties, is one of the major factors for the choice of homeworking (Ng, 2010). During Covid-19 it was highly recommended to work from home, but not everyone has enough space at home to arrange a home work environment of sufficient size.

Secondly the layout and use, according to Croon et al. (2005), means whether the office uses an open plan or cellular offices and if the workplaces are fixed or shared. The office layout in the home work environment means whether the room is used as a separate office or is used within another room (Ng, 2010), such as a living room or a bedroom. The office use is explained by whether the room is shared or not. The preference of homeworkers is to have a private office compared to a shared office, especially because of distraction issues (Ng, 2010).

The ambient factors are the third aspect that can influence productivity. Ambient factors include noise, lighting, and view. One of the reasons to prefer a private office over a shared office is that there is less noise and therefore less distraction in the work environment. At home, the noise can be controlled better than at the office, but agreements need to be made with family members or roommates to reduce the level of noise when working at home. It also depends on the original function the room has where one works in what type of noise can be reduced (Ng, 2010). Good lighting affects the job tasks in general positively, but it depends on the type of tasks what lighting is needed. Lighting is divided into natural lighting and artificial lighting. Natural lighting can be found when one works near a window. More sunlight penetration was reported to increase productivity (Ng, 2010). This is also related to the view an employee has at his office. Employees prefer to work near a window. It has not been reported that it increases productivity, but it could contribute to the reduction of boredom and decreases strain (Ng, 2010). In addition to noise and lighting, it was found that indoor air quality (IAQ) and temperature influence productivity as well (Franke & Nadler, 2020). Franke and Nadler (2020) call these aspects 'tangible factors' as they can objectively be measured and controlled. Also, Haynes (2008) discusses IAQ (ventilation), temperature, and lighting, which is summarized as the 'comfort component'. Comfort also includes décor, which can affect productivity (Haynes, 2008). This can also be applied to the home work environment as the décor of the home work environment is determined by the employee itself.

The last aspect is the job equipment. Physical resources are needed to perform basic job tasks, such as a work surface, and storage (adequate furniture), but also a computer for example (ICT facilities). Mostly the ICT facilities are provided by employers, but less often adequate furniture is supplied (Ng, 2010). Especially adequate furniture is needed during Covid-19 as not every employee was prepared to work from home and had suitable furniture available right away (Moretti et al., 2020).

The person-environment (P-E) fit theory from Edwards et al. (1998) can be applied to the physical work environment. First, as the name suggests, there is a relation between the person and the environment., which forms the basis of the model. Secondly, there is a relation between the objective and subjective variances of the person and the environment. The objective person and environment refer to the person and environment as they objectively exist, whereas the subjective person and environment entail how the person and the environment are perceived from the person's viewpoint, i.e. the experience or satisfaction with the person's attributes or situation. Last, there are two types of P-E fit, namely the fit between the demands of the environment and abilities of a person, and between the needs of a person and the supplies of the environment (Edwards et al., 1998; Bakker & Demerouti, 2007).

When there is a subjective P-E misfit, for example when the work environment and the needs of an employee are not met, the risk of strain increases (Appel-Meulenbroek et al., 2020; Edwards et al., 1998). This can have two different outcomes. On the one hand, the outcome could be a coping or defense reaction. Coping means that the objective environment is being improved to a person's needs. Defense shows the attempt to improve the subjective person or environment, such as projection or denial (Edwards et al., 1998). On the other hand, psychological strain increases, which includes dissatisfaction (Edwards et al., 1998).

Theoretical model

The aspects that influence productivity are (1) original function, (2) use (private vs. shared), (3) size, (4) ICT facilities, (5) ambient factors, (6) view, and (7) furniture. All these aspects can be summarized as the physical home work environment. When combining these aspects and the P-E fit theory, it is expected that if the physical work environment fits the employee's needs, the productivity of the homeworker increases. This is indicated by a direct arrow from the physical home work environment to perceived productivity in Figure 3.3.

Four articles have been found that mention the physical home work environment related to productivity when homeworking (see Table 3.3). Already in 1998, it was assumed that if the comfort of the home work environment was higher than the office comfort, the productivity would increase when working at home (Tunyaplin et al., 1998). Also, Nakrošienė et al. (2019), found that the suitability of the workplace had a positive effect on productivity.

Recent papers on Covid-19 address the importance of the physical home work environment related to ergonomics (Moretti et al., 2020; Ralph et al., 2020). According to Moretti et al. (2020), well-suited furniture for performing work is of high importance for homeworkers as it can decrease the risk of health problems, such as low back and neck pain. When musculoskeletal (MSK) issues occur, productivity is likely to decrease. Ralph et al. (2020) not only addresses the ergonomics of the furniture but researches also the overall ergonomics. This included distraction, noise, lighting, temperature, and chair comfort (Ralph et al., 2020). Especially the former aspect had a negative relationship with productivity (Ralph et al., 2020).

The studied variables by Ralph et al. (2020) can be summarized as the level of comfort as researched by Tunyaplin et al. (1998), two decades before. This level of comfort influences the satisfaction with the home work environment and is aligned with the P-E fit theory that explains the increase of psychological strain, when the subjective person and environment, i.e. the experience of the home work environment, does not fit. Hence, the level of satisfaction of the work environment needs to be measured to see if there is a P-E fit or misfit, as this can influence productivity.

Table 3.3 Papers addressing home work environment and homeworking productivity

Paper	Studied variables of homeworking	Type of study	Major findings related to the physical home work environment and productivity
(Moretti et al., 2020)	- Type of chair (e.g. adjustability, support, back) - Type of table (e.g. adjustability, size)	Cross-sectional (n = 51)	The home environment is not adequate for the mobile worker population, meaning an increased risk for mental health and MSK problems. When these problems are addressed job productivity can be improved.
(Nakrošienė et al., 2019)	- Suitability of a working place at home	Cross-sectional (n = 128)	The suitability of the workplace was related to higher perceived productivity. The study supports the results of prior research about the importance of the working placer on teleworker's efficiency. So, the physical home work environment is of high importance in telework arrangements.
(Ralph et al., 2020)	- Distractions - Noise - Lighting - Temperature - Chair comfort - Overall ergonomics	Cross-sectional (n = 2225)	Home office ergonomics affect productivity. To increase productivity, the ergonomics of employees' home offices have to be improved.
(Tunyaplin et al., 1998)	- Employees' level of comfort	Preliminary study (n = unknown)	When the home office of an employee is more comfortable than an office, the productivity of the employee increases when working at home.

Theoretical model

Multiple aspects can be considered to measure the satisfaction with the home work environment. The aspects in the theoretical model (Figure 3.3) is a summary of four articles addressing the home work environment and productivity (Moretti et al., 2020; Nakrošienė et al., 2019; Ralph et al., 2020; Tunyaplin et al., 1998) combined with the literature reviews of Ng (2010). These aspects are satisfaction with (1) comfort, (2) ICT facilities, (3) furniture, (4) light, (5) overall suitability, (6) possibility of concentrated work, (7) privacy level, (8) size, (9) temperature, (10) ventilation, and (11) view.

Some of the aspects match one on one with the physical home work environment aspects, such as ICT facilities, furniture, light, size, and view. Some aspects are only measured subjectively, being the overall suitability, possibility of concentrated work, privacy level, temperature, and ventilation.

As satisfaction (subjective environment) is influenced by the physical home work environment (objective environment), as explained by the P-E fit theory, consequently the physical work environment influences the satisfaction, which then again influences productivity. The direct relation between satisfaction with the home work environment and perceived productivity is drawn in the theoretical model as well as the indirect relation from the home work environment via the satisfaction with the home work environment (dashed arrow; Figure 3.3).

3.1.1 Commuting

The dominant advantage of homeworking from a societal perspective is that it can reduce travel congestion, because of less commuting to and from work. Less commuting is also reported as an advantage from an individual point of view (see Table 3.4), as it can increase productivity (Bosua et al., 2013). The saved travel time is mostly used to work longer hours (Bosua et al., 2013; Hill et al., 1998) and, therefore, homeworkers tend to start the working day earlier than their non-homework colleagues. Furthermore, people that have a

longer commuting time to work, are more likely to have the option to work at home and choose to do so (Singh et al., 2013).

Theoretical model

In addition to the aspects of the physical home work environment already mentioned, commuting time influences the perceived productivity as well and is included in Figure 3.3.

Table 3.4 Papers addressing commuting and homeworking productivity

Paper	Studied variables of homeworking	Type of study	Major findings related to commuting and productivity
(Bosua et al., 2013)	- Expenses related to travel	Cross-sectional (*n* = 28)	The time normally spent on commuting was used to work more hours per day. The working days started earlier during telework days than during non-telework days.
(Hill et al., 1998)	- Mobile teleworker vs. traditional office worker - Mobility	Cross-sectional (*n* = 399)	Mobility was significantly related to an increase in productivity, both by quantitative and qualitative data. Having more flexibility in timing and work location played a role in this as well. It enabled the respondents to work longer hours.
(Singh et al., 2013)	- One-way commute distance - Option, choice, and frequency of homeworking	Cross-sectional (*n* = 2,563)	Employees whose commuting time (one-way) is longer than 20 miles, often have the option to telecommute and are more inclined to do so.

3.2 SOCIAL ENVIRONMENT

Next to the physical home work environment, the so-called social environment influences productivity as well. The social environment consists of the level of autonomy and the managerial support received from the organization influencing productivity.

3.2.1 Level of autonomy

Four papers were identified that researched the influence of autonomy during homeworking on productivity (see Table 3.5). The increase in time flexibility and, therefore, the rise of autonomy is one of the reasons to work from home (Nakrošienė et al., 2019; Steward, 2000). This gives employees the possibility to adjust the work rhythm that is best suitable for them. When the employee can decide when to work, they can work during their most productive time, which will increase their overall productivity (Bosua et al., 2013).

However, according to Steward (2000), when homeworking most people tend to schedule their time, thus their work rhythm, from Monday to Friday within a 9 to 5 day. There are two reasons for this. First, it could be that employees are not expected by their organization to adjust their work rhythm, or (2) employees do not want to adjust their work rhythm, because they are used to it (Steward, 2000).

Furthermore, the boundary between professional and personal life is more blurred when homeworking, also known as the boundary theory (Steward, 2000). It is harder to keep in time, and because the line between work and family is more blurred, a meal or drink is not included in the calculation of work time (Steward, 2000), and it is harder to separate yourself from work when needed. According to Bosua et al. (2013) employees tend to work even more hours per day in the evening and during weekends. Employees recalculated their productive working hours because they are isolated from the original office and their colleagues (Bosua et al., 2013). This is also known as professional and social isolation, which is seen as a disadvantage of homeworking (Ng, 2010).

Table 3.5 Papers addressing autonomy and homeworking productivity

Paper	Studied variables of homeworking	Type of study	Major findings related to autonomy and productivity
(Bosua et al., 2013)	- Actual hours worked - Tasks planned - Actual completed tasks	Cross-sectional (*n* = 28)	Participants worked longer hours during telework days compared to non-telework days. During telework days they reported to be more productive. Overall, participants felt that enabling employees to be flexible in their work schedule, would increase their productivity.
(Nakrošienė et al., 2019)	- Possibility to work during the most productive time - Time planning skills	Cross-sectional (*n* = 128)	A moderate correlation is found between the most productive time and perceived productivity (r = 0.41) and between time planning skills and perceived productivity a weak correlation (r = 0.22) is found.
(Singh et al., 2013)	- Option, choice, and frequency of homeworking	Cross-sectional (*n* = 2,563)	People that find work flexibility of high importance, tend to work for an employer that provides him/her with temporal flexibility, i.e. being flexible in work timing, and spatial flexibility, meaning to have the flexibility to work anywhere.
(Steward, 2000)	- Time flexibility	Longitudinal (*n* = 39)	Teleworkers seldom work flexibly during office hours but tend to work more in the evenings and weekends. Time is recalculated by teleworkers into productive working hours, as they are isolated from the office.

Nonetheless, employees reported their work as more flexible and enjoyed it more than working at the office (Steward, 2000). Also, Bosua et al. (2013) found that when employees are enabled to be more flexible in their work schedule, their productivity would increase. Besides, the 'option' element has to be included when studying the effect of homeworking on productivity, otherwise invalid outcomes will be reported. This option element means whether the manager provides their employees the option to telecommute or not (Singh et al., 2013). This is highly relevant, as the respondents of this research most of the time did not have the option to not work from home. For some, this could be experienced as forced homeworking, whereas others may want to work more often from home already. Because of the ability to work a more flexible work schedule and the (lack of) option element, an increase in the level of autonomy can result in higher productivity.

3.2.2 Managerial support

For homeworkers, it has been found that the support and trust of managers influences productivity (see Table 4.4). An employee is most suitable for homeworking when the employee has a positive belief and attitude towards it. When an organization generates a positive belief and attitude towards homeworking, it is more likely to be successfully adapted. This can be achieved by visible and verbal promotion of homeworking by top management (Neufeld & Fang, 2005). Also, the supervisor's trust and support are crucial for the establishment of a home-work arrangement, which impacts the overall satisfaction of the employee (Nakrošienė et al., 2019).

To manage homeworkers a different approach is needed than non-homeworkers. It demands trust from both the employee and manager and it is essential to schedule frequent meetings, set clear milestones and task deadlines to monitor and measure performance (Bosua et al., 2013). This support is also related to the level of IT facilities. High IT support, such as video conference tools, provision of a laptop or mobile device, provides the homeworker to work more productive, than with low IT support (Baker et al., 2006; Bosua et al., 2013).

Theoretical model

In addition to the level of autonomy, the managerial support of the employer influences productivity as well. So, the home work environment consists of the physical home work environment and the social environment. The social environment includes (1) the level of autonomy, and (2) managerial support.

Table 3.6 Papers addressing managerial support and homeworking productivity

Paper	Studied variables of homeworking	Type of study	Major findings related to managerial support and productivity
(Baker et al., 2006)	- IT support - Appropriateness of technology - Trust by manager	Cross-sectional (n = 50)	All three variables had an impact on the reaction of employees to home-based telecommuting. These were mostly related to satisfaction, and not significantly to productivity. Productivity was related to the support variable of the organization paying costs of home-based telecommuting.
(Bosua et al., 2013)	- Feelings and attitudes towards work - Level of IT support	Cross-sectional (n = 28)	According to the participants, trust is of importance for productivity during teleworking, both from an employee and manager perspective. Teleworkers need to be managed differently than non-teleworkers. It is necessary to schedule frequent meetings, set clear milestones and task deadlines. A high IT support (e.g. providing IT facilities for the home work environment), allows employees to work more productive than when this IT support is low.
(Nakrošienė et al., 2019)	- Supervisor's trust - Supervisor's support	Cross-sectional (n = 128)	The role of the supervisor is significant in establishing homeworking arrangements. It impacts employees' overall satisfaction and perceived career opportunities.
(Neufeld & Fang, 2005)	- Beliefs and attitudes - Social factors - Situational factors	Cross-sectional (n = 100)	One of the most important factors influencing telecommuter productivity was the interactions with the manager. High perceived productivity was related to a positive interaction with the managers, and low productivity was reported when the social interaction with the manager was reported weak.

3.3 INDIVIDUAL CONTROL VARIABLES

Age has to be taken into account when looking at the home work environment and productivity, because age, to some extent, determines how your physical home work environment is designed, like the size of the workplace or the original function of the room. Besides, younger generations may value the level of freedom during homeworking more than older generations. Whereas older generations have less urge for career prospects and are therefore more likely to take on home working arrangements (Nakrošienė et al., 2019).

According to Giovanis (2018), education level and telework correlate positively. This means that the higher the education level, the more likely the employee is to take one teleworking arrangement. Besides, it was found that a high education level relates to higher performance (Giovanis, 2018).

For the variable gender, it was reported that females (compared to males) were more likely to prefer homeworking arrangements, as it allows them to balance their work-life better (see also section 3.3.2) (Nakrošienė et al., 2019; Singh et al., 2013). However, it was also argued by Nakrošienė et al. (2019) that men are getting more involved within the household. So, it remains to be seen whether women will still appreciate working from home more than men in the future. According to Neufeld & Fang (2005), gender is more associated with the satisfaction with homeworking, instead of productivity.

Already Pratt (1984) made a distinction between employees and managers related to homeworking. A manager has to manage people they are associated with working at the office. However, due to Covid-19 also the managers have to work from home. As explained in section 3.2.2 employees work better when

they are supported by their manager during homeworking. So, as a control variable, the job function has to be taken into account as well.

In addition to the variables of age, education level, gender, and job function, also personality traits can influence productivity (Franke & Nadler, 2020). The personality traits used by Franke and Nadler (2020) are (1) extraversion, (2) neuroticism, (3) openness to experience, (4) conscientiousness, and (5) agreeableness, also called the 'Big five dimensions'. Respondents with a high score on neuroticism and openness to experience had a negative correlation with performance (Franke & Nadler, 2020). It was also found by Appel-Meulenbroek et al. (2020) that personality traits influence the level and type of strain. This has to be taken into account when looking at homeworking, especially during the Covid-19 crisis, but a comprehensive discussion of the influence of personality traits on productivity is beyond the scope of this study.

Theoretical model

For individual control variables, the following aspects are added to the theoretical model: (1) age, (2) education level, (3) gender, (4) job function, and (5) personality. All these aspects have a direct relation with performance. This is shown by an arrow from the individual control variables to productivity in Figure 3.3. It can also affect the satisfaction with the home work environment and, therefore, an indirect relation is drawn from the control variables to productivity, via the satisfaction aspects.

3.3.1 Strain and motivation

The concepts of strain and motivation in a work environment are explained by the Job Demands-Resources model (JD-R model) from Baker & Demerouti (2007), shown in Figure 3.2. This model explains the psychological outcomes and objective performance outcomes (Hoornweg et al., 2016). Factors that can influence job strain are divided into job demands and job resources. Job demands are, for example, work pressure and the physical environment, in this case, the physical home work environment. Job resources are related to the literal execution of achieving work goals, reduction of job demands, and the stimulation of personal growth (Bakker & Demerouti, 2007). In the case of homeworkers, job demands are for example communication and collaboration agreements on digital facilities. Examples of job resources are managerial support (see also subsection 3.2.2 Managerial support).

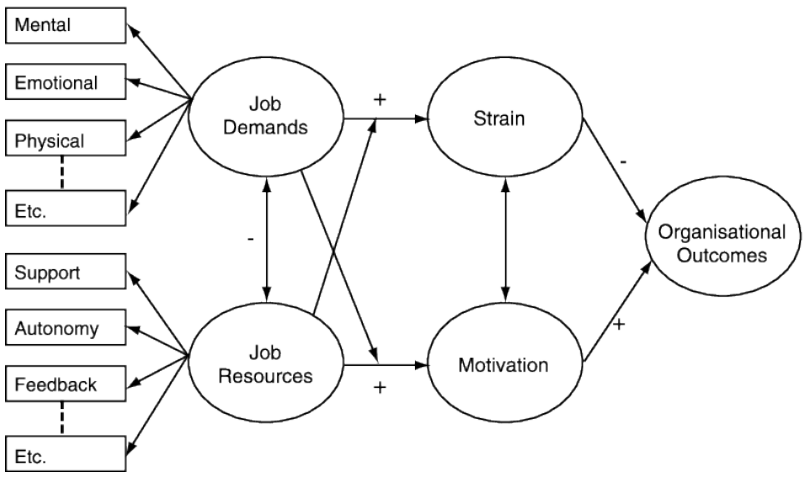

Figure 3.2 The Job Demands-Resources model (Bakker & Demerouti, 2007, p. 313)

The perception of job demands and resources are explained as two psychological processes that influence the strain and motivation of an employee. The strain and motivation of an employee then influence the organizational outcomes (Bakker & Demerouti, 2007), in this case, productivity. The first process of job demands assumes that 'health impairment process, poorly designed jobs or chronic job demands […] exhaust employees' mental and physical resources […]' (Bakker & Demerouti, 2007, p. 313).

The second process (job resources) states that when the job resources increase, the motivation of an employee rises as well. Besides, both processes influence each other, because the job resources can support the job demands. This is the case when job support by a supervisor decreases the work pressure for example (Bakker & Demerouti, 2007).

Five articles were identified that address strain and/or motivation concerning homeworking and productivity. On the one hand, Martin & MacDonell (2012), address that there is a positive relation between homeworking and organizational commitment. Eight correlations were found between homeworking and commitment, but there was weak support for the positive association telework would have on organizational commitment. Also, Bosua et al. (2013), reported self-motivation as one of the attributes associated with productive homeworking, which is aligned with the JD-R model.

On the other hand, homeworking was associated with a higher strain level. As mentioned before, Hoornweg et al. (2016) found that high telework intensity was associated with lower productivity, as this was seen as a job demand. Also, from research during Covid-19, it was found that homeworking influences the strain level. Mihai et al. (2020) reported a higher strain level but also increased productivity. This is in contradiction with the JD-R model where a higher strain level is associated with lower productivity. Moretti et al. (2020) noted a lower strain level due to Covid-19 and homeworker, which resulted in higher productivity.

Table 3.7 Papers addressing strain and/or motivation, and homeworking productivity

Paper	Studied variables of homeworking	Type of study	Major findings related to strain, motivation, and productivity
(Bosua et al., 2013)	- Individuals' general feelings of their day's productivity and wellbeing	Cross-sectional (*n* = 28)	Participants in the study were also asked to identify various attributes of productive teleworkers, and their responses included being driven, self-motivated, organized, disciplined, and being able to work independently.
(Hoornweg et al., 2016)	- Telework intensity - Autonomy - Feedback - Overtime	Cross-sectional (*n* = 111)	High-telework intensity functions as job demand, i.e. a stressor. High telework intensity reduces individual productivity. There was a lack of significant differences between intrinsic motivation and productivity.
(Martin & MacDonnell, 2012)	- Commitment	Meta-analysis (*n* = 22)	There is a small, but positive relationship between teleworking and organizational commitment. The higher the average age of the sample, the lower the correlation between teleworking and organizational commitment.
(Mihai et al., 2020)	- Level of stress	Cross-sectional (*n* = 138)	Because of the Covid-19 situation stress and fatigue increased, but productivity did as well.
(Moretti et al., 2020)	- Type of remote work - Working hours per week	Cross-sectional (*n* = 51)	Respondents were less productive, but also less stressed due to Covid-19.

Theoretical model

To summarize, strain and motivation are identified as important factors influencing productivity, as job demands and resources have changed due to mass homeworking. However, recent research has contradicting results. When homeworking, most of the meetings on a day are held online, so the job demands related to the use of ICTs increase. Job resources are changed because an office provides other facilities than a home office, such as a printer or a coffee machine, but also the level of autonomy and managerial support has changed.

Therefore, in addition to the individual control variables of age, education level, gender, job function, and personality, the level of motivation, and strain are added to these variables in the theoretical model (Figure 3.3).

3.3.2 Work-life balance

When working from home, work and family-related issues can and need to be dealt with in the same place. This can help to improve the work-life balance and work-life balance management is, therefore, one of the major motivators to work from home. It can improve the overall job satisfaction which affects overall productivity (Bosua et al., 2013; Giovanis, 2018). It generates a positive attitude towards homeworking, which results in lower strain and higher motivation (Giovanis, 2018). The ability to take care of family members, such as children, during work time can be seen as a job resource and can increase productivity (Nakrošienė et al., 2019).

Table 3.8 Papers addressing work-life balance and homeworking productivity

Paper	Studied variables of homeworking	Type of study	Major findings related to work-life balance and productivity
(Bosua et al., 2013)	- Number and type of interruptions each day	Cross-sectional (*n* = 28)	Participants reported different outcomes of teleworking relating to the work-life balance. A part of the respondents reported having a better work-life balance, and so their well-being increased. Others mentioned having more interruptions at home, so they could not be as productive as they wanted to.
(Giovanis, 2018)	n/a	Interviews (*n* = 28)	Homeworking improves the work-life balance, which generates a positive attitude towards homeworking. It increases the flexibility and autonomy of the employee. This resulted in a lower strain level and higher motivation and therefore increased productivity.
(Hill et al., 1998)	- Home office with a door	Cross-sectional (*n* = 399)	Both a better work-life balance as a decrease in the work-life balance was reported. Having a home office with a door decreased the work-life balance because the employee did not easily separate himself from work. Having children of preschool age was positively related to a greater work-life balance.
(Neufeld & Fang, 2005)	- Beliefs and attitudes - Social factors - Situational factors	Cross-sectional (*n* = 100)	Perceived productivity depends on positive or negative social interaction with family members. When social interaction is reported as negative, productivity is perceived as low, when the social interaction with family members is positive, productivity increases.
(Singh et al., 2013)	- Household demographic variables - Option, choice, and frequency of homeworking	Cross-sectional (*n* = 2,563)	Employees with children between 0 and 5 are more likely to have the option to work from home. Also, these employees choose to work from home to take care of their children. Nonetheless, they do not work from home all the time as there may be more distractions at home and also to balance out their work and family obligations.
Nakrošienė et al., 2019	- Possibility to take care of family members	Cross-sectional (*n* = 128)	The possibility to take care of family members during homeworking increased productivity. The number of children had a negative effect on the overall satisfaction of homeworking. The more children, the less satisfied the employee was.

However, also a negative effect on the number of children is found in the same research. This is emphasized by Sing et al. (2013), who found that employees with children were less likely to work from home, because of more distractions and family commitments at home. When the number of children increases, it becomes more difficult to manage the work-family conflict at home (Nakrošienė et al., 2019). However, it also depends on the age of the children as Hill et al. (1998) found that households with preschool-aged children had a better work-life balance.

Theoretical model

The findings show that the household composition can have a direct effect on productivity, but can also indirectly affect productivity, as it can decrease the satisfaction with the home work environment. So, the household composition is added to the individual control variables in the theoretical model (Figure 3.3).

3.4 THEORETICAL MODEL

For the theoretical model, the home work environment can be split into the physical home work environment and the social home work environment. The physical home work environment includes the elements found in the literature on the office work environment as discussed in subsection 3.1 Physical work environment. These are the (1) original function, (2) use (private vs. shared), (3) size, (4) ICT facilities, (5) ambient factors, (6) view, (7) furniture, and (8) commuting rime of the physical home work environment. The attributes of the social environment are the advantages and challenges of the level of autonomy and managerial support. All the elements of the home work environment affect employees' productivity.

Secondly, according to the P-E fit theory satisfaction with the work environment influences employees' productivity as well. When employees are satisfied with their home work environment their productivity is likely reported higher than when employees are dissatisfied with their home work environment. So, satisfaction with the home work environment directly influences productivity. This level of satisfaction is, by all means, influenced by the home work environment itself. For example, when someone has a separate private work room in their home, the chances are high that this particular employee has a high possibility to conduct concentrated work. This means that the satisfaction level is higher than that of someone who is not able to work concentrated. This example indicates that the home work environment also has an indirect effect on productivity via the level of satisfaction. The attributes of the satisfaction with the home work environment include the elements indicated in 3.1 Physical home work environment ((1) comfort, (2) facilities, (3) furniture, (4) light, (5) overall suitability, (6) possibility of concentrated work, (7) privacy level, (8) size, (9) temperature, (10) ventilation, and (11) view).

To summarize, the satisfaction with the home work environment affects employees' productivity, but also the home work environment has an indirect effect on employees' productivity via the satisfaction with the home work environment.

Finally, not every person reacts in the same way and has the same outcome on productivity. For this reason, individual control variables are included in the theoretical model. These control variables are not part of the variables of the home work environment but can have an effect on the outcome of productivity. The individual control variables include household composition, age, education level, gender, job function, personality, level of motivation, and level of strain. All these elements could influence productivity, the home work environment, and satisfaction with the home work environment.

All the aspects, direct, and indirect relationships are outlined in the theoretical model on the following page (Figure 3.3).

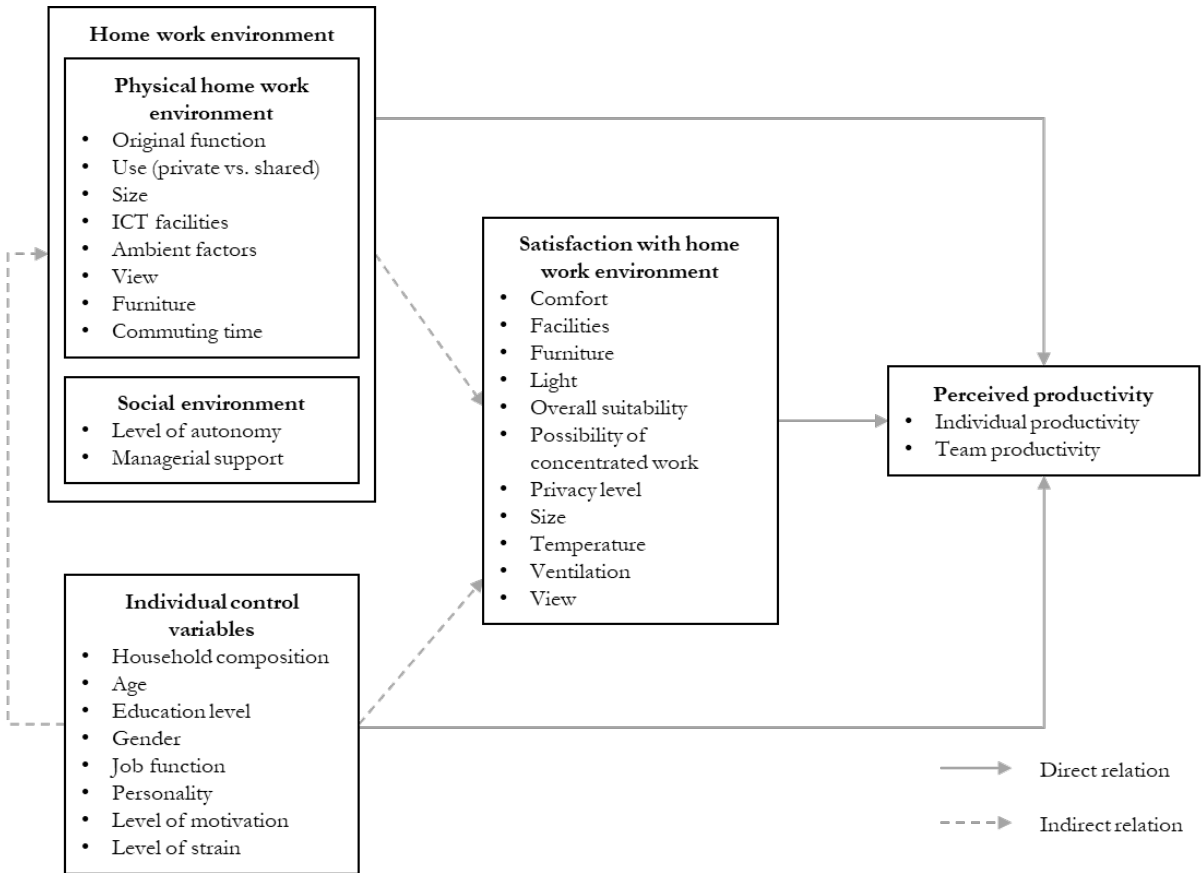

Figure 3.3 Theoretical model

3.5 SUB CONCLUSION

An extensive literature study was conducted to see what theories revolve around homeworking and productivity (SQ1) and what aspects of the home work environment influence productivity (SQ2). The results from the literature study are combined into a theoretical model as discussed in the previous section.

SQ1 – *Which theories that revolve around homeworking and productivity can be distinguished?*

The first theory is the P-E fit theory by Edwards et al. (1998). This theory was not specifically researched from a homeworking point of view but can be applied to the home work environment. It describes the relationship between the person and the environment and how that affects, in this case, work-related outcomes, such as employees' productivity. The objective environment, where work is conducted, has to fit the objective employees' needs to have a positive outcome. This suggests that, for homeworking, the (physical) home work environment has to fit the needs of the employee, in other words, has to be suitable for work activities, to be productive. Not only the objective person and environment influence productivity but also the subjective person and environment play a role. The subjective person and environment can be explained as the satisfaction with the environment and the perceived needs of the person. The objective environment influences the subjective environment and the same counts for the objective and subjective person. So, this theory explains that both the home work environment and the satisfaction with this home work environment, have to be taken into account when looking at their influence on productivity.

A variation on this theory is the JD-R model by Bakker & Demerouti (2007). Bakker and Demerouti (2007) look more into detail on the person's demands and needs and how this affects motivation and strain. It is not the objective demands and needs that influence the outcome, but the subjective motivation and strain that influence employees' outcomes. If the job demands and resources fit, motivation increases, which has a positive outcome on productivity. If there is a misfit, strain increases, which then negatively influences productivity. Again, this is not a model that is explicitly focused on homeworking, but

it can be used regarding homeworking. During homeworking, the demands have changed, as the way of working at home differed from working in an office, and the resources (office compared to the home work environment) changed as well.

Thirdly, during homeworking, it is hard to 'switch off' work when the workday is over because work is conducted in the same place as the employees' personal life. This is called the boundary theory (Steward, 2000). It also includes that is harder for an employee at home to take breaks during a work day, because, for example, having coffee or lunch at home is more associated with the personal life than with work (Bosua et al., 2013).

The last theory is known as the professional and social isolation theory. As employees do not physically work together, they tend to lose contact with their colleagues; they become isolated. This is a disadvantage that is associated with homeworking and it can reduce productivity.

SQ2 – *What aspects of the home work environment during homeworking can influence employees' productivity?*

Employees' productivity can be split into individual productivity and team productivity. For knowledge workers, it is hard to measure productivity from an objective perspective, as the route between input and output is not always clear and differs per person. Therefore, productivity is mostly measured as the perceived productivity by the employee itself.

From the P-E fit theory, it was found that the objective environment, in this case, the home work environment, and the subjective environment (the satisfaction with the home work environment) influence productivity. The home work environment can be split into the physical home work environment and the social environment. Aspects of the physical home work environment that could influence productivity are (1) the original function of the room, (2) the use (private vs. shared), (3) size, (4) ICT facilities, (5) ambient factors, (6) view, (7) furniture, and (8) commuting time. For the social environment, this includes the (1) level of autonomy and (2) managerial support. This level of autonomy and managerial support can be categorized as job resources in the JD-R model. Aspects of satisfaction with the home work environment are (1) comfort, (2) ICT facilities, (3), furniture, (4) light, (5) overall suitability, (6) possibility of concentrated work, (7) privacy level, (8) size, (9) temperature, (10), ventilation, and (11) view.

The fourth group of aspects is the individual control variables. These variables are person-related and give a broader and better context of the influence the home work environment has on productivity. It includes general aspects of a person, such as age, education level, and gender. In addition, for homeworking, the household composition has a big impact as well, because these are the people that surround you in your home work environment. Besides, the job function gives an idea of the type of work that is conducted during work hours. Lastly, the JD-R model explains how motivation and strain also affect productivity.

Chapter 04

EMPIRICAL STUDY

4 EMPIRICAL STUDY

First, the theoretical model presented at the end of the previous chapter has to be compared to the dataset of week 2 from the WWH project. In addition, the dataset has to be prepared before statistical analyses can be conducted. The comparison and preparation together result in the conceptual model. Within this conceptual model, hypotheses are posed that are tested with the use of statistical analyses.

4.1 QUESTIONNAIRE WWH PROJECT

The topics included in the questionnaire of week two are questions on characteristics of the physical home work environment, the satisfaction with the home work environment, individual control variables, and the perceived productivity. No questions were asked regarding the social environment.

All questions are summarized in a quantitative operationalization table in the appendix (see appendix A.1). The following section gives an overview of the questions in the questionnaire compared to the theoretical model of the previous chapter. All topics are summarized in Figure 4.1 on the following page.

The physical home work environment firstly focuses on where at home work is executed, and if this space is shared with other roommates. Secondly, the reason behind the use of this space is examined, such as 'If you work from home in several places, why do you switch workplaces?'. Statements, such as 'Most of the time I work in a separate room where I am not disturbed by roommates', have to be rated with a 5-point Likert scale ranging from (1) strongly disagree to (5) strongly agree. Thirdly, the characteristics of the most frequently used space are researched. Examples are the size of the space, the ambient factors within the room, the view outside the room (including aspects and percentages of these aspects), and working facilities, such as a printer or scanner. It has to be noted that the ambient factors used in the questionnaire include plants, art, and color. It does not include noise and/or lighting which was found in the literature review. Comparing the questionnaire and the theoretical model, no questions were asked about the furniture that is used and the original commuting time from home to the work office. So, this results in the variables (1) original function, (2) use, (3) size, (4) ICT Facilities, (5) ambient factors, and (6) view.

The questions on the physical home work environment are followed by the satisfaction with this physical home work environment. The satisfaction on the most frequently used room was rated with the use of a 5-point Likert scale ranging from (1) strongly disagree to (5) strongly agree. This included (1) comfort, (2) facilities, (3) furniture, (4) light (both daylight and artificial light), (5) possibility of concentrated work, (6) level of privacy, (7) size, (8) temperature, (9) ventilation, and (10) view. Besides, other elements of green and the regulation of the indoor climate were also found in the dataset. The regulation of the indoor climate could also be linked to the literature found on the air quality that could influence productivity. The question that comes closes to the overall suitability is question Q45038T on the functionality and comfort in general. However, this question was asked on a 10-point scale and all other satisfaction questions were asked on a 5-point scale. For this reason, it was decided to not include this question in the conceptual model.

Thirdly individual control variables were asked of each respondent. These were five variables, being the household composition (including the age of kids living at home if applicable), education level, age, gender, and job function. Questions on personality and the level of motivation and strain were not asked in the questionnaire.

Finally, two questions were formulated on the perceived productivity. The first question regards the perceived individual productivity, followed by the question of the perceived team productivity. These are rated from a 10-point Likert scale ranging from (1) worst to (10) best.

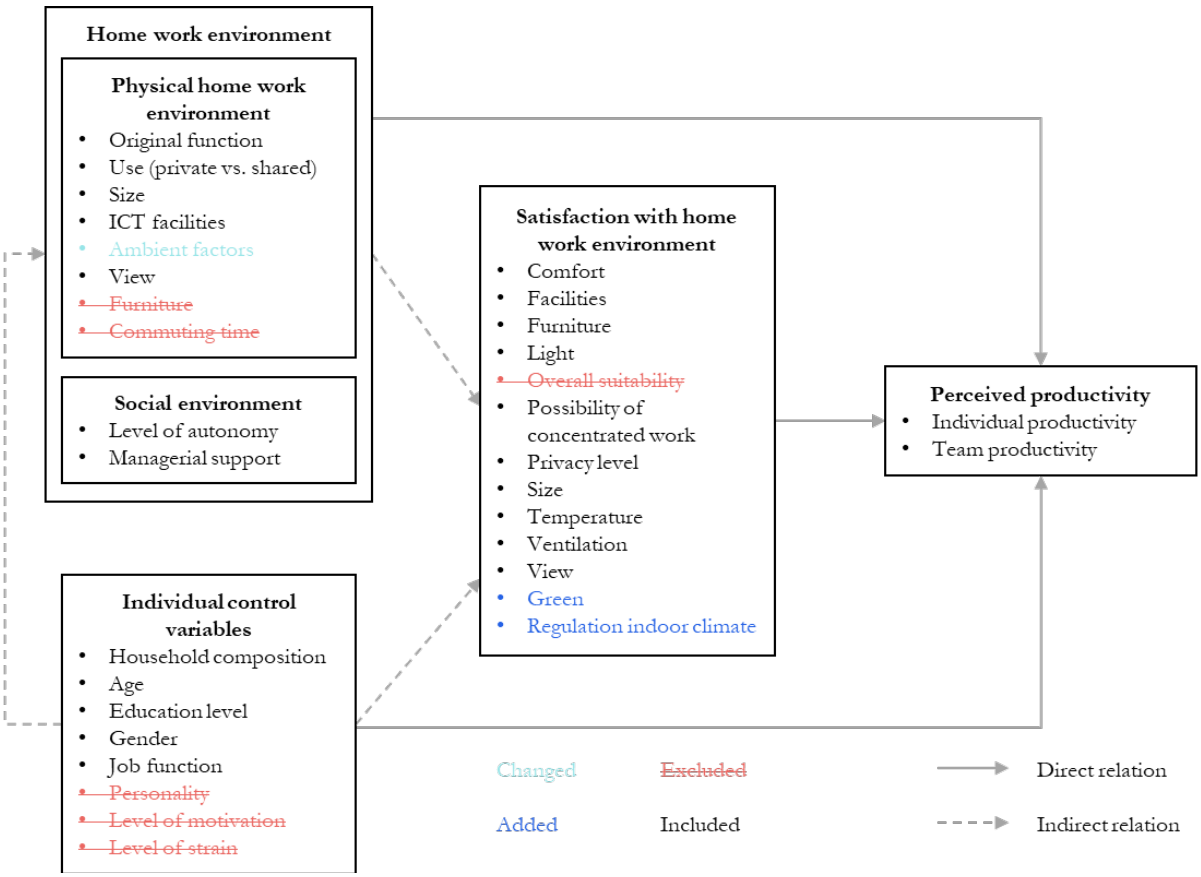

Figure 4.1 Theoretical model compared to the questionnaire of week 2 WWH project

4.2 DATA PREPARATION

As already mentioned in Section 2.1.2, the dataset has to be prepared before statistical analyses can be conducted. This preparation is done twofold. The first step is to look at the missing values of the dataset to determine which questions are going to be used for the analyses, and which questions are of essential importance to determine the exclusion criteria. The following step is to recode certain questions to make the variable(s) suitable for statistical analyses. Both steps are explained in the following sections.

4.2.1 Missing values

The program used for the questionnaire reported everyone that opened the questionnaire, even if no questions were filled in. Of the 36,102 respondents, 1,710 respondents did not fill in any question of the questionnaire. These respondents are not taken into account for the analysis and are therefore excluded from the dataset.

After excluding these respondents, still, 2,382 respondents did not fill in their perceived individual productivity (question Q45013T: With what rating do you rate your estimated individual productivity?). This question is considered essential for the analysis of this research and therefore it is decided to also exclude the respondents that did not fill in this question. This resulted in 32,010 respondents that are used for the analyses.

Lastly, it was found of high importance to profile every respondent on individual control variables, such as age, gender, and job function, for the analyses on individual control variables. Therefore, the last exclusion criterium was that every respondent had to answer questions Q1159 (job function), Q45001T (household composition), Q1 (gender), Q50 (age), and Q3 (education level). With all the exclusion criteria taken into account, the data of 31,301 respondents are used for the initial analyses.

However, for some questions still missing values occur. For the correlation analysis, this is not a problem, as only the respondents that answered both questions are used for the analysis. For the path analysis, this results in less than 31,301 respondents as everyone had to answer all questions that are analyzed. Appendix A.2 shows all missing values before and after excluding the respondents based on the exclusion criteria. Some of these variables are recoded (see also Section 4.2.2 Recoding), which sometimes results in a lower number of missing values (e.g. when the missing value is recoded into 'no answer'), and others will be excluded from the analyses and only used for descriptive statistics.

4.2.2 Recoding

Before conducting bivariate and regression analyses, data from the questionnaire was recoded. The reason for recoding differed per variable but included combining multiple questions to determine the variable or combining categories because of a low number of respondents for a certain category. The recoding is described per variable group, namely the physical home work environment, the satisfaction with the home work environment, and the individual control variables.

Physical home work environment

The physical home work environment contains six variables: (1) the original function of the room, (2) private vs shared use, (3) size, (4) ICT facilities, (5) ambient factors, and (6) view. Only the first four variables are recoded for the analysis. The ambient factors and view questions were asked with a single choice yes/no answer which was suitable to conduct independent samples t-tests.

The first two variables are recoded with the information from question Q45024T: 'Can you indicate how often you work in these rooms during the working day?' When a respondent indicated to use a certain room, the following question would be with what frequency this room was used. The options were on a 5-point Likert scale from never to always. If a respondent indicated to use the specific room often (4) to always (5), the relevant respondent was labeled with that certain type of function. The type of functions that were used never (1) to sometimes (3) was not taken into account in the analysis. This was also the case for respondents that only indicated to use one type of room. After this labeling, the respondents that answered often to always to multiple types of rooms received the label 'multiple rooms'. The type of rooms 'nursery', 'garden room', 'garden/balcony', and 'other room' were combined into the category 'other room'. Lastly when the respondents did not answer the frequency question and/or indicated to only use one room 'never' to 'sometimes' were labeled 'no room assigned/no answer'.

For the variable 'use (private vs. shared)' the same method is used. If the respondent indicated to use a certain room 'frequently' to 'often' the next question that was looked at was question Q45022T: 'Do you share this space(s) with other housemates when you work?'. The respondents that answered yes to this question are labeled 'shared' for that certain room. Vice versa for the respondents that answered 'no'. When the respondents use multiple rooms and used these rooms differently they were labeled as 'both private and shared use'. Respondents that did not answer this question were labeled as 'no use assigned/no answer'.

Question Q45023T: 'What is the surface area of the workspace you use the most?' was used for the variable 'size of the workplace'. This was an open question and the respondents filled in the m2 of the surface area. The answered ranged between 1 and 99 m2. It was looked at how the response could be categorized, so the categories were almost equally divided. Therefore, the answers were recoded into three categories: (1) small size workplace between 1 – 10 m2, (2) medium size workplace between 11 – 25 m2, and (3) large size workplace >25 m2.

The last variable of the physical home work environment that was recoded was 'ICT facilities'. Respondents were asked what type of ICT facilities they had in their home work environment. There were six options, being (1) printer, (2) copier, (3) scanner, (4) laptop stand, (5) document standard, and (6) ergonomic aids. To compute the variable it was counted how many ICT facilities the respondent had ranging from 0 to 6 ICT facilities.

Satisfaction with the home work environment

For the satisfaction with the home work environment, multiple questions were asked on a 5-point Likert scale ranging from 'very dissatisfied' to 'very satisfied'. These questions have been asked in two ways, namely 'How satisfied are you in your home working environment with:' including the variables agreements, ambiance, control climate, facilities, green, light, the possibility of concentrated work, privacy, size, temperature, and ventilation and 'How satisfied are you at your home workplace with:' including the questions regarding the furniture (worktop, desk, and (desk)chair).

First, correlation analysis has been conducted. From this correlation analysis it became clear that, in addition to the correlations between the individual productivity and the satisfaction variables, there were strong relationships between the satisfaction variables themselves. Besides, a lot of variables were used to determine the satisfaction with the home work environment. For these reasons, it was decided to conduct an exploratory factor analysis to see if and which variables cluster, and what underlying variables had been measured.

For this factor analysis, it was decided to not take into account all variables, due to a high percentage of missing values. The exclusion criterium for the factor analysis was that the percentage of missing values had to be smaller than 10%. Therefore, the variables that were excluded from the factor analysis are Q45035T – The agreements made with housemates, Q45036T – The extent to which housemates adhere to these agreements, Q1229 – The adjustability of the desk, Q1231 – The adjustability of the (desk) chair), and Q1232 – Ergonomic aids (see also Appendix A.2).

A principal axis factor analysis has been carried out on 14 items with oblique rotation (direct oblimin), which means that the items are assumed to be dependent. The Kaiser-Meyer-Olkin measurement shows that the sample size is suitable for the analysis (KMO = .888). This is confirmed by the KMO statistics for individual variables at which the value was .81, which is greater than the minimum of .5 according to Field (2013). Three factors had eigenvalues over Kaiser's criterion of 1, but this criterion is determined on a much smaller sample size than this dataset provides. Also, when looking at the scree plot there are points of inflection at three and five factors. Therefore, it is decided to extract four factors. These four factors explain 69.60% of the variance. Table 4.1 shows the rotated factor loadings per item after rotation. The items that were identified as clusters imply that factor 1 can be summarized as 'satisfaction with the ambiance', factor 2 as 'satisfaction with privacy and concentration', factor 3 as 'satisfaction with the indoor climate', and factor 3 as 'satisfaction with the functionality'. These four new variables all had high reliabilities (Cronbach's $\alpha >= .85$, with an exception of Cronbach's $\alpha = .64$ for the variable 'satisfaction with the functionality').

The four variables are calculated from the mean of all items within the new variable. These new variables are used for the correlation and regression analysis in the following chapter. It is decided to compute these variables based on the highest load factor because this keeps clear what these new satisfaction factors include. It means that for the first factor 'satisfaction with ambiance' the mean of the satisfaction variables green, view, atmosphere and appearance, daylight, size workplace, and lighting on worksurface is calculated per respondent. For the factor 'satisfaction with privacy and concentration', the mean of the satisfaction variables privacy, and level of concentration are combined. The mean per respondent of the factor 'satisfaction with indoor climate' was calculated by the satisfaction variables regulation indoor climate, temperature, and ventilation. The last factor that was computed was 'satisfaction with functionality'. For this factor, the mean was calculated of the satisfaction variables comfort of the (desk)chair, available facilities, and the surface of the worktop.

Table 4.1 Summary of exploratory factor analysis (N = 24128)

		Rotated Factor Loadings			
Item		Satisfaction with ambiance	Satisfaction with privacy and concentration	Satisfaction with indoor climate	Satisfaction with functionality
Q9506	The green present	**.87**	-.12	.01	-.03
Q1223T	The view from your workplace at home	**.82**	-.01	.08	-.04
Q18	The atmosphere and appearance	**.69**	.15	-.01	.04
Q1239	The entry of daylight	**.52**	.09	.36	-.09
Q1225	The size of the workplace(s)	**.44**	.26	-.03	.37
Q1241	The lighting on the work surface	**.43**	.09	.29	.09
Q16	The level of privacy	-.03	**.96**	.01	-.05
Q19	The possibilities to be able to work concentrated	-.04	**.92**	.03	.02
Q1238	Being able to regulate the indoor climate yourself	-.05	-.01	**.93**	.03
Q1235T	The temperature	.03	-.03	**.87**	.04
Q1236T	The ventilation(possibilities)	.07	.08	**.80**	.02
Q1230	The comfort of the (desk)chair	-.14	-.04	.06	**.88**
Q15779	The available facilities that support working from home	.08	.02	.08	**.73**
Q1226	The surface of the worktop	.41	.14	-.10	**.43**
Eigenvalues		6.16	1.59	1.03	.97
% of variance		43.97	11.36	7.35	6.92
α		.86	.85	.88	.64

Note: The highest rotated factor loadings appear in bold and are underlined.

Individual control variables

For the individual control variables, multiple categories per variable are combined because of a relatively low number of respondents. Table 4.2 on the following page shows which variables are combined, how they are combined, and what the new group of categories is.

Table 4.2 Recoding individual control variables

Variable	Old categories	Description combining variables	New categories
Household composition	1. Single household 2. Single-parent households with children living at home 3. Couple without children (living at home) 4. Couple with children living at home 5. Living independently with housemates 6. Living at (parents) home	'Living independently with housemates' (N = 405) and 'living at (parents) home' (N = 398) are combined because of a low number of respondents. The new category is named 'other'.	1. Single household 2. Single-parent households with children living at home 3. Couple without children (living at home) 4. Couple with children living at home 5. Other
Education level	1. Primary education 2. Secondary education 3. MBO 4. HBO 5. University 6. Otherwise	'Primary education' (N = 51) is combined with 'otherwise' (N = 281) to the category 'low and other education level'. 'Secondary education' (N = 1,963) and 'MBO' (N = 5575) are combined; this is defined as 'medium education level'. 'HBO' (N = 12,473) and 'university' (N = 10,958) are combined and recoded as 'high level education'.[1]	1. Low and other education level 2. Medium education level 3. High education level
Age	1. < 21 year 2. 21 – 30 year 3. 31 – 40 year 4. 41 – 50 year 5. 51 – 60 year 6. > 60 year	For the variable age only the first two categories (< 21 year, N = 19; 21 – 30 year N = 2,716) are combined. The new category is '< 30 year'.	1. < 30 year 2. 31 – 41 year 3. 41 – 50 year 4. 51 – 60 year 5. > 60 year
Gender	1. Male 2. Female 3. Other	Because of a relatively low response on 'other' (N = 104), this category is combined with 'male' (N = 14,733).[2]	1. Male and other 2. Female
Job function	1. Director 2. Manager 3. Employee 4. Teacher	The categories 'director' (N = 68) and 'manager' (N = 2,166) are combined as they both have managerial tasks. This new category is defined as 'manager'. The categories 'employee' (N = 29,063) is combined with 'teacher' (N = 4) and is named 'employee' as teachers could also be defined as employees.	1. Manager 2. Employee

[1] These categories are also used by the Central Bureau of Statistics (CBS) from the Netherlands. This makes it easier for the following stages to compare the representativeness of the data (see also Section 5.1.2)

[2] There is no specific reason to combine other with male instead of female; it has only been merged because of the low response rate. Other is not excluded from the analysis because this is also way to identify yourself.

4.3 CONCEPTUAL MODEL

By comparing the theoretical model with the questionnaire, a conceptual model was made. Figure 4.2 shows this conceptual model displaying the (recoded) variables. For the physical home work environment and the individual control variables, this includes the variables as described in Section 4.1. For the satisfaction with the home work environment, these are the factors as recoded due to the factor analysis explained in Section 4.2.2.

Within the conceptual model relations, both direct and indirect, with the perceived productivity are displayed as discussed in the literature review. To conduct statistical analyses, six hypotheses are drawn from these relationships.

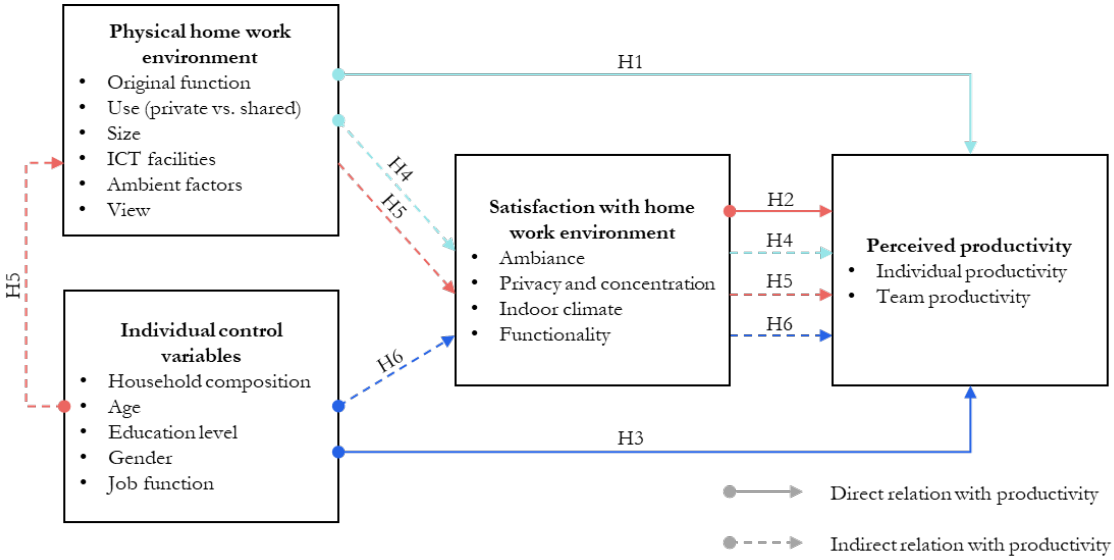

Figure 4.2 Conceptual model

First, it is assumed that the physical home work environment has a direct relationship with the perceived productivity. Most of these aspects are categorical, which means that the relation with productivity can not be classified as positive or negative. Therefore, the following hypothesis is posed:

H1 – *The physical home work environment affects perceived productivity*

Secondly, the satisfaction with the home work environment influences the perceived productivity as well. It is expected that when the satisfaction level increases, productivity increases as well. This indicates a positive relationship between satisfaction and productivity. So, the second hypothesis is:

H2 – *Satisfaction with the home work environment affects perceived productivity positively*

As explicitly the perceived productivity is asked, and everyone reacts differently towards homeworking, it is expected that also individual control variables influence productivity. Again, because these variables are mostly categorical, no distinction can be made between a positive or negative relation. So, the third hypothesis posed, is:

H3 – *Individual control variables affect perceived productivity*

Next to the direct relations between these aspects and perceived productivity, it is assumed that the aspects influence each other as well. This is referred to as indirect relations between the aspects and the perceived productivity. The fourth hypothesis posed includes the relation the aspects of the physical home work environment has with the satisfaction of this home work environment:

H4 – *The physical home work environment has an indirect effect on perceived productivity, via satisfaction with the home work environment*

In addition, the individual control variables influence how the physical home work environment looks and is used, and it affects the satisfaction with the home work environment as well. Therefore, the last (indirect) relations are represented by the following hypotheses:

H5 – The individual control variables indirectly affect perceived productivity, via the physical home work environment and the satisfaction with the home work environment

H6 – The individual control variables indirectly affect perceived productivity, via the satisfaction with the home work environment

Chapter 05

RESULTS

5 RESULTS

In this chapter, the results from statistical analyses are presented. These include descriptive data, bivariate analyses (correlation, independent samples t-test, and one-way ANOVA tests including post-hoc tests), and regression analyses. The type of bivariate analysis is determined by the decision tree as explained in section 2.1.2.

First, the representativeness of the sample is mapped out by comparing the individual control variables with data of the population of the Netherlands. Secondly, the overall data on the individual productivity and the satisfaction with the home work environment is outlined per cohort (in the Covid-19 context). This is followed by all three elements of the conceptual model, being (1) the physical home work environment, (2) satisfaction with the physical home work environment, and (3) individual control variables. Last, all these aspects are combined in an integral path model. This path model explains whether there are direct and indirect relations between the three elements in combination with individual productivity.

Individual productivity and team productivity were found to be highly positively correlated; $r(25,211) = .61$, $p < 0.001$. Therefore, most results found for individual productivity are likely to be found for team productivity as well. To keep this chapter as compact as possible and for the scope of this research, it is chosen to focus on individual productivity.

5.1 REPRESENTATIVENESS SAMPLE

For the data description of the individual control variables, a comparison is made with the population of the Netherlands. The aim is to determine the representativeness of the sample and, therefore, see whether generalization is applicable. For the population of the Netherlands, the data is used of Centraal Bureau voor de Statistiek (Central Bureau of Statistics; CBS), because the data of the CBS is the most representative for the population of the Netherlands. The most recent data found in this dataset is from the fourth quarter of 2020, i.e. from October 2020 till December 2020. The socio-demographic characteristics from the questionnaire are household composition, education level, age, gender, and job function.

First, the household composition is compared to the CBS dataset of the whole population of the Netherlands. Secondly, the education level is compared to the CBS dataset of the labor market in the Netherlands. With this comparison, the corresponding education level is determined for the comparison with the characteristics age, and gender of the sample with the population. Lastly, the job function of the respondents is shown. However, CBS uses too many types of professions in their numbers to make a clear comparison with the sample. Besides, it should be taken into account that the data from CBS does not make a distinction between the type of worker, so there is no specific data available on office workers.

5.1.1 Household composition

The distribution of household composition in the sample is shown in Figure 5.1. The categories that were used in the questionnaire are single household, single-parent households with children living at home, couple without children (living at home), couple with children living at home, living independently with housemates, and living at (parents) home. As explained in section 4.2.2 the categories 'living independently with housemates' and 'living at (parents) home' are combined. The household composition of most respondents is couple with children living at home (40.3%), followed by couple without children (living at home) (35.4%). Both living independently with housemates and living at (parents) home are covered by 1.3%. When only looking at whether the household composition is with or without children a 50/50 ratio was found. Respondents living without children is 53.8% and respondents living with children encompasses 46.2%.

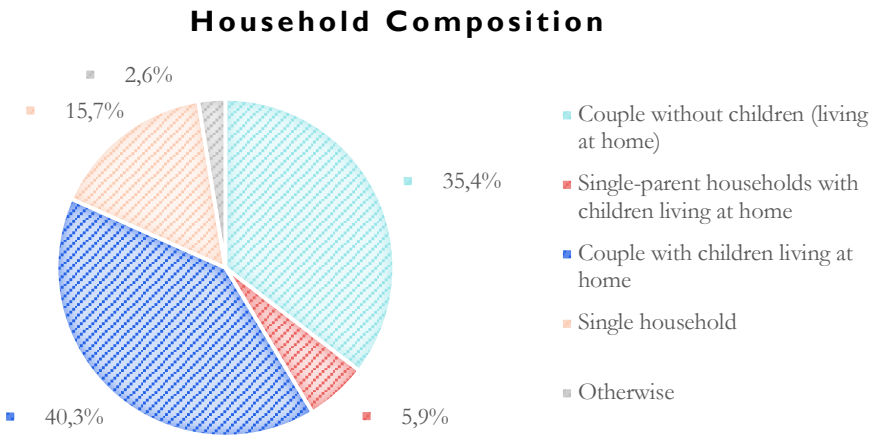

Figure 5.1 Pie chart distribution of household composition in research sample (N = 31,301)

The CBS data (see also Table 5.1) shows that the single household composition is underrepresented in the sample (15.8% compared to 38.5%). The couples with and without children are overrepresented with a difference of 5 to 7%. The single-parent households with children living at home are quite comparable to the population (5.9% compared to 7.4%). Last, the category 'otherwise' is 2.6% compared to 0.5% and is therefore slightly overrepresented. To summarize, the single household is underrepresented, and the couples with and without children are overrepresented. The other categories are quite comparable.

Table 5.1 Distribution of household composition in the research sample compared to the population of the Netherlands

Household composition	**Sample**		**CBS (2020)**
	N	%	%
Couple without children (living at home)	11,093	35.4%	28.3%
Single-parent households with children living at home	1,857	5.9%	7.4%
Couple with children living at home	12,622	40.3%	25.3%
Single household	4,926	15.7%	38.5%
Otherwise	803	2.6%	0.5%

5.1.2 Education level

The education level in the questionnaire was recoded into three categories, (1) low education and other, (2) medium education, and (3) high education. These are the same categories as used by CBS (2021). Primary education falls in the category of low education level, secondary education and MBO can be compared with medium education level, and HBO and university can be defined as high education level. CBS (2021) does not use the category of 'otherwise'. In the questionnaire, this is combined with 'low education' because of the low response rate.

The pie chart shows that the vast majority are HBO (39.8%) or university (35.0%) level educated (total 'high education' 74.9%). One-quarter of the sample consists of 'medium level education' (24.1%), with the emphasis on MBO (17.8%). Only 0.2% of the respondents indicated to have an education level of primary school, and 0.9% answered the question with 'otherwise' (total of 1.1%).

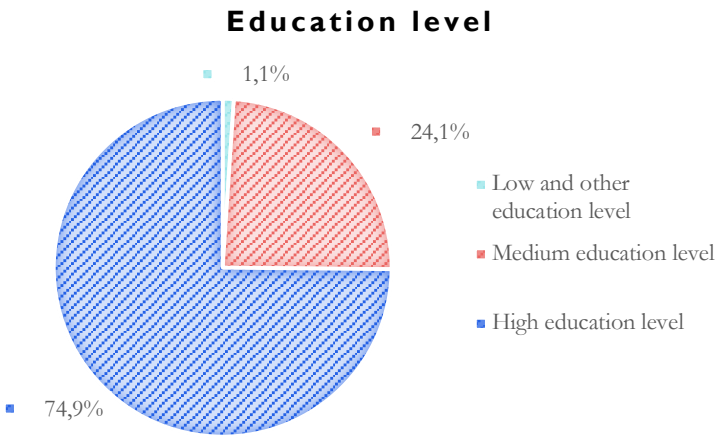

Figure 5.2 Pie chart distribution of education level in research sample (N = 31,301)

Table 5.2 shows the comparison between the sample and the labor market population of the Netherlands. It shows that the percentage of low education level is underrepresented in the sample (1.1% compared to 18.2%), and the percentage of high education is overrepresented (74.9% compared to 42.3%). The medium education level is also underrepresented, but less than the high education level (24.1% in the sample compared to 39.5% in the population).

Table 5.2 Distribution of education level in the research sample compared to the population of the Netherlands

Education level	**Sample**		**CBS (2021)**
	N	*%*	*%*
Low and other education level	332	1.1%	18.2%
Medium education level	7,538	24.1%	39.5%
High education level	23,431	74.9%	42.3%

Due to the distribution of education level in the sample, the characteristics of age and gender are compared to the population of the labor market of medium and high education level in the dataset of CBS. So, the CBS data on low education is excluded from the comparison, but the 332 respondents in the dataset of this research are still being used for analysis.

5.1.3 Age

The characteristic age is divided into six categories ranging from under 21 to over 60 years old. Around 75% of the sample is 41 years or older. Most respondents are between 51 - 60 years old (36.0%), followed by 41 - 50 year (23.6%).

When the percentages of the age categories are compared (see Table 5.3), we see that the 'younger' generation (< 21 – 30 years) is underrepresented in the sample (8.7% compared to 22.9%). The age range 31 – 40 year and 41 – 50 year is quite comparable to the population (26.8% compared to 19.3% and 23.6% compared to 18.3%). On the other hand, the older generation of 51 - 60 year is overrepresented. In the sample, the category 51 - 60 year is 36.0% compared to 20.0% in the population. Older than 60 year is 4.6% higher than the population, so this is quite comparable. So, it has to be taken into account that overall the older generation is overrepresented and the younger generation is underrepresented.

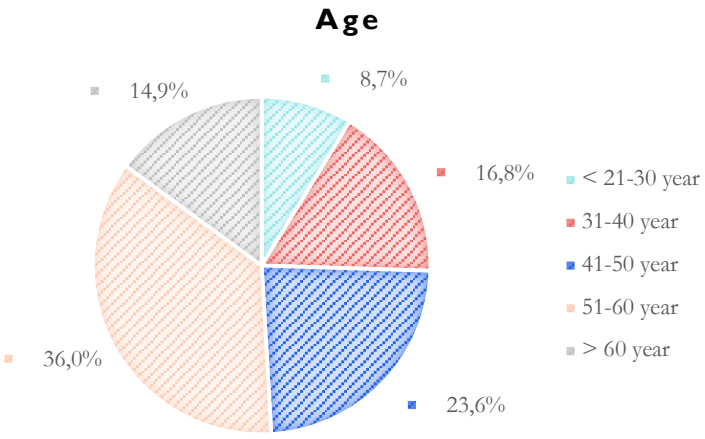

Figure 5.3 Pie chart distribution of age in research sample (N = 31,301)

Table 5.3 Distribution of age in the research sample compared to the population of the Netherlands

Age	**Sample**		**CBS (2021)**
	N	*Percentage (%)*	*Percentage (%)*
< 30 year	2,735	8.7%	22.9%
31 - 40 year	5,245	16.8%	19.3%
41 - 50 year	7,387	23.6%	18.3%
51 - 60 year	11,261	36.0%	20.0%
> 60 year	4,673	14.9%	19.5%

5.1.4 Gender

Table 5.4 shows the comparison with the numbers of CBS on the variable gender. Both the sample and the population show a 50/50 ratio. In the sample, the percentage of male and other is slightly less compared to the percentage of CBS (difference of around 3%) and vice versa for the category female.

Table 5.4 Distribution of gender in the research sample compared to the population of the Netherlands

Gender	**Sample**		**CBS (2021)**
	N	*Percentage (%)*	*Percentage (%)*
Male and other	14,837	47.4%	50.7%
Female	16,464	52.6%	49.3%

5.1.5 Job function

Lastly, there were four categories to describe the job function, namely director, manager, employee, and teacher. Most respondents answered being an employee (92.8%). Only 4 respondents answered specifically being a teacher. Directors and managers (recoded as 'manager') encompass in total 7.1%.

Table 5.5 Distribution of job functions in the research sample

Job function	**Sample**	
	N	*Percentage (%)*
Manager	2,234	7.1%
Employee	29,067	92.9%

5.1.6 Sub conclusion

The sample is compared to the data of CBS (2020) to determine the representativeness of the sample. The aim is to find if the results from the research for the population of the Netherlands can be generalized. Overall, there are differences between the sample and the population of the Netherlands. Only the gender of the sample is comparable to the CBS data. When the results are generalized the following aspects should be taken into account:

- Single households are underrepresented in the sample size and couples without children are overrepresented.
- The overall education level of the sample is medium to high. The low education level of the population is underrepresented.
- The older generations (> 51 year) are overrepresented in the sample. The younger generation (< 30 year) is underrepresented.

5.2 PER COHORT

As explained in section 2.1.2, the data from WWH is gathered in three cohorts. This means that at three points in time the questionnaire is presented to respondents. These respondents differed per cohort. Therefore, it should be noted that is not possible to do longitudinal analysis. However, as there were many respondents per cohort, the descriptive data can be presented in their context. Here it is taken into account what point in time (the year 2020) the questionnaire was presented to the respondents, the ratios within the individual control variables, which Covid-19 measures by the government were in place, and how long the respondents were already coping with the Covid-19 situation.

The questionnaire in the first cohort was presented at the beginning of April 2020. Since the middle of March, the first lockdown was taken place. This first lockdown meant that it was highly advised to work from home, schools and universities were closed, and restaurants and cafés were closed. According to the governmental website 'April was all about persistence'. At the end of April it was decided to open the primary schools again (Ministerie van Algemene Zaken, 2021).

At the beginning of July, the questionnaire was presented to the second cohort. At first, it seemed to be going well with the infections, but at the end of the month, the infections increased again. It is during summer break, so most children are at home. The government reminds everyone explicitly to adhere to the basic rules of keeping distance, washing hands regularly, and work from home as much as possible (Ministerie van Algemene Zaken, 2021).

The last cohort took place at the beginning of October. Things are going worse than expected with the infections. New measures will be introduced in mid-October and the conversation of closing the schools again takes place. Only during this questionnaire schools are open so children are not at home all the time (Ministerie van Algemene Zaken, 2021).

The individual productivity, satisfaction with ambiance, privacy and concentration, indoor climate, and functionality are compared between cohorts. For the individual productivity Table 5.6 shows that this has increased per cohort. The means differ significantly from each other. One reason for the increase could be that the respondents were more used to working from home overtime. It should always be taken into account that the respondent per cohort differs from each other. However, the ratios for the physical home work environment variables and the individual control variables do not differ much from each other (see

Appendix B.2). This suggests that other external factors, like Covid-19 or the weather, influence productivity, and satisfaction.

The satisfaction with the home work environment shows different patterns per satisfaction factor. For the satisfaction with the ambiance, the means decreased per cohort. For the satisfaction with privacy and concentration, the mean did not differ that much, but overall the satisfaction increased. For the satisfaction with indoor climate, a decrease was shown in the second cohort. This could be because this cohort took place during the summer which makes it harder to control the indoor climate at home because of the high outside temperature. For the satisfaction with functionality, no clear pattern was found.

Table 5.6 Descriptives individual productivity and satisfaction with the home work environment per cohort

	N	Individual productivity	Satisfaction with ambiance	Satisfaction with privacy and concentration	Satisfaction with indoor climate	Satisfaction with functionality
		Mean (std)				
Cohort 1	6,093	7.58 (1.34)	4.04 (0.65)	4.06 (0.89)	3.98 (0.80)	3.47 (0.85)
Cohort 2	13,066	7.65 (1.32)	3.94 (0.69)	4.07 (0.87)	3.79 (0.88)	3.40 (0.85)
Cohort 3	11,810	7.85 (1.21)	3.91 (0.69)	4.14 (0.82)	3.91 (0.80)	3.48 (0.83)
Total	*30,969*	*7.71 (1.28)*	*3.95 (0.68)*	*4.10 (0.85)*	*3.87 (0.84)*	*3.44 (0.85)*

5.3 PHYSICAL HOME WORK ENVIRONMENT

For the physical home work environment, six variables are taken into account. First, the descriptive statistics are presented followed by the bivariate analysis per variable. When all variables are discussed a regression analysis is conducted and a subconclusion is drawn. The variables of the physical home work environment are (1) the original function of the room, (2) the use of the room (private vs. shared), (3) the size of the workplace, (4) ICT facilities, (5) ambiance factors, and (6) view. The order within the variables is based on the average mean (from high to low) or the already logical existing order, e.g. small to large workplace.

The assumption of homogeneity of variance was not met for the data on the aspects original function of the room, use of the room, and size of the workplace. So, a Welch's adjusted F ratio was used, which was significant on all three aspects (original function of the room Welch's $F(6, 5146.87) = 45.56$, $p < 0.001$, use of the room Welch's $F(3, 3451.99) = 100.97$, $p < 0.001$, and size of the workplace Welch's $F(3, 5348.97) = 29.465$, $p < 0.001$). This indicates that at least two of the categories per aspect significantly differed from each other. Table 5.7 till Table 5.9 will show if, and how, the categories significantly differ in mean.

5.3.1 Original function of the room

The distribution of the original function of the room where the respondent mostly works is shown in Appendix B.3.1. Almost three-quarters of the respondents work in a work room (39.7%) or living room (31.3%). This is followed by working in the kitchen or bedroom. Only 8.0% of the respondents have indicated to work often in multiple rooms at home.

Respondents working in a work room indicate to be the most productive compared to all the other types of rooms ($M = 7.84$, std. = 1.18). The living room and kitchen score the same mean for individual productivity and the bedroom shows the lowest mean for individual productivity.

Post hoc comparisons using the Games-Howell test indicated that the mean individual productivity for respondents mainly working in the work room ($M = 7.84$, std = 1.18) was significantly different from all the other categories, for example, the living room ($M = 7.68$, std = 1.33). The mean for respondents working in the bedroom ($M = 7.45$, std. = 1.38) was also significantly different from all the other categories, with an exception of the categories 'Other room' and 'No type of room assigned / No response'. These results suggest that the respondents working in a work room are the most productive and the respondents

working in the bedroom are the least productive, compared to all the other types of functions. As the work room is specifically designed to conduct work, this was an expected outcome.

Table 5.7 Summary results one-way ANOVA test (post hoc Games-Howell) original function of the room and individual productivity

	Mean	**Mean compared to***						
		Work room	Living room	Kitchen	Multiple rooms	Other room	Bedroom	Not assigned / no answer
Work room	7.84	-	↑	↑	↑	↑	↑	↑
Living room	7.68	↓	-	=	=	↑	↑	↑
Kitchen	7.68	↓	=	-	=	=	↑	↑
Multiple rooms	7.45	↓	=	=	-	=	↑	=
Other room	7.57	↓	↓	=	=	-	=	=
Bedroom	7.62	↓	↓	↓	↓	=	-	=
Not assigned / no answer	7.44	↓	↓	↓	=	=	=	-

* significant difference when $p < 0.05$; ↑ significant higher mean than; ↓ significant lower mean than; = no significant difference

These results are aligned with the findings in the literature. According to Ng (2010), it is most preferable to have a separate work room, and not work within another type of room, such as the living room. This is supported by the lay-out findings by Croon et al. (2005) where it is preferable to have a separate office in the office environment. Besides, noise within the room affects productivity as well. Noises are easier to control in a separate work room compared to the kitchen, which is again aligned with the office environment where in an open office more distractions are found because of noise (Croon et al., 2005; Ng, 2010).

5.3.2 Private vs. shared use of the room

Most respondents indicate to only work privately (51.4%). Around one quarter always shares a room with others when working at home (23.6%). Only 2.4% (N = 761) indicated to both (often) work privately and shared[3] (see also Appendix B.3.2). It has to be noted that 22.5% (N = 7,058) did not answer the question of whether they share (some of) the room(s) they work in.

When looking at the use of the room, the post hoc Games-Howell test shows that the mean for the private use of the home work environment (M = 7.83, std. = 1.19) was significantly different from all the other types of use. However, the mean for shared use (M = 7.57, std. = 1.34) did not significantly differ from the mean of both private and shared use (M = 7.52, std. = 1.34). This implies that the respondents working privately are more productive, but the respondents working both private and shared are not necessarily more productive than respondents that only work in a shared home work environment.

When comparing the literature from the office environment and these outcomes, a clear similarity is found. In the office environment, it was preferable to work privately to conduct concentrated work (Ng, 2010). As shown by the mean of private use compared with the other type of uses, this is also the case for working at home.

[3] Only respondents that were assigned 'multiple rooms' could be labeled with 'both private and shared use' as question Q45022T only asked per room whether it was shared or not.

Table 5.8 Summary results one-way ANOVA test (post hoc Games-Howell) private vs. shared use of the room and individual productivity

	Mean	Mean compared to*			
		Private	Shared	Both private and shared	Not assigned / no answer
Private	7.83	-	↑	↑	↑
Shared	7.57	↓	-	=	=
Both private and shared	7.52	↓	=	-	=
Not assigned / no answer	7.60	↓	=	=	-

* significant difference when p < 0.05; ↑ significant higher mean than; ↓ significant lower mean than; = no significant difference

5.3.3 Size of the workplace

As explained in Section 4.2.2 the workspace size is cataloged so that approximately every category contains one-third of the sample size. Most people have a workplace between 11 and 25 m2 (medium size workplace, N = 13,217, 42.2%). Almost as many respondents indicated that they had a small or a large workplace (around 25%). Respondents with a large size workplace score the largest mean productivity. They indicated that their mean individual productivity is 7.80 (10-point scale).

The Games-Howell test on the size of the workplace shows that the small size workplace (M = 7.62, std. = 1.32) is significantly different (lower) compared to all the other categories and the medium size workplace (M = 7.70, std. = 1.28) is also significantly different (lower) from the large workplace (M = 7.80, std. = 1.25). So, the size of the workspace is conducive to individual productivity, as all three sizes of workplaces significantly differ from each other.

Table 5.9 Summary results one-way ANOVA test (post hoc Games-Howell) size of the workplace and individual productivity

	Mean	Mean compared to*			
		Small size workplace	Medium size workplace	Large size workplace	No answer
Small size workplace	7.62	-	↓	↓	↓
Medium size workplace	7.70	↑	-	↓	=
Large size workplace	7.80	↑	↑	-	=
No answer	7.78	↑	=	=	-

* significant difference when p < 0.05; ↑ significant higher mean than; ↓ significant lower mean than; = no significant difference

These results are as expected because with more space you simply have more room to conduct your work. Therefore, it was also one of the most common reasons to implement homeworking arrangements for employees according to Ng (2010).

5.3.4 ICT facilities

In the questionnaire, the respondents are asked about the availability of six different ICT facilities. These ICT facilities are a (1) printer, (2) copier, (3) scanner, (4) laptop standard, (5) document stand, and (6) ergonomic aids. The respondents mostly reported to have a printer (N = 12,425) and copier (N = 9,783) available (see Figure 5.4). A Smaller number of respondents have other types of ICT facilities available.

Both a bivariate correlation analysis and a one-way ANOVA test has been conducted, including a Games-Howell test. For the bivariate correlation analysis, the number of ICT facilities is counted per respondent. Then it was examined whether and how this correlates with individual productivity (see Appendix B.3.4).

The bivariate correlation analysis shows that there is a significant correlation between the number of ICT facilities and individual productivity; $r(31,301) = .094$, $p < 0.001$. However, this correlation is according to the rules of thumb by Field (2013) a weak relation. This means that the likelihood is relatively low that when the number of ICT facilities increases with 1 the perceived productivity increases as well on an individual level.

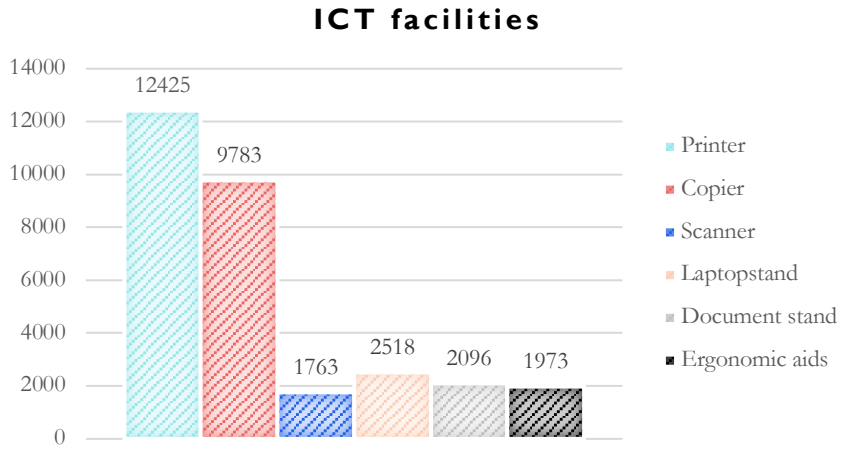

Figure 5.4 Bar graph ICT facilities respondents have at home

Almost two-fifths of the sample indicated not have any of the ICT facilities mentioned by the questionnaire. Half of the respondents have 1 to 3 ICT facilities. Only 0.8% indicated to have all six ICT facilities available. When the number of ICT facilities increases, also the mean of individual productivity increases.

The Games-Howell test on the number of ICT facilities indicates that the mean of zero facilities was not significantly different than having one facility. The mean of two ICT facilities ($M = 7.72$, std. = 1.23) is significantly different from the mean of zero facilities ($M = 7.60$, std. = 1.35). The same is found for the means of four to six facilities; they were significantly different from the zero to three facilities. This indicates that it is preferable to have as many ICT facilities available as possible.

Table 5.10 Summary results one-way ANOVA test (post hoc Games-Howell) number of ICT facilities and individual productivity[4]

	Mean	**Mean compared to***						
		0	1	2	3	4	5	6
0	7.60	-	=	↓	↓	↓	↓	↓
1	7.64	=	-	=	↓	↓	↓	↓
2	7.72	↑	=	-	=	↓	↓	↓
3	7.79	↑	↑	=	-	↓	↓	↓
4	7.93	↑	↑	↑	↑	-	=	=
5	7.98	↑	↑	↑	↑	=	-	=
6	8.17	↑	↑	↑	↑	=	=	-

* significant difference when $p < 0.05$; ↑ significant higher mean than; ↓ significant lower mean than; = no significant difference

The one-way ANOVA test shows a more clear result than the Pearson correlation test. It has to be noted that the correlation is measured on an individual level, whereas the one-way ANOVA compares the means in relation to the standard deviation. So, on an individual level, the results show high variations, whereas the means indicate a trend for the number of ICT facilities and productivity.

[4] The assumption of homogeneity of variance was not met for the data on the # of ICT facilities. So, a Welch's adjusted F ratio was used instead of anova.

Both findings are aligned with the literature found on facilities. As these facilities support doing the work, the more facilities the higher the productivity was predicted (Ng, 2010). Also, the managerial support should focus on this ICT support as the employee than is able to use these facilities as good as possible (Baker et al, 2006; Bosua et al., 2013).

5.3.5 Ambiance

There are three ambient factors, being (1) plants, (2) art, and (3) color (other than neutral, light colors). For each ambient factor, it was asked whether the respondent had this certain element in their home work environment or not. This was done via a multiple answer question where the respondent could select the ambient factors they had present in their home work environment. So, the respondent could either answer 'yes' or 'no answer' indicating the respondent did not have the ambient factor in their home work environment. First, independent-samples t-tests were conducted on each factor, followed by a one-way ANOVA test combining the ambient factors.

There was a significant difference in the mean for having plants (M = 7.77, std. = 1.27) and not having plants (M = 7.66, std. = 1.30) in the home working environment; t (31,295) = 7.50 , $p < 0.001$. Also a significant difference in means was found between having art (M = 7.80, std. = 1.25) and not having art (M = 7.65, std. = 1.31) in the home work environment; t(31,295) = 10.40, $p < 0.001$. Lastly, the same results were found for color. There was a significant difference between having color (M = 7.82, std. = 1.24) and not having color (M = 7.63, std. 1.32) in the home work environment; t(31,295) = 12.77, $p < 0.001$. All these results indicate that it is preferable to have ambient factors, i.e. plant, art, and/or color, in the home work environment.

Table 5.11 Summary results independent samples t-tests plants, art, color, and the individual productivity

	Mean	**Mean compared to***	
		Yes	No answer
Plants			
Yes	7.77	-	↑
No answer	7.66	↓	-
Art			
Yes	7.72	-	↑
No answer	7.79	↓	-
Color			
Yes	7,82	-	↑
No answer	7,63	↓	-

* significant difference when $p < 0.05$; ↑ significant higher mean than; ↓ significant lower mean than; = no significant difference

When these ambient factors are combined, four different combinations can be generated. These are (1) plants and art, (2) plants and color, (3) art and color, and (4) all ambient factors together (plants, art, and color). Two-fifths of the whole sample has all three ambient factors in their home work environment. More than half of the respondents (56.7%) did not indicate having one of these three ambient factors.

As expected, all combinations had a significantly higher individual productivity mean than 'no ambient factors'. When looking at the significant differences between the combinations it stood out that only the combinations that included color had a significantly higher mean than the combination plants and art (without color). No significant differences were found between the combinations including color. This indicates that having color in the home work environment is even more preferable over the other two ambient factors.

Table 5.12 Summary results one-way ANOVA test (post hoc Games-Howell) combinations of ambient factors and individual productivity[5]

	Mean	Mean compared to*				
		Plants and art	Plants and color	Art and color	Plants art and color	No ambient factors
Plants and art	7.71	-	↓	↓	↓	↑
Plants and color	7.80	↑	-	=	=	↑
Art and color	7.87	↑	=	-	=	↑
Plants art and color	7.84	↑	=	=	-	↑
No ambient factors	7.64	↓	↓	↓	↓	-

* significant difference when $p < 0.05$; ↑ significant higher mean than; ↓ significant lower mean than; = no significant

5.3.6 View

Respondents were asked if they had a view from the place they mainly worked at home. Most respondents (88.5%) answered yes to this question. An independent samples t-test was executed to see if the mean of the respondents with and without a view significantly differed. Respondents with a view ($M = 7.75$, std. = 1.26) had a significantly different higher mean than respondents without a view ($M = 7.44$, std. = 1.45); $t(31,299) = 13.57$, $p < 0.001$. This indicates that it is preferable to have a view from your workplace compared to not having a view.

This was also addressed by literature for two reasons. First, it is preferable to have a view because of natural lighting in your home work environment, which increases productivity. Secondly, a view can help reduce boredom and strain. Therefore, a view has an indirectly positive influence on productivity (Ng, 2010).

Table 5.13 Summary results independent samples t-test on view and individual productivity

	Mean	Mean compared to*	
		Yes	No
Yes	7.75	-	↑
No	7.44	↓	-

* significant difference when $p < 0.05$; ↑ significant higher mean than; ↓ significant lower mean than; = no significant difference

5.3.7 Regression analysis

Multiple linear regression was calculated to predict the individual productivity, being the dependent variable, based on the aspects of the physical home work environment (independent variables) as shown in Table 5.14. A significant regression equation was found ($F(17, 30951) = 74.352$, $p < 0.001$), with an R square of .039. It has to be noted that the R square is quite low as it only explains 3.9% of the variances for the individual productivity explained by the variables of the physical home work environment.

All categorical variables, i.e. original function of the room, use, and size of the workplace, are recoded into dummy variables. These are compared to the category that significantly differed from the other categories. For the original function of the room, this is the work room, as this category significantly differed (higher) in mean from the others. Therefore, it is expected that all dummy variables have a negative coefficient in the regression analysis. The same goes for the use of the room in which all categories are compared to

[5] The assumption of homogeneity of variance was not met for the data on the aspect combination of ambient factors. So, a Welch's adjusted F ratio was used instead of anova; Welch's $F(4, 7039.30) = 42.49$, $p < 0.001$.

private use. Private use had the highest mean and therefore, again, it is expected that the alternative dummy variables have a negative coefficient. For the size of the workplace, it is compared to the small size of the workplace as the small size in mean significantly differed (lower) from the other categories. For the size of the workplace, it is expected that the alternative categories have a positive coefficient.

The number of ICT facilities is coded as an ordinal variable and is therefore measured in counts. So if the number of ICT facilities increases by 1 (one) the regression analysis shows that the individual productivity would increase by 0.06. The other variables (ambient factors and view) were already coded as binary variables in which 1 = yes and 0 = no answer. All independent variables were significant predictors of individual productivity.[6]

As the variables are measured differently the standardized coefficients can compare the influence of the variables. When looking at the highest standardized coefficients it shows that the living room (compared to working in the work room) had the highest negative influence on individual productivity. The second-highest negative standardized coefficient is the bedroom (again compared to the work room). This implies that the function of the room has a large influence on individual productivity. When looking at the highest positive standardized coefficient, Table 5.14 shows that the size (large compared to small) has the highest positive effect on individual productivity. This is followed by the number of ICT facilities.

Table 5.14 Linear model of predictors the physical home work environment of individual productivity

		Unstandardized coefficients		**Standardized coefficients**	
		B	SE	β	p
	Constant	7.44	0.03		
Original function of the room	(Work room)				
	Living room	-0.23	0.02	**-.08**	< 0.001
	Kitchen	-0.12	0.03	-.02	< 0.001
	Multiple rooms	-0.19	0.03	-.04	< 0.001
	Other room	-0.22	0.03	-.04	< 0.001
	Bedroom	-0.32	0.03	-.06	< 0.001
	Not assigned / no answer	-0.34	0.05	-.04	< 0.001
Use of the room	(Private use)				
	Shared use	-0.29	0.02	-.01	< 0.001
	Private and shared use	*0.03*	*0.06*	*.00*	*0.585*
	Use not assigned / no answer	-0.19	0.02	-.06	< 0.001
Size workplace	(Small size workplace)				
	Medium size workplace	0.08	0.02	.03	< 0.001
	Large size workplace	0.29	0.02	**.10**	< 0.001
	No answer	0.29	0.04	.04	< 0.001
-	Number of ICT Facilities	0.06	0.00	.07	< 0.001
Ambiance	Plants	0.09	0.02	.04	< 0.001
	Art	0.04	0.02	.02	0.008
	Color	0.13	0.02	.05	< 0.001
-	View	0.21	0.02	.05	< 0.001

Note: R^2 = .039; the highest regression with individual productivity (both positive and negative) is marked in bold. In brackets the dummy variables that have been compared to.

[6] Within the 'use of the room' variable the dummy category 'private and shared use' was not a significant predictor for individual productivity, but as the other alternative categories were significant predictors ($p < 0.001$) the overall variable can be identified as an significant predictor.

5.3.8 Interrelations physical home work environment

When looking at the interrelations between the variables of the physical home work environment, correlations were mostly found between the function of the room and the use. The highest percentage of private use was found for the work room (75%; $r(31299) = .351$, $p < .01$). This is followed by 'other room' (72%) and bedroom (68%). The rooms that are mostly shared are the living room (45%) and kitchen (44%). This can explain that even though the bedroom scored the lowest average individual productivity for all functions, comparing all the variables the lowest standardized coefficient was the living room instead of the bedroom.

Zooming in on the living room, most ambient factors were reported within this type of room and were 63% 'large' in size. All the other function types were mostly 'medium size'. Besides, 38% of the respondent that had 0 facilities available in the work room worked in the living room.

All these findings are supported by a Pearson's correlation test between all variables of the physical home work environment (see Appendix X), in which the following variables correlated between .2 and .6 (indicating a weak to a moderate relationship (Field, 2013)):

- The work room correlated with private use ($r(31,299) = .35$, $p < .01$) and small workplace ($r(31,299) = .24$, $p < .01$);
- The living room had a correlation with shared use ($r(31,299) = .295$, $p < .01$), a large workplace ($r(31,299) = .53$, $p < .01$), having plants ($r(31,295) = .42$, $p < .01$), and having art ($r(31,295) = .21$, $p < .01$) in the home work environment;
- The use of multiple rooms had a correlation with private and shared use ($r(31,299) = .53$, $p < .01$)[7];
- Room 'Not assigned/no answer' and use 'Not assigned/no answer' had a correlation ($r(31,299) = .29$, $p < .01$);
- The shared use variables correlated with a large workplace ($r(31,299) = .24$, $p < .01$), and having plants in the work environment ($r(31,295) = .20$, $p < .01$);
- A large workplace has a correlation with plants ($r(31,295) = .33$, $p < .01$);
- All ambient variables correlate with eachother, so plants correlate with art ($r(31,295) = .38$, $p < .01$), plants with color ($r(31,295) = .31$, $p < .01$), and art and color ($r(31,295) = .34$, $p < .01$).

5.3.9 Sub conclusion

The first hypothesis was: 'The physical home work environment affects perceived productivity'. The null hypothesis is then $H1_0$: 'The physical home work environment does not affect perceived productivity'. This hypothesis can be rejected from the results presented in section 5.3.1 to section 5.3.7. Therefore it can be said that the physical home work environment has a direct influence on individual productivity.

According to the results from the bivariate analyses on the physical home work environment, it is most preferable to work in a large (> 25 m2) private workroom including plants, art, and color, with access to 4 to 6 ICT facilities and a view to the outside.

From the regression analysis, it can be concluded that working in a large size workplace compared to a small size workplace has the highest positive influence on individual productivity. This is followed by the number of ICT facilities available. Working in the living room compared to working in a workroom has the highest negative influence on individual productivity and the second-highest negative influence is working in a bedroom compared to working in a workroom. The reason why the living room has a higher negative coefficient than the bedroom (in relation to working in a workroom) could be explained by the interrelations found between the physical home work environment variables. A living is most likely to be shared and, therefore, may score a higher negative influence than a bedroom which more likely to be used privately.

[7] It was only possible to get the label 'private and shared use' when a respondent indicates using multiple rooms often to always. This means it was not possible to get the label 'private and shared use' when the respondent did not got the label 'multiple rooms'.

5.4 SATISFACTION WITH THE HOME WORK ENVIRONMENT

The factors of satisfaction with the home work environment and individual productivity are all ordinal variables. The satisfaction factors were measured on a 5-point Likert scale and individual productivity on a 10-point Likert scale. Table 5.15 shows the results from a Pearson correlation test.

Individual productivity was significantly correlated with satisfaction with ambiance, r = .37, satisfaction with privacy and concentration, r = .44, satisfaction with indoor climate, r = .28, and satisfaction with functionality, r = .33 (all $p < 0.001$). These are, according to Field (2013), moderate relationships. The highest correlation found between individual productivity and satisfaction with the home work environment is with satisfaction with privacy and concentration. This indicates that productivity is mostly perceived when the respondent can work in privacy and concentrated.

As explained in Section 4.2.2 Recoding, the satisfaction factors were determined with a 'direct oblimin' analysis. This indicates that the factors would also correlate with each other. Table 5.15 shows that satisfaction with ambiance significantly correlates with satisfaction with privacy and concentration, r = .49, satisfaction with indoor climate, r = .62, and satisfaction with functionality, r = .55. From the numbers, these are mostly strong relationships (r > .5) (Field, 2013). Moderate relationships (r is between .3 to .5) are found between the other satisfaction factors. So, the satisfaction with the ambiance is highly influenced by the other satisfaction factors with an emphasis on the satisfaction with indoor climate.

Table 5.15 Results Pearson correlation analysis satisfaction with the home work environment and individual productivity

	Individual productivity	Satisfaction with ambiance	Satisfaction with privacy and concentration	Satisfaction with indoor climate	Satisfaction with functionality
Individual productivity	1	31,229	31,198	31,060	31,170
Satisfaction with ambiance	.37*	1	31,192	31,059	31,147
Satisfaction with privacy and concentration	.44*	.49*	1	31,033	31,115
Satisfaction with indoor climate	.28*	.62*	.34*	1	30,996
Satisfaction with functionality	.33*	.55*	.45*	.35*	1

Note: the lower part of the table shows the correlation coefficients, the upper part of the table shows the number of respondents;
* Correlation is significant at $p < 0.001$

5.4.1 Regression analysis

For the satisfaction with the home work environment, also a multiple linear regression was executed, to forecast individual productivity based on the satisfaction with ambiance, satisfaction with privacy and concentration, satisfaction with indoor climate, and satisfaction with functionality. A significant regression equation was found ($F(4, 30964) = 2{,}373.253$, $p < 0.001$), with an R square of .235. The R square shows that the satisfaction with the home work environment has a larger influence on productivity compared to the physical home work environment itself (R square physical home work environment = .036) (see also Section 5.3.7).

From the data it was predicted individual productivity is equal to 3.97 + 0.23 (satisfaction with ambiance) + 0.47 (satisfaction with privacy and concentration) + 0.10 (satisfaction with indoor climate) + 0.16 (satisfaction with functionality), where all satisfaction factors are coded as the mean of multiple satisfaction factors (5-point Likert Scale). So, individual productivity, for example, increases 0.47 for each increase of 1 on the satisfaction with privacy and concentration. All satisfaction factors were significant

predictors of individual productivity. The satisfaction with privacy and concentration has the highest (positive) standardized coefficients and the satisfaction with indoor climate the lowest. This suggests that satisfaction with privacy and concentration has the largest impact on individual productivity.

Table 5.16 Linear model of predictors satisfaction with the home work environment of individual productivity

	Unstandardized coefficients		**Standardized coefficients**	
	B	SE	β	p
Constant	3.97	0.04		
Satisfaction with ambiance	0.23	0.01	0.12	< 0.001
Satisfaction with privacy and concentration	0.47	0.01	**0.31**	< 0.001
Satisfaction with indoor climate	0.10	0.01	0.06	< 0.001
Satisfaction with functionality	0.16	0.01	0.11	< 0.001

Note: R^2 = .235; the highest regression with individual productivity is marked in bold.

5.4.2 Sub conclusion

The null hypothesis that has been tested was $H2_0$: 'Satisfaction with the home work environment does not affect perceived productivity'. Both the results from the Pearson correlation and regression analysis show that this hypothesis can be rejected.

Zoomed in on the satisfaction factors, satisfaction with privacy and concentration has the highest influence (Pearson correlation r = .44, and regression β = .031). The second highest influence is the satisfaction with ambiance. All satisfaction factors significantly correlate with each other where the satisfaction with the ambiance has strong relationships with the other satisfaction factors.

Besides, the R square of the satisfaction with the home work environment is higher than the R square of the physical home work environment itself. This indicates that satisfaction has a larger influence on individual productivity than the physical home work environment.

5.5 INDIVIDUAL CONTROL VARIABLES

The individual control variables are used to increase the reliability of the other variables (physical home work environment and satisfaction). Besides, these variables can not be 'changed' by the respondents. So, it is used to get a better overall picture of the influence of homeworking on employees' productivity. The individual control variables include the household composition, education level, age, gender, and job function as shown in Section 5.1. The order of the variables is based on the average mean (from high to low) or the already logical existing order, such as the age from '< 30 year' to '> 60 year'.

The assumption of homogeneity of variance was not met for the data on the household composition, education level, and age. Therefore, Welch's adjusted F ratio was used, which was significant in all three aspects. For the household composition: Welch's $F(4,4220.28) = 49.49$, $p < 0.001$; education level $F(6, 5146.87) = 45.56$, $p < 0.001$; and age $F(6, 5146.87) = 45.56$, $p < 0.001$. This suggests that at least two of the categories per aspect significantly differ in mean. The variables of gender and job function were binary and therefore an independent samples t-test was conducted.

5.5.1 Household composition

When looking at the different household types compared to their productivity, it shows that the couples without children (living at home) score the highest mean for individual productivity (M = 7.84, std. = 1.29). This is followed by the household types with children living at home (single-parent households with children and couples with children). The household type 'otherwise' has the lowest mean for individual productivity (M = 7.48, std. = 1.48).

Most means are, according to the Games-Howell test, significantly different from each other. The mean individual productivity of the couple without children scores higher than all the other household types. The household types with children, single parents or as a couple, do not significantly differ from each other. Lastly, the individual productivity mean of the category 'otherwise' was significantly lower compared to the other categories, with an exception of the single household.

Table 5.17 Results one-way ANOVA test (post hoc Games-Howell) household composition and individual productivity

	Mean	**Mean compared to***				
		Couple without children	Single-parent households with children	Couple with children	Single household	Otherwise
Couple without children	7.84	-	↑	↑	↑	↑
Single-parent households with children	7.73	↓	-	=	↑	↑
Couple with children	7.65	↓	=	-	=	↑
Single household	7.61	↓	↓	=	-	=
Otherwise	7.48	↓	↓	↓	=	-

* significant difference when $p < 0.05$; ↑ significant higher mean than; ↓ significant lower mean than; = no significant difference

Comparing these results with the literature review, the same outcomes have been found. According to Sing et al. (2013), employees with children are less likely to work at home because of distraction. These distractions can explain the lower individual productivity mean for household compositions with children compared to couples without children. However, single-parent households with children second-highest individual productivity mean from the household categories, which could be because during homeworking they can simultaneously take care of their children. Having the possibility to take care of family members while working at home could positively affect productivity (Nakrošienė et al., 2019). It has to be noted that the number and age of the children are not taken into account for this analysis, which was discussed by among others Hill et al. (1998) and Nakrošienė et al. (2019).

5.5.2 Education level

Respondents with a 'medium education level' have the highest mean on individual productivity (M = 7.95, std. = 1.20). This mean decreases when the education level increases (high education level: M = 7.63, std. = 1.31). As mentioned in Section 5.1.2, most respondents have a 'high education level' (74.9%).

From the Games-Howell test, only the high education level significantly differs (lower) in mean from the low and other education level and the medium education level. The low and other education level and the medium education level do not significantly differ in mean. So, respondents with a high education level report their productivity lower than the other two education levels.

This result is not in line with the results of previous research. According to Giovanis (2018) education level correlates positively with productivity, whereas the data from this research has a contradictory outcome where the high education level had the lowest mean in individual productivity.

Table 5.18 Results one-way ANOVA test (post hoc Games-Howell) education level and individual productivity

	Means	Mean compared to*		
		Low and other education level	Medium education level	High education level
Low and other education level	7.90	-	=	↑
Medium education level	7.95	=	-	↑
High education level	7.63	↓	↓	-

* significant difference when $p < 0.05$; ↑ significant higher mean than; ↓ significant lower mean than; = no significant difference

5.5.3 Age

For the socio-demographic variable of age the mean of individual productivity increases when the age increases as well. The lowest mean is found in the category < 30 year (M = 7.40, std. = 1.33) and the highest mean in the category older than 60 year (M = 7.85, std. = 1.23). This can be explained by multiple other variables. For example, respondents of a younger age may have a smaller workplace, have to share their home workplace, etc. whereas the older respondents (> 60 year) probably do not have children living at home anymore and have a workroom available.

The Games-Howell test confirms that the means significantly differ from each other whereas the < 30 year significantly differ lower from all the other categories. The categories 51 – 60 year and > 60 year do not significantly differ from each other.

Table 5.19 Results one-way ANOVA test (post hoc Games-Howell) age range and individual productivity

	Mean	Mean compared to*				
		< 30 year	31 - 40 year	41 - 50 year	51 - 60 year	> 60 year
< 30 year	7.40	-	↓	↓	↓	↓
31 - 40 year	7.52	↑	-	↓	↓	↓
41 - 50 year	7.68	↑	↑	-	↓	↓
51 - 60 year	7.84	↑	↑	↑	-	=
> 60 year	7.85	↑	↑	↑	=	-

* significant difference when $p < 0.05$; ↑ significant higher mean than; ↓ significant lower mean than; = no significant difference

5.5.4 Gender

For the category 'male and other' the mean is 7.40 (std. = 1.34) is lower compared to the mean of individual productivity for females (M = 7.81, std. = 1.23) According to the independent samples t-test these means differ significantly; $t(31299) = -14.99$, $p < 0.001$. The variable gender, as explained in section 5.1.4, was comparable to the population of the Netherlands. This indicates that these results can be generalized.

Table 5.20 Results independent samples t-test on gender and individual productivity

	Mean	Mean compared to*	
		Male and other	Female
Male and other	7.60	-	↓
Female	7.81	↑	-

* significant difference when $p < 0.05$; ↑ significant higher mean than; ↓ significant lower mean than; = no significant difference

The findings are aligned with previous research where females (compared to males) score a higher mean in productivity (Nakrošienė et al., 2019; Singh et al., 2013). The most common explanation is that females find a better work-life balance when working at home.

5.5.5 Job function

Last, the job function variable had two categories, namely manager and employee. Managers score their productivity individual mean (M = 7.85, std. = 1.13) higher compared to employees (M = 7.70, std. = 1.30) ; $t(31299) = 5.26$, $p < 0.001$. This is remarkable, because, as discussed in the introduction, managers are more hesitant towards homeworking (for their employees).

Table 5.21 Results independent samples t-test on job function and individual productivity

	Mean	**Mean compared to***	
		Manager	Employee
Manager	7.85	-	↑
Employee	7.70	↓	-

* significant difference when $p < 0.05$; ↑ significant higher mean than; ↓ significant lower mean than; = no significant difference

5.5.6 Regression analysis

Table 5.22 shows a multiple linear regression analysis to calculate the dependent variable individual productivity based on the independent individual control variables. A significant regression equation was found ($F(12, 31288) = 99.310$, $p < 0.001$), with an R square of 0.037. This means that only 3.7% of the variances can be explained by the individual control variables.

The variables household composition, education, and age are recoded into dummy variables. The category 'couple with children' scored the highest mean for the household composition. Therefore, it is expected that the alternative categories will have a negative coefficient. For the education level, the categories are compared with the high education level. As the high education level had the lowest mean it is expected that the other categories have a positive coefficient. The same is expected for the age as the categories are compared to the category younger than 30 year. This category had the lowest mean in individual productivity compared to the other categories within the variable age.

The variables gender and job function only had two categories and can therefore be seen as binary variables. Within the variable gender, female is compared to men and other. In the variable, the job function employee is compared to manager.

The highest positive standardized coefficient was 51 – 60 year (compared to < 30 year) followed by the category > 60 year. This indicates that for all individual control variables having an age higher than 51 year is favorable for individual productivity. The highest negative standardized coefficients were the household composition categories 'couple with children' and 'single household'. This is remarkable as the one-way ANOVA test of the household composition showed that the category 'otherwise' had the lowest individual productivity mean.

Table 5.22 Linear model of predictors the physical home work environment of individual productivity

		Unstandardized coefficients		Standardized coefficients	
		B	SE	β	p
	Constant	7.45	0.04		
Household composition	(Couple without children)				
	Single-parent households with children	-0.18	0.03	-0.03	< 0.001
	Couple with children	-0.17	0.02	**-0.06**	< 0.001
	Single household	-0.20	0.02	**-0.06**	< 0.001
	Otherwise	-0.12	0.05	-0.01	0.015
Education	Low and other education level	0.19	0.07	0.02	0.006
	Medium education level	0.25	0.02	0.08	< 0.001
	(High education level)				
Age	(< 30 year)				
	31 – 40 year	0.18	0.03	0.05	< 0.001
	41 – 50 year	0.33	0.03	0.11	< 0.001
	51 – 60 year	0.45	0.03	**0.17**	< 0.001
	> 60 year	0.46	0.03	0.13	< 0.001
Gender	(Male and other)				
	Female	0.27	0.01	0.10	< 0.001
Job function	(Manager)				
	Employee	-0.18	0.03	-0.04	< 0.001

Note: R^2 = .037; the highest regression with individual productivity (both positive and negative) is marked in bold. In brackets the dummy variables that have been compared to.

5.5.7 Interrelations individual control variables

Less clear interrelations were found between the individual control variables, compared to the interrelations between the physical home work environment. What can be observed is that 59% of the household type is aged 30 years or younger. The couples without children are 66% older than 50 years. All household types have around a 50/50 ratio between male (and other) and female. An exception is the single-parent households with children, where the percentage of females is 70%.

A Pearson's correlation test between the individual control variables show three correlations between .2 and .4 (see appendix X), which indicates a weak relationship (Field, 2013):

- The household composition couple without children correlated with > 60 year old ($r(31,299) = .25$, $p < .01$).
- The household composition couple with children living at home had a correlation with respondent between 41 and 50 year old ($r(31,299) = .23$, $p < .01$).
- The household composition otherwise showed a weak correlation with respondent younger than 30 year ($r(31,299) = .29$, $p < .01$).

5.5.8 Sub conclusion

The third hypothesis was: 'Individual control variables affect perceived productivity'. The bivariate analyses and the regression analysis on the individual control variables show that the null hypothesis can be rejected as every variable shows a significant difference in the mean of individual productivity.

Respondents with a household composition of a couple without children (living at home), with a low to medium education level, age of older than 51 year, female gender, and a managerial job function score the best on individual productivity when looking at the individual control variables. The highest influence, according to the regression analysis, is the age of the respondent (preferably > 51 year) and the household composition (couple with children and single household, compared to the couple without children household composition category).

5.6 INTEGRAL PATH MODEL ANALYSIS

All three aspects of the conceptual model concerning individual productivity are combined in an integral path model. This model aims to see whether there are indirect relationships between the physical home work environment aspects, individual control variables, and individual productivity. For example, the function of the room influences the satisfaction of the ambiance, which then influences productivity.

The fit of the model meets the requirements for the root mean square error of approximation (RMSEA), and the comparative fit index (CFI) (Hooper et al., 2008). First, the cut-off value of the RMSEA is 0.1 and preferably lower than 0.08 (Hooper et al., 2008). The RMSEA of this model is 0.065. The RMSEA is sensitive to the number of parameters. This model has a lot of parameters, therefore, it was difficult to minimize the RMSEA. However, in the integral path model, all the interrelations as discussed in sections 5.3.8 and 5.5.7 were added to the model.

Secondly, the larger the CFI, the better, with a preference of higher than 0.9 (Hooper et al., 2008). The model has a CFI of 0.921, which indicates a good model fit. All the (other) model fit indices can be found in Table B.60 in Appendix B.5.

Last, the chi-square is preferred to be insignificant. For this model, the chi-square was significant at $p < 0.001$. However, chi-square is sensitive to the size of the sample. This could be an explanation of why the chi-square is significant for this model.

5.6.1 Physical home work environment

For the physical home work environment, the relationship assumed in the conceptual model is via the satisfaction with the home work environment. This means that the variables of the physical home work environment influence the satisfaction with the home work environment. Table B.61 in Appendix B.5 shows the effect of the path model on the aspect of the physical home work environment.

First, it was found that the variable original function of the room has a relationship with all four satisfaction variables. Every original function category compared to the workroom had a negative coefficient with the satisfaction factors, with the emphasis on the living room having the highest negative coefficient on the satisfaction with the functionality ($\beta = -0.202$, $p < 0.001$). So, this indicates that there is an indirect (negative) relationship between the original function of the room and individual productivity via satisfaction with the home work environment. An exception is the function kitchen (compared to the workroom) having a positive relationship with the satisfaction with the indoor climate ($\beta = 0.042$, $p < 0.001$).

Table 5.23 Standardized direct effect integral path model function of the room on satisfaction factors

	Satisfaction with…			
	Ambiance	Privacy and concentration	Indoor climate	Functionality
(Workroom)				
Living room	**-0.116**	**-0.231**	*0.001*	**-0.202**
Kitchen	*-0.010*	-0.100	0.042	-0.075
Multiple rooms	-0.046	-0.091	*0.005*	-0.102
Other room	-0.086	-0.075	**-0.074**	-0.086
Bedroom	-0.103	-0.075	-0.047	-0.113
Not assigned / no answer	-0.044	-0.086	*-0.016*	-0.051

Note: significant at p < .01; non-signifcant outcomes in italic; highest positive/negative outcome marked in bold

Secondly, for the size of the workplace, the comparable category was the small size workplace. As already found by the regression analysis of the physical home work environment (Table 5.14), it is expected that the coefficients are positive, meaning the bigger the workplace the higher the individual productivity. Here it was also found that the size of the workplace had a positive relationship with the satisfaction factors. The highest coefficient was found between the large size workplace and the satisfaction ambiance ($\beta = 0.2$, $p < 0.001$).

Table 5.24 Standardized direct effect integral path model size of the workplace on satisfaction factors

	Satisfaction with…			
	Ambiance	Privacy and concentration	Indoor climate	Functionality
(Small size workplace)				
Medium size workplace	0.132	0.049	0.074	0.073
Large size workplace	**0.200**	**0.088**	**0.137**	**0.137**
No answer	0.044	0.027	0.041	0.042

Note: significant at p < .01; non-signifcant outcomes in italic; highest positive/negative outcome marked in bold

Thirdly, the use of the workplace is examined. Only a clear negative relation is found for shared use (compared to private use) as it mostly negatively influences the satisfaction with privacy and concentration ($\beta = -0.275$, $p < 0.001$). Probably, there is more distraction in the room when the room is shared with others. A remarkable result was a significant relationship between the private and shared use with the satisfaction with privacy and concentration ($\beta = 0.039$, $p < 0.001$).

Table 5.25 Standardized direct effect integral path model use of the room on satisfaction factors

	Satisfaction with…			
	Ambiance	Privacy and concentration	Indoor climate	Functionality
(Private use)				
Shared use	**-0.088**	**-0.286**	**-0.042**	**-0.113**
Private and shared use	*0.009*	0.040	*0.005*	0.022
Use not assigned / no answer	*-0.001*	-0.070	*-0.006*	-0.036

Note: significant at p < .01; non-signifcant outcomes in italic; highest positive/negative outcome marked in bold

The last variables were the number of ICT facilities, ambient factors, and view. All these aspects had a positive relationship with the factors of satisfaction and therefore also the individual productivity. Plants had the highest standardized coefficient with the satisfaction of the ambiance ($\beta = 0.143$, $p < 0.001$).

The same was found for art ($\beta = 0.106$, $p < 0.001$), color ($\beta = 0.092$, $p < 0.001$), and view ($\beta = 0.263$, $p < 0.001$). The number of ICT facilities mostly effected the satisfaction with functionality ($\beta = 0.275$, $p < 0.001$).

Table 5.26 Standardized direct effect integral path model facilities, ambient factors, and view on satisfaction factors

	Satisfaction with…			
	Ambiance	Privacy and concentration	Indoor climate	Functionality
Number of ICT Facilities	0.118	0.089	0.078	0.232
Plants	0.143	0.028	0.081	0.053
Art	0.106	0.039	0.05	0.046
Color	0.092	0.056	0.074	0.061
View	0.275	0.067	0.132	0.08

Note: significant at $p < .01$

When comparing the standardized total effect on individual productivity of all the physical home work environment variables, the following was found:

- Working in a living room (compared to working in a workroom) and sharing the workspace (compared to using it privately) has the biggest negative influence on individual productivity.
- The highest positive coefficient was found for the large workspace (compared to a small workplace), followed by the number of ICT facilities.

5.6.2 Individual control variables

It was predicted that the individual control variables indirectly influence productivity in two ways. First, it has an indirect relationship with productivity via satisfaction with the home work environment. Secondly, the individual control variables affect the physical home work environment which in itself influences the satisfaction with the home work environment. Table B.68 in Appendix B.5 shows the direct effects the individual control variables have on the physical home work environment variables. As explained in the previous section (0), these physical home work environment variables affect the satisfaction factors as well.

For the variable household composition, mostly negative coefficients were found for the satisfaction factors (compared to the household composition category 'couple without children'). The household composition couple with children (compared to couples without children) have the highest negative effect on all satisfaction factors (see also Table 5.27). Furthermore, a positive coefficient was observed between single households, compared to couples without children, on satisfaction with privacy and concentration ($\beta = 0.090$, $p < 0.001$). An explanation could be that single households do not have roommates to be distracted from.

Table 5.27 Standardized direct effect integral path model household composition on satisfaction factors

	Satisfaction with…			
	Ambiance	Privacy and concentration	Indoor climate	Functionality
(Couple without children)				
Single-parent with children	-0.033	-0.032	*-0.011*	-0.024
Couple with children	**-0.055**	**-0.146**	**-0.025**	**-0.047**
Single household	-0.050	0.090	*-0.015*	*0.004*
Otherwise	*-0.012*	-0.025	*0*	*0.006*

Note: significant at $p < .01$; non-signifcant outcomes in italic; highest positive/negative outcome marked in bold

For the category of age only positive coefficients were found for the satisfaction factors (age categories from > 30 years compared to the category < 30 years). The highest coefficient was found for the age category 51 – 60 years on all satisfaction factors (see Table 5.28).

Table 5.28 Standardized direct effect integral path model age on satisfaction factors

	Satisfaction with…			
	Ambiance	Privacy and concentration	Indoor climate	Functionality
(< 30 year)				
31 – 40 year	0.042	0.031	0.073	0.043
41 – 50 year	0.109	0.055	0.118	0.083
51 – 60 year	**0.151**	**0.118**	**0.165**	**0.094**
> 60 year	0.111	0.088	0.137	0.069

Note: significant at p < .01; non-signifcant outcomes in italic; highest positive/negative outcome marked in bold

For the education level only significant coefficients were found for the medium education level (compared to high education level). All these coefficients were positive. The highest positive coefficient was with the satisfaction with functionality ($\beta = 0.081$, $p < 0.001$).

Table 5.29 Standardized direct effect integral path model education level on satisfaction factors

	Satisfaction with…			
	Ambiance	Privacy and concentration	Indoor climate	Functionality
Low and other education level	*-0.003*	*0.008*	*0.001*	*0.013*
Medium education level	**0.039**	**0.055**	**0.058**	**0.081**
(High education level)				

Note: significant at p < .01; non-signifcant outcomes in italic; highest positive/negative outcome marked in bold

Last, for the variable gender, female compared to male and other, only positive coefficients were detected, with the highest coefficient for satisfaction with indoor climate ($\beta = 0.066$, $p < 0.001$). For the variable job function, only one significant (negative) coefficient was found with the satisfaction with ambiance ($\beta = -0.013$, $p < 0.001$; employee compared to manager).

Table 5.30 Standardized direct effect integral path model gender and job function on satisfaction factors

	Satisfaction with…			
	Ambiance	Privacy and concentration	Indoor climate	Functionality
(Male and other)				
Female	0.060	0.039	0.066	0.034
(Manager)				
Employee	-0.013	-	-	-

Note: significant at p < .01

When looking at the function of the living room, both positive and negative relationships were found with all the individual control variables.

This was also the case for the use, with an exception of job function and age. This indicates that employees (compared to managers) and respondents older than 30 year are less likely to share/private and share their home work environment compared to private use.

Additionally, employees (compared to managers) are less likely to work in a medium or large size workplace (compared to a small size workplace.

For the number of ICT facilities, the results show all three types of relationships with the individual control variables. The education level 'low and other' and 'medium' both had a negative relation with the number of ICT facilities, which means that compared to high education level they are less likely to have (multiple) ICT facilities. This was also found for females compared to man and other. Comparing the age levels a positive relationship was shown with the number of ICT facilities, indicating the older you are the more likely you have (multiple) ICT facilities.

The ambient factors show various results. Negative coefficients were found from education level (low and other, and medium compared to high). Positive coefficients were established between female (compared to male and other) and plants, indicating that females are more likely to have plants. For art two negative relationships were shown by the results, being job function (employee compared to manager) and education level. Positive relationships were gender (female compared to male and other) and age (age levels older than 30 compared to younger than 30). The same type of relationships were found for color.

Last, for view, only three significant relationships were shown. Education level and household composition had negative coefficients with view, and age had a positive relationship.

So, all the individual control variables have to some extend relationships with the physical home work environment variables, and, therefore, influence the individual productivity via these variables. All the relationships are summarized in Figure 5.5; more detailed relationships per category can be found in Appendix B.6 Integral path model.

5.6.3 Sub conclusion

The last three hypotheses (H4 – H6) include the indirect effects the physical home work environment, and the individual control variables have on perceived productivity. The integral path analysis shows that the following null hypotheses can be rejected:

- $H4_0$: 'The physical home work environment has no indirect effect on perceived productivity, via satisfaction with the home work environment'

- $H5_0$: 'The individual control variables do not indirectly affect perceived productivity, via the physical home work environment and the satisfaction with the home work environment'

- $H6_0$: 'The individual control variables do not indirectly affect perceived productivity, via the satisfaction with the home work environment'

For the physical home work environment variables it is shown that indirectly working in a living room, and sharing the room, has the highest negative effect on productivity, mostly via the satisfaction with privacy and satisfaction. A large size room (compared to a smalls size room) had the highest positive effect on individual productivity, via the satisfaction with ambiance.

When looking at the individual control variables affecting productivity via the satisfaction factors it was found that the older, the higher perceived productivity. The highest total positive effect was the age level 51 - 60 (compared to < 30 year). The household composition of a couple with children (living at home) compared to a couple without children (living at home) has the highest negative influence on productivity, via the satisfaction with ambiance and satisfaction with privacy and concentration. Other positive coefficients were found for medium education level (compared to high education level), female (compared to male and other), and employees (compared to managers).

Comparing all variables, from the physical home work environment, satisfaction factors, and individual control variables, the highest total effect was found for the satisfaction with privacy and concentration. When this variable is positive, it is most likely for the individual productivity to increase (see also bar graph in Appendix B.6).

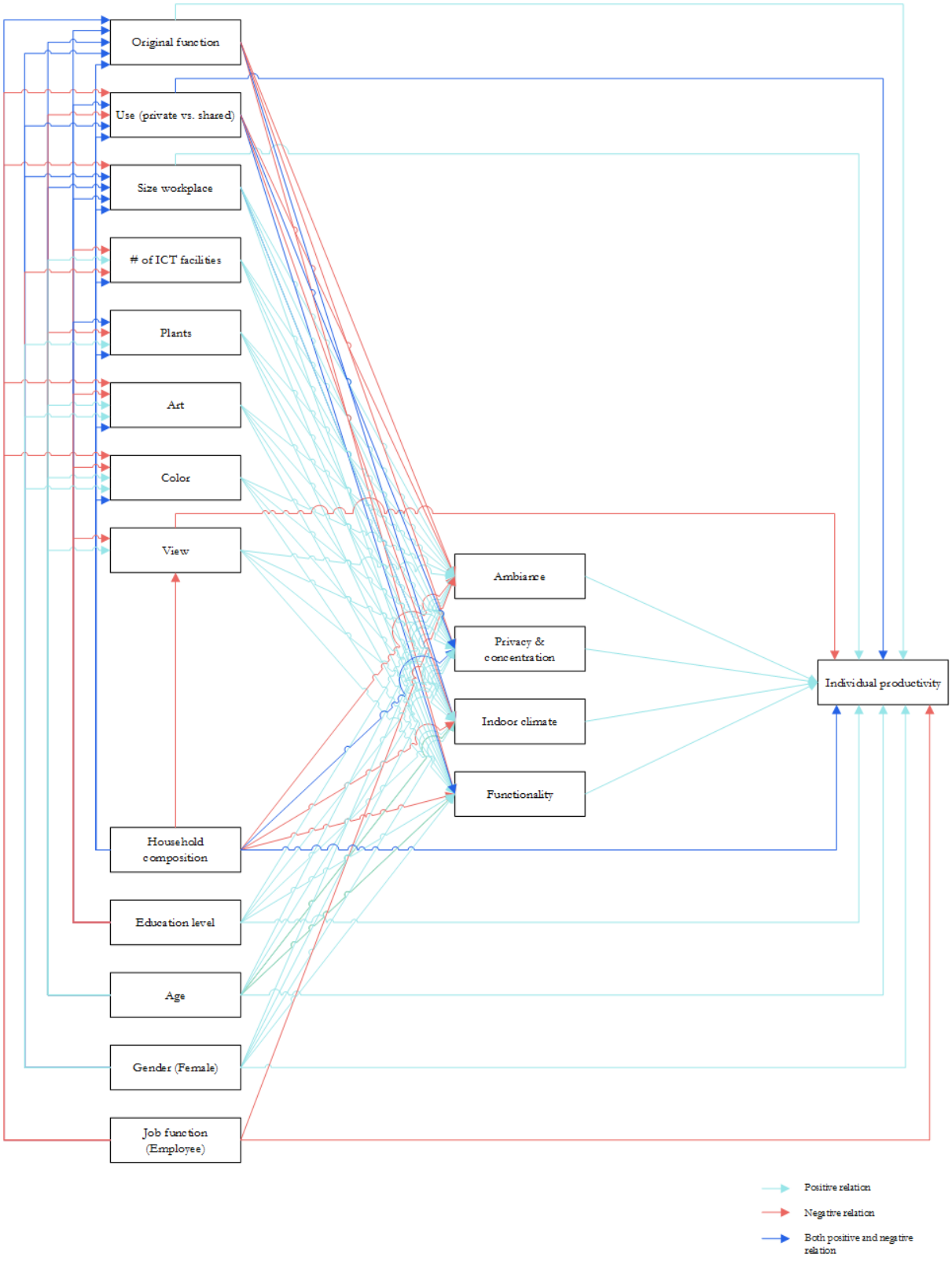

Figure 5.5 Outcomes significant relationships integral path model

Chapter 06

DISCUSSION

6 DISCUSSION

This is one of the first studies that looked specifically at aspects within the (physical) home work environment and how this affects productivity with the use of quantitative data. It is a first attempt to make an integral model on this topic, which can be used for further research. The literature review looked at theories that were not explicitly based on homeworking, but are applied within this context. The results of the statistical analyses gave new insights into what extend the home work environment influences productivity.

The sub conclusions drawn in previous chapters have to be discussed in a broader context. This means that first the limitations of the research are addressed. Secondly, the reliability and validity of the research are discussed to interpret the results correctly.

6.1 LIMITATIONS OF THE RESEARCH

The questionnaire used from the WWH project was already made in April 2020. The literature review of this study was only finished in January 2021. Therefore, some findings in the literature review did not match completely with the questions asked from the questionnaire. Therefore, some aspects could not be researched concerning productivity. Also, the way some questions were asked limited the accuracy of some variables. An example of this is that only respondents that got the label 'multiple rooms' could get the label 'both private and shared use' because per room it was asked whether the room was shared or used privately. So, respondents did not have the opportunity to fill in that they used a certain room sometimes with others and sometimes privately. Another example was the question on the size of the workplace. Some respondents answered this question with 1 m2. It looks like these respondents answered the question of how big the size of their desk was instead of how big the size was of the room they mainly worked in.

Even though many aspects have been included in the analyses, the R squares of the regression analyses (0.037 – 0.24) were relatively low. This indicates that many of the variances could not be explained by the aspects researched. It suggests that other aspects (revolving around homeworking) also influence productivity, such as managerial support or commuting time. Some of these aspects were already discussed in the literature review. Furthermore, it has to be noted that many aspects were subjective (e.g. satisfaction and perceived productivity) and therefore it is harder to explain all variances.

6.2 RELIABILITY AND VALIDITY

This research is conducted during the Covid-19 pandemic. This, as explained before, gave the unique opportunity to gather extensive data on homeworking and, more specifically, the physical home work environment. However, all the outcomes from the statistical analyses have to be placed in this Covid-19 context as well. The data is gathered in three cohorts. The context during these cohorts is described in section 5.2. However, the data is not longitudinal, so a clear course over time cannot be explained. Besides, no questions on the Covid-19 situation were asked in the questionnaire used for the analysis. Questions on, for example, the attitude towards homeworking or if the respondent was concerned about the Covid-19 situation and/or measures, could have influenced perceived productivity.

When looking at the validity of the research, overall the sample size was quite large (31,301 respondents). The larger the sample size, the smaller the sample error (Field, 2013). Therefore, the approximation of the population is valid. However, section 5.1 discussed the representativeness of the sample. There it was shown that the sample itself was not very representative of the Dutch population. For this research, the group of respondents was office workers. Office workers tend to have a higher education level than non-office workers. This explains the under representativeness of the low education level and the over representativeness of the high education level population. When looking at the average age of the sample compared to the population, the younger generations were underrepresented and the older generations were overrepresented. However, the average age of the Dutch population is 41 years (CBS, 2019) which is similar to the average age of people working in governmental organizations, namely 41,5 years old

(Ministerie van Binnenlandse Zaken en Koninkrijkrelaties, 2019). Furthermore, an explanation of the difference in household composition between the sample and the population was not found.

Another aspect that has to be taken into account is the type of organizations that participated in the research. These organizations were mostly public. In general, public organizations are strict about working from home during Covid-19. This means that the respondents have spent all working hours at home. As literature shows, the option element on homeworking and/or working in the office, i.e. level of autonomy, plays a role in homeworking implementations and perceived productivity (Singh et al, 2013). The policy of only working at home by the public organization has not always been the policy of other organizations, making the experience of working from home more difficult to generalize for all types of organizations.

Chapter 07

CONCLUSION

7 CONCLUSION

For this thesis, three concepts were researched, namely homeworking, the work environment, and productivity. The first two concepts were combined into the concept of the 'home work environment'. Through the years, homeworking and how this affects productivity have been researched consistently. The focus was mainly on the phenomenon itself, instead of aspects of homeworking and the home work environment. Mostly, homeworking was investigated from a voluntary point of view, assuming that the home work environment was suitable to conduct work at home. Now, due to Covid-19, most people are recommended to work at home as much as possible. This meant that employees had to work from home, sometimes non-voluntarily. As everybody's home work environment differs, it was possible to look more into detail at aspects of the physical home work environment on how this influences the productivity of employees. Therefore, the main research question of this study is:

What is the influence of the home work environment during telehomeworking on perceived productivity?

All aspects of the physical home work environment, satisfaction with the home work environment, and individual control variables influence productivity directly.

For the original function of the room, the workroom has the highest mean on perceived productivity. The bedroom scores the lowest perceived individual productivity. When looking at the variable of use, it is most preferable to work privately compared to shared and both private and shared use. In addition, the larger the workplace, the higher the perceived productivity. The same was found for the number of ICT facilities; the more ICT facilities available, the higher the mean for productivity. Furthermore, it is preferable to have plants, art, and color in your workplace, whereas color seems to have the highest impact. Moreover, having a view from your workplace has a positive influence on perceived productivity compared to not having a view. Of all these aspects it seems that a large size workplace (positive effect), compared to a small size workplace, and working in the living room (negative effect) compared to working in a workroom has the highest impact on perceived productivity. Overall 3.9% of the variance can be explained by the physical home work environment aspects.

The satisfaction with the home work environment explains 23.5% of the variance in perceived individual productivity. This suggests that satisfaction with the home work environment has a bigger influence on perceived productivity than the physical home work environment itself. From the satisfaction factors, the satisfaction with privacy and concentration had the biggest influence on productivity. This is followed by satisfaction with ambiance.

All individual control variables influence perceived productivity. For the household composition, it is most preferable to be a couple without children (living at home). Respondents with a medium education level score the highest perceived productivity compared to low and other education level and high education level. Furthermore, the older the higher the mean on perceived individual productivity, and female respondents score their perceived productivity higher than male and other. Last, a managerial function scores higher on productivity than a general employee job function. From all these aspects the age and household composition seem to have the biggest influence on productivity directly.

Also, indirectly, the physical home work environment and the individual control variables influence employees' productivity. The physical home work environment influences the satisfaction with the home work environment. This is also the case for the individual control variables; they have a relationship with the satisfaction with the home work environment variables, but also with the physical home work environment itself.

For the physical home work environment, the large size workplace (compared to small size workplace) has indirectly the highest positive influence on productivity. The second highest influence (indirectly) is the number of ICT facilities. The highest negative influence is shared use (compared to private use) of the home work environment, following by working in the living room compared to the workroom. This is consistent with the results of the regression analysis for the direct relationship between the physical home work environment and perceived productivity.

The individual control variables indirectly show that the older the higher the individual perceived productivity. Respondents aged above 50 years are more satisfied with ambiance, privacy and concentration, indoor climate, and functionality. Employees in these age categories are more likely to have ambiance

factors, view, and ICT facilities available in their home work environment. The household composition category 'couple with children' compared to couple without children (living at home) had the highest negative influence. This category scores negatively on the ambiance factors, view, and ICT facilities. In addition, they are more likely to share their workspace instead of using it privately.

So, to answer the main research question, the influence of the home work environment on productivity is determined by the physical work environment, the satisfaction with the work environment, and individual control variables. Of all aspects, the satisfaction with ambiance and satisfaction with privacy and concentration have the highest positive influence on individual perceived productivity. Working in a living room compared to working in a workroom has the highest negative influence on perceived productivity.[8]

Most findings are aligned with literature on previous research before Covid-19 on the effect of the office environment on productivity. Perceived productivity is mostly associated with conducting concentrated work, as this satisfaction factor had the biggest influence on productivity. Especially for the physical home work environment variables, clear similarities have been found, such as working privately in a dedicated work room has a positive effect on productivity compared to working in a shared 'open office'. For the satisfaction factors, it was remarkable that the indoor climate did not have a big effect on productivity, whereas in the office environment this variable is studied extensively related to productivity. Looking at the individual control variables, most results matched the expectations drawn by literature, with an exception of the job function where the managers reported their productivity higher than their employees.

[8] The aspects furniture, commuting time, social environment, satisfaction with the overall suitability, personality, and the level of strain and motivation were not taken into account when the influence of the aspects on the perceived productivity were compared in the statistical analysis.

Chapter 08

RECOMMENDATIONS

8 RECOMMENDATIONS

As explained in section 1.2, in addition to filling the research gap in the home work environment influencing productivity, the findings of this research can be used as a starting point for policy on homeworking arrangements in the future. For organizations both the employer and the employee are affected by new policies on working at home, but it also impacts the built environment. Therefore, recommendations are drawn for organizations (employers and employees) and designers of the built environment, i.e. practice. Furthermore, recommendations are made for further research.

8.1 PRACTICE

First of all, the average score on productivity given by the respondents is 7.7 (10-point scale). This implies that in general, the employees are productive when they work from home. Productivity is mostly associated with the level of privacy and concentration, which implicates that the home work environment can be suitable to conduct concentrated work. Collaborative work is likely to be more suitable to conduct in the office. For the future, a hybrid form of working could therefore be considered, in which the employee can work both at home and the office. In addition to these two types of workplaces, a third 'location, i.e. working remotely from anywhere, has to be considered as well. At home, they can conduct concentrated work, where at the office the employee can get the opportunity to work together with employees, but also remotely meetings can be held or concentrated work can be conducted.

It has to be noted that the interpretation of this hybrid working method differs per organization, but also per department and even per employee. Previously, most studies were focused on the office and its effect on productivity. Due to Covid-19, this focus shifted to the home work environment. Post-Covid, the emphasis should be on the needs of the organization and its employees and how hybrid forms of work can support those needs. Therefore, the office, but also remote and home work arrangements have to be redefined.

In the long term, the ambition is to find a balance between working at the office, home, and remotely for employees and employers, but also on meta-level for the organization. This balance can also differ per month, week, or even per day, as homeworking can be conducted, for example, in the morning, and in the afternoon the employee will work at the office.

Furthermore, the availability of an employee when working at home has to be taken into account, as flexibility in scheduling time is one of the advantages of homeworking (Steward, 2000). On the one hand, this should not result in being available 24 hours, 7 days per week. However, on the other hand, it is not preferable for the organization when the employee is not available at all when working at home.

The statistical analyses show that the physical home work environment influences employees' productivity. So, when it is chosen to introduce homeworking arrangements, both the employee and employer have a responsibility for a suitable home work environment. The aspects studied differ in the easiness of adaption. For example, it is easier to add plants, art, or ICT facilities in the home work environment compared to changing the size of the workplace. However, the employer can support the employee in making the home work environment suitable. This can be done financially, but also by providing some guidelines, such as working in the bedroom is more preferable than working in the living room, if this means that the employee works privately instead of shared.

With the hybrid forms of working, the office also has to be rearranged. One should think of an activity-based office with an emphasis on collaboration. This collaboration can be both physical and hybrid, as some employees or guests work remotely or from home. Therefore, the office also needs to have the facilities for hybrid forms of meetings. Besides, as mentioned in the literature review and discussion, the level of autonomy plays a role in productivity as well. This means that the employee can, to some extend, determine to work at home, remotely, or in the office. This could be because of an unsuitable home work environment, but also because on that particular day, the employee has meetings planned in the office. Therefore, the office still needs to provide workplaces to conduct concentrated work as well. Again, the balance within the office will differ per organization, and maybe per department, if applicable, as well.

These homeworking arrangements not only affect the layout and design of the office, but they can also influence the built environment long term. First, it can influence the design and layout of (new) homes. As it is preferable to have privacy and work concentrated, this needs to be possible at home in, for example, a separate (work) room. It was reported that home seekers are looking more often for a home with an extra (work) room compared to before the pandemic (Funda, 2020). This is probably to conduct homeworking in the future. In addition, the distance between home and work has become less important for home seekers, and having a garden has become more popular (Funda, 2020). This could results, in the long term, in people moving more outside of the city. Therefore, preferences within the housing market must be closely monitored and taken into account for the design of the built environment.

8.2 FURTHER RESEARCH

On the one hand, the focus of further research can be even broader than this thesis. This means that the approach is more holistic and includes additional aspects. First, data could be gathered on the aspects that were found in the literature review of this thesis. These are the social environment, including managerial support, and level of autonomy, satisfaction with the overall suitability of the home work environment, the level of motivation and strain of the respondents, and personality traits. As shown by the R square and fit of the integral path model, a lot of variances in the dataset could not be explained. Therefore, a more complete dataset is needed to better understand the whole context of homeworking. Also, on some aspects found in the literature study, already data is gathered by WWH, such as the commuting time of employees. However, because the data was asked in a different week, it was not possible to match the variables of the questionnaire of week two with other questionnaires.

Another (more holistic) approach is to look at other outcomes homeworking can have on, for example, well-being, performance, health, attitude, etc. as found by Appel-Meulenbroek et al. (2018) and Franke and Nadler (2020). As these outcomes are to some extent related to each other, this can be researched more extensively within the context of the home work environment.

On the other hand, more detailed research can be conducted. This can be done within the existing WWH dataset, where for example extra research can be conducted on what type of view, for example, a forest compared to only buildings, influences productivity or within the individual control variables, such as difference in the age of children and how this affects productivity. Also, new data can be gathered on elements that seem to have a high influence on productivity. This research could focus on the satisfaction with the ambiance and satisfaction with privacy and concentration. What measures are useful to enhance these satisfaction factors and therefore productivity. Also, more detailed research on personality traits concerning homeworking and productivity can be of value for academic research and practice.

In addition, it is very interesting to monitor the policy and implementation of working from home in the post-Covid world. This research focused only on working at home, but in the future, a more hybrid way of working could be implemented in organizations' policies. Further research could look into to what extent hybrid working is implemented and how this affects employee outcomes, such as productivity.

REFERENCES

REFERENCES

Aestate. (n.d.). *Projecten Archive*.

Appel-Meulenbroek, R., Clippard, M., & Pfnür, A. (2018). The effectiveness of physical office environments for employee outcomes: An interdisciplinary perspective of research efforts. *Journal of Corporate Real Estate*, *20*(1), 56–80. https://doi.org/10.1108/JCRE-04-2017-0012

Appel-Meulenbroek, R., Voordt, T. van der, Aussems, R., Arentze, T., & le Blanc, P. (2020). Impact of activity-based workplaces on burnout and engagement dimensions. *Journal of Corporate Real Estate*, *22*(4), 279–296. https://doi.org/10.1108/JCRE-09-2019-0041

Baker, E., Avery, G. C., & Crawford, J. (2006). Home alone: The role of technology in telecommuting. *Information Resources Management Journal*, *19*(4), 1–22. https://doi.org/10.4018/irmj.2006100101

Bakker, A. B., & Demerouti, E. (2007). The Job Demands-Resources model: State of the art. *Journal of Managerial Psychology*, *22*(3), 309–328. https://doi.org/10.1108/02683940710733115

Belanger, F., Collins, R. W., & Cheney, P. H. (2001). Technology Requirements and Work Group Communication for Telecommuters. *Information Systems Research*, *12*(2), 155–176. https://doi.org/10.1287/isre.12.2.155.9695

Bosch-Sijtsema, P. M., Ruohomäki, V., & Vartiainen, M. (2009). Knowledge work productivity in distributed teams. *Journal of Knowledge Management*, *13*(6), 533–546. https://doi.org/10.1108/13673270910997178

Bosua, R., Gloet, M., Kurnia, S., Mendoza, A., & Yong, J. (2013). Telework, productivity and wellbeing: an Australian perspective. *Telecommunications Journal of Australia*, *63*(1), 1–12. https://doi.org/10.7790/tja.v63i1.390

Bryman, Alan. (2012). Social Research Strategies: Social Research Methods. *OUP Oxford*, *32*(4), 766.

CBRE Netherlands. (2020). *Vraag naar kantoorruimte bereikt record in grote Nederlandse steden*. 03-02-2020.

Center for People and Buildings. (n.d.). *Over ons*.

Centraal Bureau voor de Statistiek (CBS) (2019, June 18). De gemiddelde leeftijd van de werkzame beroepsbevolking. https://www.cbs.nl/nl-nl/maatwerk/2019/25/de-gemiddelde-leeftijd-van-de-werkzame-beroepsbevolking

Centraal Bureau voor de Statistiek (CBS) (2020). Particuliere huishoudens naar samenstelling en grootte, 1 januari. https://opendata.cbs.nl/statline/number/CBS/nl/dataset/37975/table?ts=1613724400648

Centraal Bureau voor de Statistiek (CBS) (2021). Arbeidsdeelname; kerncijfers. https://opendata.cbs.nl/statline/number/CBS/nl/dataset/82309NED/table?ts=1613724104147

de Croon, E. M., Sluiter, J. K., Kuijer, P. P. F. M., & Frings-Dresen, M. H. W. (2005). The effect of office concepts on worker health and performance: A systematic review of the literature. In *Ergonomics* (Vol. 48, Issue 2, pp. 119–134). https://doi.org/10.1080/00140130512331319409

Edwards, J. R., Caplan, R. D., & Harrison, R. van. (1998). Person-Environment Fit Theory: Conceptual Foundations, Empirical Evidence, and Directions for Future Research. In *Theories of Organizational Stress* (pp. 28–67).

Felstead, A., & Henseke, G. (2017). Assessing the growth of remote working and its consequences for effort, well-being and work-life balance. *New Technology, Work and Employment*, *32*(3), 195–212. https://doi.org/10.1111/ntwe.12097

Field, A. (2013). Discovering statistics using IBM SPSS statistics (4th ed.). SAGE Publications.

Franke, M., & Nadler, C. (2020). Towards a holistic approach for assessing the impact of IEQ on satisfaction, health, and productivity. *Building Research and Information*, *0*(0), 1–28. https://doi.org/10.1080/09613218.2020.1788917

Funda. (2020, May 26). Veranderende woonwensen tijdens de coronacrisis. Funda voor makelaars. https://www.funda.nl/voormakelaars/artikel/veranderende-woonwensen-tijdens-de-coronacrisis/

Giovanis, E. (2018). The relationship between flexible employment arrangements and workplace performance in Great Britain. *International Journal of Manpower*, *39*(1), 51–70. https://doi.org/10.1108/IJM-04-2016-0083

Halford, S. (2005). Hybrid workspace: Re-spatialisations of work, organisation and management. *New Technology, Work and Employment*, *20*(1), 19–33. https://doi.org/10.1111/j.1468-005X.2005.00141.x

Haynes, B. P. (2008). An evaluation of the impact of the office environment on productivity. *Facilities*, *26*(5–6), 178–195. https://doi.org/10.1108/02632770810864970

Hill, E. J., Miller, B. C., Weiner, S. P., & Colihan, J. (1998). Influences of the virtual office on aspects of work and work/life balance. *Personnel Psychology*, *51*(3), 667–683. https://doi.org/10.1111/j.1744-6570.1998.tb00256.x

Hooper, D., Coughlan, J.P., & Mullen, M.R. (2008). Evaluating Model Fit:a Synthesis of the Structural Equation Modelling Literature.

Hoornweg, N., Peters, P., & van der Heijden, B. (2016). Finding the optimal mix between telework and office hours to enhance employee productivity: A study into the relationship between telework intensity and individual productivity, with mediation of intrinsic motivation and moderation of office hours. In *Advanced Series in Management* (Vol. 16, pp. 1–28). https://doi.org/10.1108/S1877-636120160000016002

Kurland, N. B., & Bailey, D. E. (2000). Telework: The advantages and challenges of working here, there, anywhere, and anytime. *IEEE Engineering Management Review*, *28*(2), 49–60. https://doi.org/10.1016/S0090-2616(00)80016-9

Maarleveld, M., & de Been, I. (2011). The influence of the workplace on percieved productivity. In *10th EuroFM Research Symposium* (pp. 1–13). https://www.researchgate.net/publication/255910695_The_influence_of_the_workplace_on_perceived_productivity

Martin, B. H., & MacDonnell, R. (2012). Is telework effective for organizations?: A meta-analysis of empirical research on perceptions of telework and organizational outcomes. *Management Research Review*, *35*(7), 602–616. https://doi.org/10.1108/01409171211238820

Mihai, F., Stan, M., Radu, G., & Dumitru, V. F. (2020). HEAVY WORK INVESTMENT FOR THE ACCOUNTING PROFESSION IN ROMANIA AT TIME OF CORONAVIRUS PANDEMIC. *Amfiteatru Economic*, *22*(14), 1121–1139. https://doi.org/10.24818/EA/2020/S14/1121

Ministerie van Algemene Zaken. (2021, March 5). Coronavirus tijdlijn. Rijksoverheid.nl. https://www.rijksoverheid.nl/onderwerpen/coronavirus-tijdlijn

Ministerie van Binnenlandse Zaken en Koninkrijkrelaties. (2019). Trends Cijfers 2019 - Kennisbank Openbaar Bestuur. https://kennisopenbaarbestuur.nl/media/256376/trends-en-cijfers-2019-definitief1.pdf

Moretti, A., Menna, F., Aulicino, M., Paoletta, M., Liguori, S., & Iolascon, G. (2020). Characterization of home working population during Covid-19 emergency: A cross-sectional analysis. *International Journal of Environmental Research and Public Health*, *17*(17), 1–13. https://doi.org/10.3390/ijerph17176284

Nakrošienė, A., Bučiūnienė, I., & Goštautaitė, B. (2019). Working from home: characteristics and outcomes of telework. *International Journal of Manpower*, *40*(1), 87–101. https://doi.org/10.1108/IJM-07-2017-0172

Neufeld, D. J., & Fang, Y. (2005). Individual, social and situational determinants of telecommuter productivity. *Information and Management*, *42*(7), 1037–1049. https://doi.org/10.1016/j.im.2004.12.001

Ng, C. F. (2010). Teleworker's home office: An extension of corporate office? In *Facilities* (Vol. 28, Issues 3–4, pp. 137–155). https://doi.org/10.1108/02632771011023113

NOS. (2020). *Provider VodafoneZiggo laat medewerkers ook na pandemie meer thuiswerken*. 27-10-2020. https://nos.nl/artikel/2354055-provider-vodafoneziggo-laat-medewerkers-ook-na-pandemie-meer-thuiswerken.html

NVM Business. (2020). *Kantoren in cijfers 2020*. 71. https://www.nvm.nl/media/vdbbuddx/kantoren-in-cijfers-2020.pdf

Ralph, P., Baltes, S., Adisaputri, G., Torkar, R., Kovalenko, V., Kalinowski, M., Novielli, N., Yoo, S., Devroey, X., Tan, X., Zhou, M., Turhan, B., Hoda, R., Hata, H., Robles, G., Milani Fard, A., & Alkadhi, R. (2020). Pandemic programming: How Covid-19 affects software developers and how their organizations can help. *Empirical Software Engineering*, *25*(6), 4927–4961. https://doi.org/10.1007/s10664-020-09875-y

Singh, P., Paleti, R., Jenkins, S., & Bhat, C. R. (2013). On modeling telecommuting behavior: Option, choice, and frequency. *Transportation*, *40*(2), 373–396. https://doi.org/10.1007/s11116-012-9429-2

Stanworth, C. (1998). Telework and the information age. *New Technology, Work and Employment*, *13*(1), 51–62. https://doi.org/10.1111/1468-005X.00038

Steward, B. (2000). Changing times: The meaning, measurement and use of time in teleworking. *Time and Society*, *9*(1), 57–73. https://doi.org/10.1177/0961463X00009001004

Sullivan, C. (2003). What's in a name? Definitions and conceptualisations of teleworking and homeworking. *New Technology, Work and Employment*, *18*(3), 158–165. https://doi.org/10.1111/1468-005X.00118

Toscano, F., & Zappalà, S. (2020). Social isolation and stress as predictors of productivity perception and remote work satisfaction during the Covid-19 pandemic: The role of concern about the virus in a moderated double mediation. *Sustainability (Switzerland)*, *12*(23), 1–14. https://doi.org/10.3390/su12239804

Tunyaplin, S., Lunce, S., & Maniam, B. (1998). The new generation office environment: The home office. *Industrial Management and Data Systems*, *98*(4), 178–183. https://doi.org/10.1108/02635579810219327

Wilkinson, M. D., Dumontier, M., Aalbersberg, Ij. J., Appleton, G., Axton, M., Baak, A., Blomberg, N., Boiten, J. W., da Silva Santos, L. B., Bourne, P. E., Bouwman, J., Brookes, A. J., Clark, T., Crosas, M., Dillo, I., Dumon, O., Edmunds, S., Evelo, C. T., Finkers, R., … Mons, B. (2016). Comment: The FAIR Guiding Principles for scientific data management and stewardship. *Scientific Data*, *3*(1), 1–9. https://doi.org/10.1038/sdata.2016.18

APPENDIX

APPENDIX A SURVEY

A.1 QUANTITATIVE OPERATIONALIZATION TABLE

Questionnaires We Werken Thuis research project – Week 2
(available upon request only)

A.2 MISSING VALUES BEFORE AND AFTER EXCLUSION OF CASES

Questionnaires We Werken Thuis research project – Week 2
(available upon request only)

APPENDIX B STATISTICAL ANALYSIS

B.1 DECISION TREE – BIVARIATE ANALYSIS

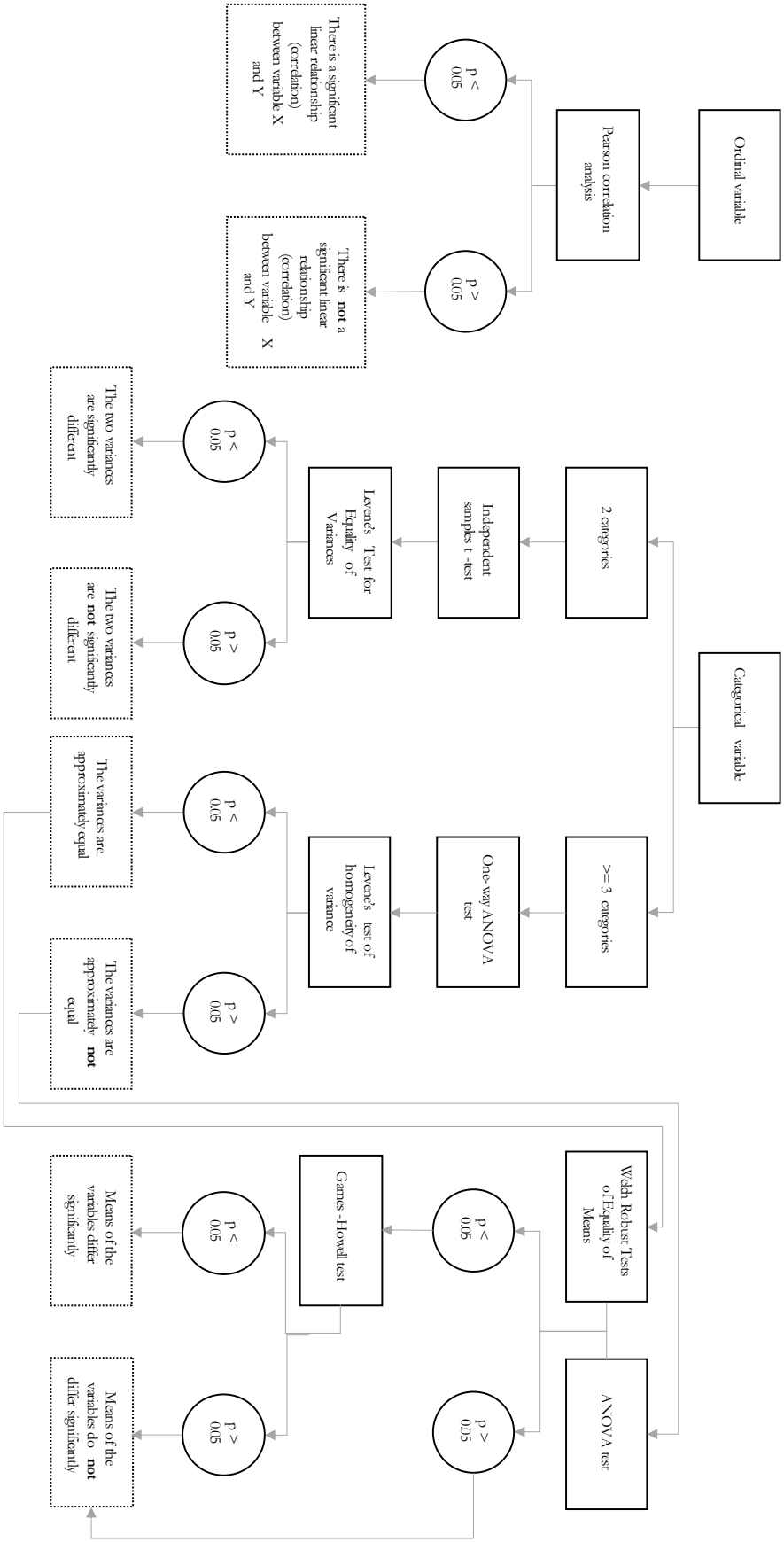

Figure B.1 Decision tree type of bivariate testing and how to interpret the results

B.2 DESCRIPTIVES PER COHORT

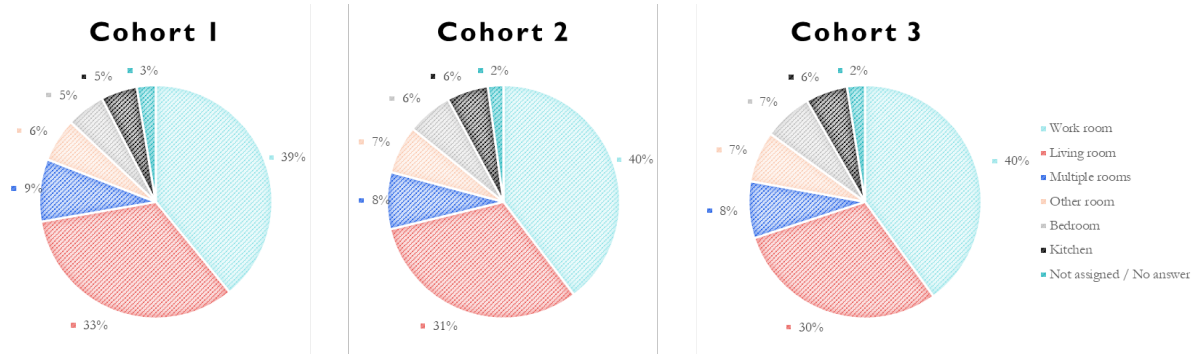

Figure B.2 Original function of the room per cohort

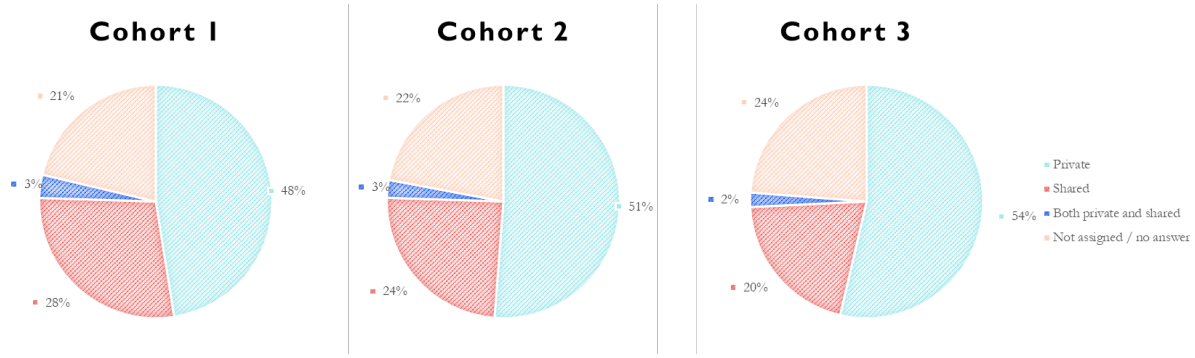

Figure B.3 Use (private vs. shared) of the workplace per cohort

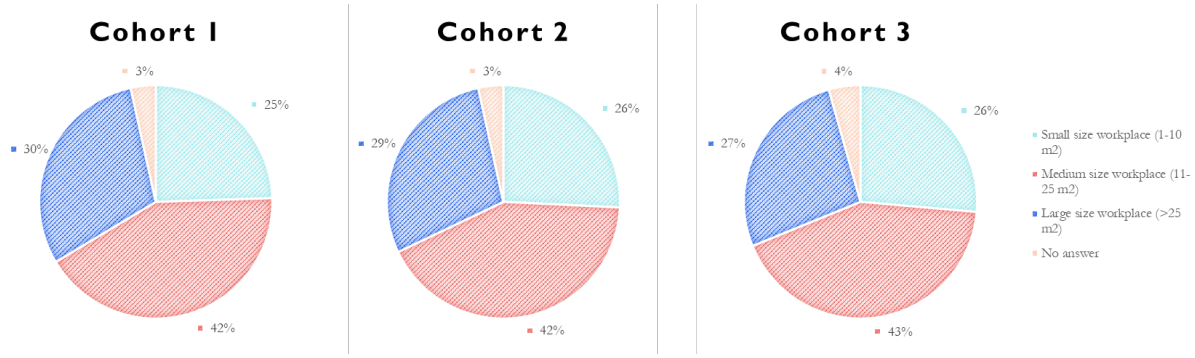

Figure B.4 Size of the workplace per cohort

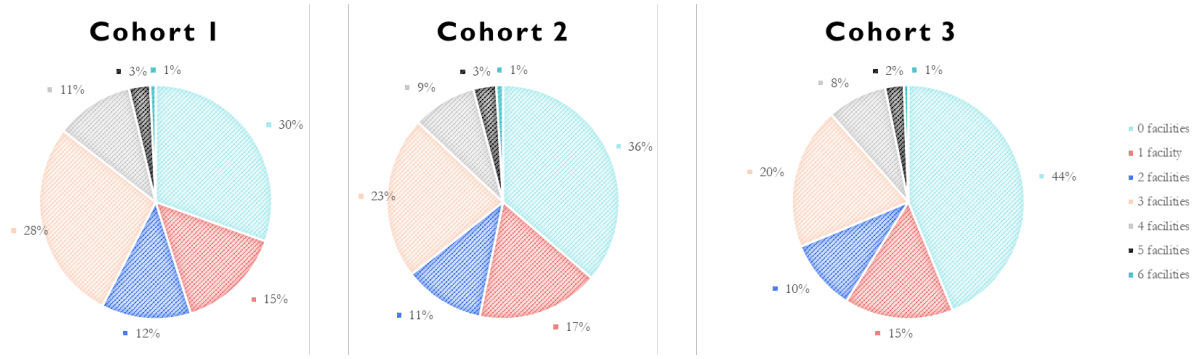

Figure B.5 # of ICT facilities per cohort

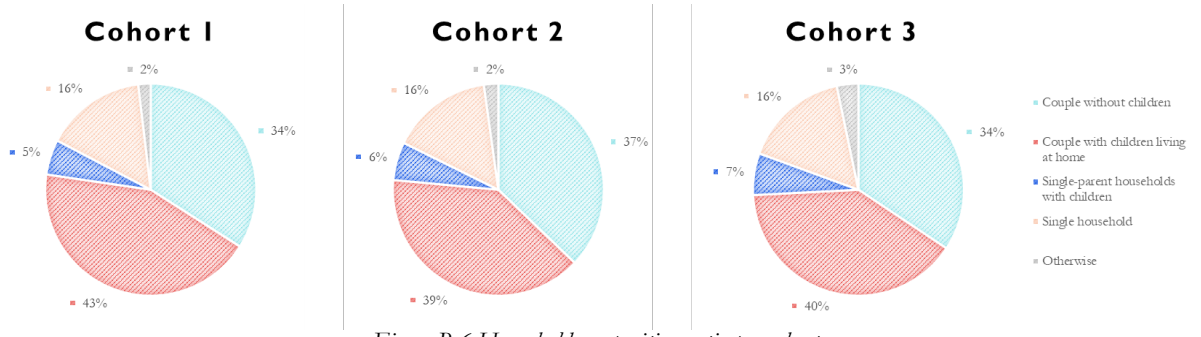

Figure B.6 Household composition ratio per cohort

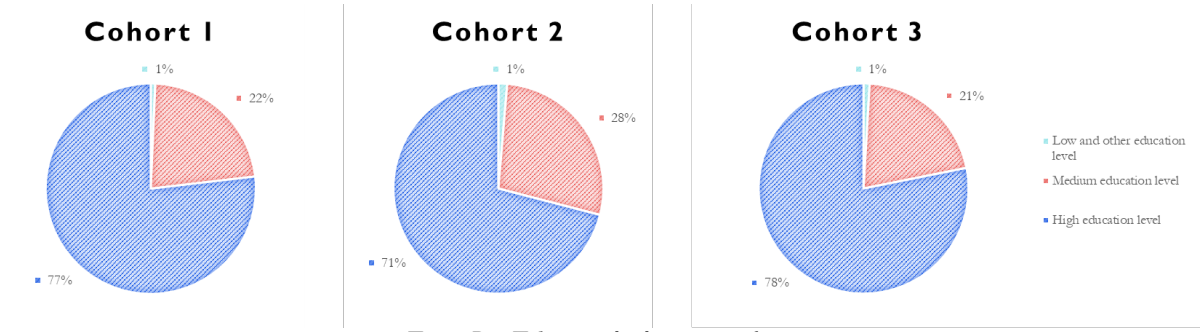

Figure B.7 Education level ratio per cohort

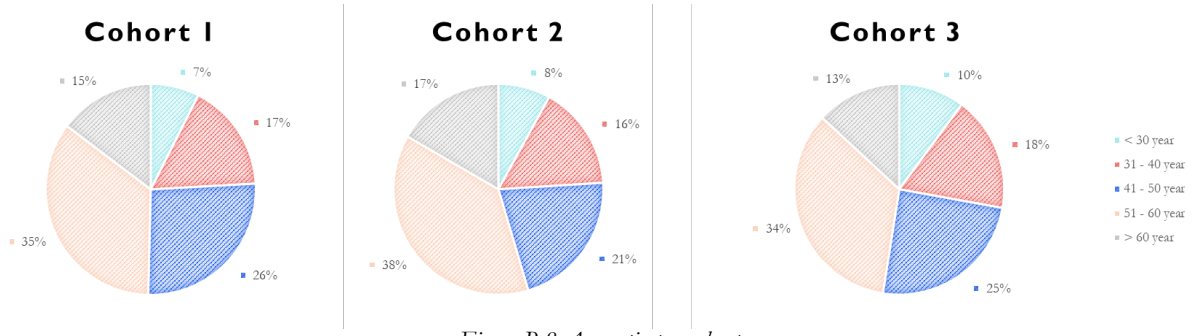

Figure B.8 Age ratio per cohort

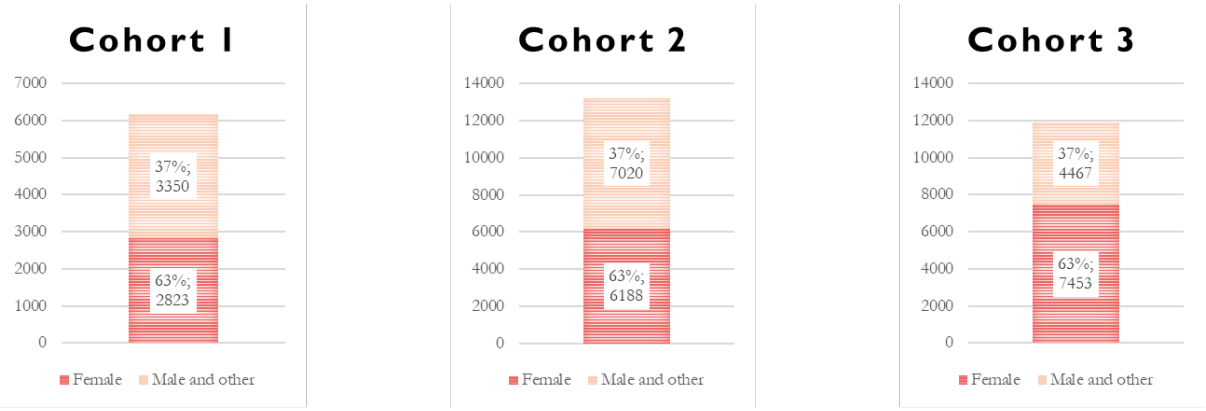

Figure B.9 Gender ratio per cohort

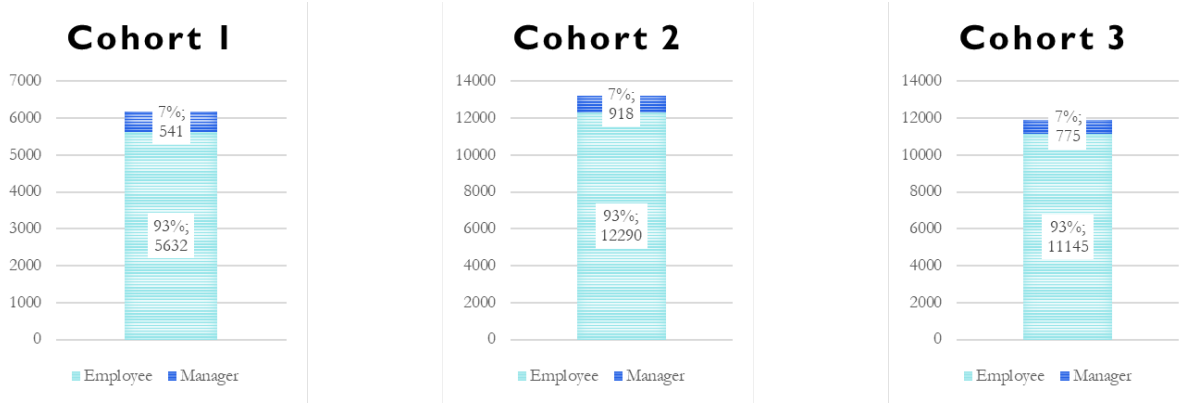

Figure B.10 Job function ratio per cohort

B.3 RESULTS STATISTICAL ANALYSIS – PHYSICAL HOME WORK ENVIRONMENT

B.3.1 Results original function of the room – One-way ANOVA

Table B.1 Descriptives individual productivity – Original function of the room

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Work room		12,425	7.84	1.183	.011	7.82	7.86	1	10
Living room		9,783	7.68	1.328	.013	7.65	7.70	1	10
Kitchen		1,763	7.68	1.319	.031	7.62	7.74	1	10
Multiple rooms		2,518	7.62	1.336	.027	7.57	7.67	1	10
Other room		2,096	7.57	1.316	.029	7.52	7.63	1	10
Bedroom		1,973	7.45	1.380	.031	7.39	7.51	1	10
Not assigned / No answer		743	7.44	1.599	.059	7.33	7.56	1	10
Total		31,301	7.71	1.288	.007	7.70	7.72	1	10
Model	Fixed Effects			1.282	.007	7.70	7.72		
	Random Effects				.074	7.53	7.89		

Table B.2 Test of homogeneity of variances – Original function of the room

		Levene Statistic	df1	df2	Sig.
Individual productivity	Based on Mean	45.185	6	31,294	< 0.001
	Based on Median	26.280	6	31,294	< 0.001
	Based on Median and with adjusted df	26.280	6	30,259.972	< 0.001
	Based on trimmed mean	43.789	6	31,294	< 0.001

Table B.3 ANOVA test – Original function of the room

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	461.776	6	76.963	46.794	< 0.001
Within Groups	51469.829	31,294	1.645		
Total	51931.605	31,300			

Table B.4 Robust Tests of Equality of Means – Original function of the room

	Statistic[a]	df1	df2	Sig.
Welch	45,555	6	5146,874	< 0.001
Brown-Forsythe	41,101	6	8973,674	< 0.001

a. Asymptotically F distributed.

Table B.5 Post-hoc Games Howell test – Original function of the room

(I) Original function of the room	(J) Original function of the room	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Work room	Living room	.161*	.017	< 0.001	.11	.21
	Kitchen	.160*	.033	< 0.001	.06	.26
	Multiple rooms	.221*	.029	< 0.001	.14	.31
	Other room	.264*	.031	< 0.001	.17	.35
	Bedroom	.386*	.033	< 0.001	.29	.48
	Not assigned / No answer	.395*	.060	< 0.001	.22	.57
Living room	Work room	-.161*	.017	< 0.001	-.21	-.11
	Kitchen	-.001	.034	1.000	-.10	.10
	Multiple rooms	.060	.030	.410	-.03	.15
	Other room	.103*	.032	.020	.01	.20
	Bedroom	.225*	.034	< 0.001	.12	.32
	Not assigned / No answer	.234*	.060	.002	.06	.41
Kitchen	Work room	-.160*	.033	< 0.05	-.26	-.06
	Living room	.001	.034	1.000	-.10	.10
	Multiple rooms	.061	.041	.756	-.06	.18
	Other room	.104	.043	.181	-.02	.23
	Bedroom	.226*	.044	< 0.001	.10	.36
	Not assigned / No answer	.235*	.067	.008	.04	.43
Multiple rooms	Work room	-.221*	.029	< 0.001	-.31	-.14
	Living room	-.060	.030	.410	-.15	.03
	Kitchen	-.061	.041	.756	-.18	.06
	Other room	.043	.039	.929	-.07	.16
	Bedroom	.165*	.041	.001	.04	.29
	Not assigned / No answer	.174	.064	.100	-.02	.36
Other room	Work room	-.264*	.031	< 0.001	-.35	-.17
	Living room	-.103*	.032	.020	-.20	-.01
	Kitchen	-.104	.043	.181	-.23	.02
	Multiple rooms	-.043	.039	.929	-.16	.07
	Bedroom	.122	.042	.061	.00	.25
	Not assigned / No answer	.131	.065	.414	-.06	.32
Bedroom	Work room	-.386*	.033	< 0.001	-.48	-.29
	Living room	-.225*	.034	< 0.001	-.32	-.12
	Kitchen	-.226*	.044	< 0.001	-.36	-.10
	Multiple rooms	-.165*	.041	.001	-.29	-.04
	Other room	-.122	.042	.061	-.25	.00
	Not assigned / No answer	.009	.066	1.000	-.19	.21
Not assigned / No answer	Work room	-.395*	.060	< 0.001	-.57	-.22
	Living room	-.234*	.060	.002	-.41	-.06
	Kitchen	-.235*	.067	.008	-.43	-.04
	Multiple rooms	-.174	.064	.100	-.36	.02
	Other room	-.131	.065	.414	-.32	.06
	Bedroom	-.009	.066	1.000	-.21	.19

*. The mean difference is significant at the 0.05 level.

B.3.2 Results use private vs. shared – One-way ANOVA

Table B.6 Descriptives individual productivity – Use private vs. shared

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Private		16,091	7.83	1.189	.009	7.81	7.85	1	10
Shared		7,391	7.57	1.338	.016	7.54	7.60	1	10
Both private and shared		761	7.52	1.335	.048	7.43	7.62	2	10
Not assigned / no answer		7,058	7.60	1.414	.017	7.57	7.63	1	10
Total		31,301	7.71	1.288	.007	7.70	7.72	1	10
Model	Fixed Effects			1.282	.007	7.70	7.72		
	Random Effects				.097	7.40	8.02		

Table B.7 Test of homogeneity of variances – Use private vs. shared

		Levene Statistic	df1	df2	Sig.
Individual productivity	Based on Mean	112.528	3	31,297	< 0.001
	Based on Median	61.675	3	31,297	< 0.001
	Based on Median and with adjusted df	61.675	3	30,224.549	< 0.001
	Based on trimmed mean	109.204	3	31,297	< 0.001

Table B.8 ANOVA test – Use private vs. shared

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	498.205	3	166.068	101.052	< 0.001
Within Groups	51,433.400	31,297	1.643		
Total	51,931.605	31,300			

Table B.9 Robust Tests of Equality of Means – Use private vs. shared

	Statistic[a]	df1	df2	Sig.
Welch	100.974	3	3,451.991	< 0.001
Brown-Forsythe	93.269	3	6,206.648	< 0.001

a. Asymptotically F distributed.

Table B.10 Post-hoc Games Howell test – Use private vs. shared

(I) Private vs. shared use of the room	(J) Private vs. shared use of the room	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Private	Shared	.262*	.018	< 0.001	.22	.31
	Both private and shared	.308*	.049	< 0.001	.18	.44
	Not assigned / no answer	.233*	.019	< 0.001	.18	.28
Shared	Private	-.262*	.018	< 0.001	-.31	-.22
	Both private and shared	.046	.051	.801	-.08	.18
	Not assigned / no answer	-.029	.023	.588	-.09	.03
Both private and shared	Private	-.308*	.049	< 0.001	-.44	-.18
	Shared	-.046	.051	.801	-.18	.08
	Not assigned / no answer	-.075	.051	.460	-.21	.06
Not assigned / no answer	Private	-.233*	.019	< 0.001	-.28	-.18
	Shared	.029	.023	.588	-.03	.09
	Both private and shared	.075	.051	.460	-.06	.21

*. The mean difference is significant at the 0.05 level.

B.3.3 Results size of the workplace – One-way ANOVA

Table B.11 Descriptives individual productivity – Size of the workplace

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Small size workplace (1-10 m2)		8,059	7.62	1.323	.015	7.59	7.65	1	10
Medium size workplace (11-25 m2)		13,217	7.70	1.278	.011	7.68	7.72	1	10
Large size workplace (>25 m2)		8,832	7.80	1.254	.013	7.77	7.83	1	10
No answer		1,193	7.78	1.358	.039	7.70	7.86	1	10
Total		31,301	7.71	1.288	.007	7.70	7.72	1	10
Model	Fixed Effects			1.286	.007	7.70	7.72		
	Random Effects				.047	7.56	7.86		

Table B.12 Test of homogeneity of variances – Size of the workplace

		Levene Statistic	df1	df2	Sig.
Individual productivity	Based on Mean	13.479	3	31,297	< 0.001
	Based on Median	6.343	3	31,297	< 0.001
	Based on Median and with adjusted df	6.343	3	31,151.009	< 0.001
	Based on trimmed mean	13.979	3	31,297	< 0.001

Table B.13 ANOVA test – Size of the workplace

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	147.211	3	49.070	29.657	< 0.001
Within Groups	51,784.393	31,297	1.655		
Total	51,931.605	31,300			

Table B.14 Robust Tests of Equality of Means – Size of the workplace

	Statistic[a]	df1	df2	Sig.
Welch	29.465	3	5,348.970	< 0.001
Brown-Forsythe	28.600	3	8,649.606	< 0.001

a. Asymptotically F distributed.

Table B.15 Post-hoc Games Howell test – Size of the workplace

(I) Size of the workplace	(J) Size of the workplace	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Small size workplace (1-10 m2)	Medium size workplace (11-25 m2)	-.084*	.018	< 0.001	-.13	-.04
	Large size workplace (>25 m2)	-.182*	.020	< 0.001	-.23	-.13
	No answer	-.162*	.042	.001	-.27	-.05
Medium size workplace (11-25 m2)	Small size workplace (1-10 m2)	.084*	.018	< 0.001	.04	.13
	Large size workplace (>25 m2)	-.099*	.017	< 0.001	-.14	-.05
	No answer	-.078	.041	.223	-.18	.03
Large size workplace (>25 m2)	Small size workplace (1-10 m2)	.182*	.020	< 0.001	.13	.23
	Medium size workplace (11-25 m2)	.099*	.017	< 0.001	.05	.14
	No answer	.020	.042	.961	-.09	.13
No answer	Small size workplace (1-10 m2)	.162*	.042	.001	.05	.27
	Medium size workplace (11-25 m2)	.078	.041	.223	-.03	.18
	Large size workplace (>25 m2)	-.020	.042	.961	-.13	.09

*. The mean difference is significant at the 0.05 level.

B.3.4 Results number of ICT Facilities – bivariate correlation and One-way ANOVA

Table B.16 Bivariate correlation – number of ICT Facilities

		Individual productivity
number of ICT Facilities	Pearson Correlation	.094*
	Sig. (2-tailed)	< 0.001
	N	31,301

*. Correlation is significant at the 0.01 level (2-tailed).

Table B.17 Descriptives individual productivity – number of ICT Facilities

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
0		11,890	7.60	1.352	.012	7.58	7.63	1	10
1		4,950	7.64	1.311	.019	7.61	7.68	1	10
2		3,422	7.72	1.234	.021	7.68	7.76	1	10
3		7,045	7.79	1.222	.015	7.77	7.82	1	10
4		2,839	7.93	1.162	.022	7.89	7.98	2	10
5		911	7.98	1.159	.038	7.91	8.06	2	10
6		244	8.17	1.321	.085	8.00	8.33	1	10
Total		31,301	7.71	1.288	.007	7.70	7.72	1	10
Model	Fixed Effects			1.282	.007	7.70	7.72		
	Random Effects				.069	7.54	7.88		

Table B.18 Test of homogeneity of variances – number of ICT Facilities

		Levene Statistic	df1	df2	Sig.
Individual productivity	Based on Mean	35.989	6	31,294	< 0.001
	Based on Median	15.141	6	31,294	< 0.001
	Based on Median and with adjusted df	15.141	6	30,641.730	< 0.001
	Based on trimmed mean	34.290	6	31,294	< 0.001

Table B.19 ANOVA test – number of ICT Facilities

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	471.882	6	78.647	47.827	< 0.001
Within Groups	51,459.722	31,294	1.644		
Total	51,931.605	31,300			

Table B.20 Robust Tests of Equality of Means – number of ICT Facilities

	Statistic[a]	df1	df2	Sig.
Welch	50,616	6	2734,870	< 0.001
Brown-Forsythe	50,427	6	5472,967	< 0.001

a. Asymptotically F distributed.

Table B.21 Post-hoc Games Howell test – number of ICT Facilities

(I) number of ICT Facilities	(J) number of ICT Facilities	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
0	1	-.042	.022	.507	-.11	.02
	2	-.118*	.024	< 0.001	-.19	-.05
	3	-.193*	.019	< 0.001	-.25	-.14
	4	-.331*	.025	< 0.001	-.41	-.26
	5	-.381*	.040	< 0.001	-.50	-.26
	6	-.566*	.085	< 0.001	-.82	-.31
1	0	.042	.022	.507	-.02	.11
	2	-.076	.028	.096	-.16	.01
	3	-.151*	.024	< 0.001	-.22	-.08
	4	-.290*	.029	< 0.001	-.37	-.21
	5	-.340*	.043	< 0.001	-.47	-.21
	6	-.524*	.087	< 0.001	-.78	-.27
2	0	.118*	.024	< 0.001	.05	.19
	1	.076	.028	.096	-.01	.16
	3	-.075	.026	.055	-.15	.00
	4	-.213*	.030	< 0.001	-.30	-.12
	5	-.263*	.044	< 0.001	-.39	-.13
	6	-.448*	.087	< 0.001	-.71	-.19
3	0	.193*	.019	< 0.001	.14	.25
	1	.151*	.024	< 0.001	.08	.22
	2	.075	.026	.055	.00	.15
	4	-.139*	.026	< 0.001	-.22	-.06
	5	-.189*	.041	< 0.001	-.31	-.07
	6	-.373*	.086	< 0.001	-.63	-.12
4	0	.331*	.025	< 0.001	.26	.41
	1	.290*	.029	< 0.001	.21	.37
	2	.213*	.030	< 0.001	.12	.30
	3	.139*	.026	< 0.001	.06	.22
	5	-.050	.044	.917	-.18	.08
	6	-.235	.087	.106	-.49	.02
5	0	.381*	.040	< 0.001	.26	.50
	1	.340*	.043	< 0.001	.21	.47
	2	.263*	.044	< 0.001	.13	.39

(I) number of ICT Facilities	(J) number of ICT Facilities	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
6	3	.189*	.041	< 0.001	.07	.31
	4	.050	.044	.917	-.08	.18
	6	-.184	.093	.425	-.46	.09
	0	.566*	.085	< 0.001	.31	.82
	1	.524*	.087	< 0.001	.27	.78
	2	.448*	.087	< 0.001	.19	.71
	3	.373*	.086	< 0.001	.12	.63
	4	.235	.087	.106	-.02	.49
	5	.184	.093	.425	-.09	.46

*. The mean difference is significant at the 0.05 level.

B.3.5 Results Ambiance factors – independent-samples t-test and one-way ANOVA

Table B.22 Group statistics – Ambiance factor Plants

	Plants	N	Mean	Std. Deviation	Std. Error Mean
Individual productivity	Yes	14,610	7.77	1.268	.010
	Not selected	16,687	7.66	1.303	.010

Table B.23 Independent samples test – Ambiance factor Plants

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Individual productivity	Equal variances assumed	19.129	< 0.001	7.500	31,295	< 0.001	.109	.015	.081	.138
	Equal variances not assumed			7.513	30,947.775	< 0.001	.109	.015	.081	.138

Table B.24 Group statistics – Ambiance factor Art

	Art	N	Mean	Std. Deviation	Std. Error Mean
Individual productivity	Yes	12,686	7.80	1.249	.011
	Not selected	18,611	7.65	1.311	.010

Table B.25 Independent samples test – Ambiance factor Art

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Individual productivity	Equal variances assumed	58.899	< 0.001	10.395	31,295	< 0.001	.154	.015	.125	.183
	Equal variances not assumed			10.490	28,090.122	< 0.001	.154	.015	.125	.183

Table B.26 Group statistics – Ambiance factor Color

	Color	N	Mean	Std. Deviation	Std. Error Mean
Individual productivity	Yes	13,446	7.82	1.235	.011
	Not selected	17,851	7.63	1.321	.010

Table B.27 Independent samples test – Ambiance factor Color

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Individual productivity	Equal variances assumed	103.756	< 0.001	12.772	31,295	< 0.001	.187	.015	.159	.216
	Equal variances not assumed			12.894	29,893.101	< 0.001	.187	.015	.159	.216

Table B.28 Descriptives individual productivity – Combination of ambience factors

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Plants and art		2,821	7.71	1.269	.024	7.66	7.76	1	10
Plants and color		2,670	7.80	1.215	.024	7.76	7.85	2	10
Art and color		2,037	7.87	1.179	.026	7.81	7.92	1	10
Plants art and color		6,025	7.84	1.262	.016	7.81	7.87	1	10
No ambient factors		17,748	7.64	1.316	.010	7.62	7.65	1	10
Total		31,301	7.71	1.288	.007	7.70	7.72	1	10
Model	Fixed Effects			1.285	.007	7.70	7.72		
	Random Effects				.072	7.51	7.91		

Table B.29 Test of homogeneity of variances – Combination of ambience factors

		Levene Statistic	df1	df2	Sig.
Individual productivity	Based on Mean	24.594	4	31,296	< 0.001
	Based on Median	10.161	4	31,296	< 0.001
	Based on Median and with adjusted df	10.161	4	31,013.396	< 0.001
	Based on trimmed mean	25.215	4	31,296	< 0.001

Table B.30 ANOVA test – Combination of ambience factors

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	270.844	4	67.711	41.019	< 0.001
Within Groups	51,660.760	31,296	1.651		
Total	51,931.605	31,300			

Table B.31 Robust Tests of Equality of Means – Combination of ambience factors

	Statistic[a]	df1	df2	Sig.
Welch	42.488	4	7,039.297	< 0.001
Brown-Forsythe	44.026	4	14,664.780	< 0.001

a. Asymptotically F distributed.

Table B.32 Post-hoc Games Howell test – Combination of ambience factors

(I) Combination of ambience factors	(J) Combination of ambience factors	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Plants and art	Plants and color	-.094*	.034	.039	-.19	.00
	Art and color	-.155*	.035	< 0.001	-.25	-.06
	Plants art and color	-.128*	.029	< 0.001	-.21	-.05
	No ambient factors	.075*	.026	.032	.00	.15
Plants and color	Plants and art	.094*	.034	.039	.00	.19
	Art and color	-.061	.035	.412	-.16	.03
	Plants art and color	-.034	.029	.764	-.11	.04
	No ambient factors	.169*	.026	< 0.001	.10	.24
Art and color	Plants and art	.155*	.035	< 0.001	.06	.25
	Plants and color	.061	.035	.412	-.03	.16
	Plants art and color	.027	.031	.901	-.06	.11
	No ambient factors	.230*	.028	< 0.001	.15	.31
Plants art and color	Plants and art	.128*	.029	< 0.001	.05	.21
	Plants and color	.034	.029	.764	-.04	.11
	Art and color	-.027	.031	.901	-.11	.06
	No ambient factors	.203*	.019	< 0.001	.15	.25
No ambient factors	Plants and art	-.075*	.026	.032	-.15	.00
	Plants and color	-.169*	.026	< 0.001	-.24	-.10
	Art and color	-.230*	.028	< 0.001	-.31	-.15
	Plants art and color	-.203*	.019	< 0.001	-.25	-.15

*. The mean difference is significant at the 0.05 level.

B.3.6 Results View – independent-samples t-test

Table B.33 Group statistics – View

	View	N	Mean	Std. Deviation	Std. Error Mean
Individual productivity	Yes	27,690	7.75	1.261	.008
	Not selected	3,611	7.44	1.450	.024

Table B.34 Independent samples test – View

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Individual productivity	Equal variances assumed	112.891	< 0.001	13.567	31,299	< 0.001	.308	.023	.264	.353
	Equal variances not assumed			12.186	4,351.281	< 0.001	.308	.025	.259	.358

B.3.7 Regression analysis – Physical home work environment

Table B.35 Model summary linear regression analysis individual productivity and variables of the physical home work environment

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.198[a]	.039	.039	1.259	.039	74.352	17	30,951	.000

a. Predictors: (Constant), Livingroom, Kitchen, Multiple rooms, Other room, Bedroom, Room not assigned, Shared use, Private and shared use, Use not assigned, Medium workplace, Large workplace, Size workplace not selected, number of ICT Facilities, Plants, Art, Color, View

Table B.36 ANOVA[a] linear regression analysis individual productivity and variables of the physical home work environment

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2,002.357	17	117.786	74.352	.000[b]
	Residual	49,031.532	30,951	1.584		
	Total	51,033.889	30,968			

a. Dependent Variable: Individual productivity
b. Predictors: (Constant), Livingroom, Kitchen, Multiple rooms, Other room, Bedroom, Room not assigned, Shared use, Private and shared use, Use not assigned, Medium workplace, Large workplace, Size workplace not selected, number of ICT Facilities, Plants, Art, Color, View

B.4 RESULTS STATISTICAL ANALYSIS – SATISFACTION WITH THE PHYSICAL HOME WORK ENVIRONMENT

Table B.37 Descriptives individual productivity – Household composition

	Mean	Std. Deviation	N
Individual productivity	7.71	1.288	31,301
Satisfaction with ambiance	3.95	.685	31,229
Satisfaction with privacy and concentration	4.09	.853	31,198
Satisfaction with indoor climate	3.87	.837	31,060
Satisfaction with functionality	3.44	.847	31,170

B.4.1 Regression analysis additional tables – Satisfaction with the physical home work environment

Table B.38 Model summary linear regression analysis individual productivity and variables of the physical home work environment

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.484[a]	.235	.235	1.123	.235	2,373.253	4	30,964	< 0.001

a. Predictors: (Constant), Satisfaction with functionality, Satisfaction with indoor climate, Satisfaction with use, Satisfaction with ambiance

Table B.39 ANOVA[a] linear regression analysis individual productivity and variables of the physical home work environment

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	11,974.816	4	2,993.704	2,373.253	< 0.001[b]
	Residual	39,059.073	30,964	1.261		
	Total	51,033.889	30,968			

a. Dependent Variable: Individual productivity
b. Predictors: (Constant), Satisfaction with functionality, Satisfaction with indoor climate, Satisfaction with use, Satisfaction with ambiance

B.5 RESULTS STATISTICAL ANALYSIS – INDIVIDUAL CONTROL VARIABLES

B.5.1 Results household composition – One-way ANOVA

Table B.40 Descriptives individual productivity – Household composition

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Couple without children (living at home)	11,093	7.84	1.211	.011	7.82	7.86	1	10
Single-parent households with children living at home	1,857	7.73	1.335	.031	7.67	7.79	1	10
Couple with children living at home	12,622	7.65	1.285	.011	7.62	7.67	1	10
Single household	4,926	7.61	1.386	.020	7.57	7.65	1	10
Otherwise	803	7.48	1.479	.052	7.38	7.59	1	10
Total	31,301	7.71	1.288	.007	7.70	7.72	1	10

Table B.41 Test of homogeneity of variances – Household composition

		Levene Statistic	df1	df2	Sig.
Individual productivity	Based on Mean	46.378	4	31,296	< 0.001
	Based on Median	25.473	4	31,296	< 0.001
	Based on Median and with adjusted df	25.473	4	30,751.722	< 0.001
	Based on trimmed mean	46.395	4	31,296	< 0.001

Table B.42 ANOVA test – Household composition

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	323.235	4	80.809	49.004	< 0.001
Within Groups	51,608.369	31,296	1.649		
Total	51,931.605	31,300			

Table B.43 Robust Tests of Equality of Means – Original function of the room

	Statistic[a]	df1	df2	Sig.
Welch	49.493	4	4,220.280	< 0.001
Brown-Forsythe	43.937	4	6,878.749	< 0.001

a. Asymptotically F distributed.

Table B.44 Post-hoc Games Howell test – Original function of the room

(I) Household composition	(J) Household composition	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Couple without children (living at home)	Single-parent households with children living at home	.111*	.033	.007	.02	.20
	Couple with children living at home	.192*	.016	< 0.001	.15	.24
	Single household	.226*	.023	< 0.001	.16	.29
	Otherwise	.356*	.053	< 0.001	.21	.50
Single-parent households with children living at home	Couple without children (living at home)	-.111*	.033	.007	-.20	-.02
	Couple with children living at home	.081	.033	.100	-.01	.17
	Single household	.116*	.037	.014	.02	.22
	Otherwise	.245*	.061	.001	.08	.41
Couple with children living at home	Couple without children (living at home)	-.192*	.016	< 0.001	-.24	-.15
	Single-parent households with children living at home	-.081	.033	.100	-.17	.01
	Single household	.034	.023	.563	-.03	.10
	Otherwise	.164*	.053	.019	.02	.31
Single household	Couple without children (living at home)	-.226*	.023	< 0.001	-.29	-.16
	Single-parent households with children living at home	-.116*	.037	.014	-.22	-.02
	Couple with children living at home	-.034	.023	.563	-.10	.03
	Otherwise	.130	.056	.137	-.02	.28
Otherwise	Couple without children (living at home)	-.356*	.053	< 0.001	-.50	-.21
	Single-parent households with children living at home	-.245*	.061	.001	-.41	-.08
	Couple with children living at home	-.164*	.053	.019	-.31	-.02
	Single household	-.130	.056	.137	-.28	.02

*. The mean difference is significant at the 0.05 level.

B.5.2 Results education level – One-way ANOVA

Table B.45 Descriptives individual productivity – Education level

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Low and other education level	332	7.90	1.236	.068	7.77	8.03	1	10
Medium education level	7,538	7.95	1.199	.014	7.92	7.98	1	10
High education level	23,431	7.63	1.307	.009	7.61	7.65	1	10
Total	31,301	7.71	1.288	.007	7.70	7.72	1	10

Table B.46 Test of homogeneity of variances – Education level

		Levene Statistic	df1	df2	Sig.
Individual productivity	Based on Mean	113.334	2	31,298	< 0.001
	Based on Median	31.567	2	31,298	< 0.001
	Based on Median and with adjusted df	31.567	2	30,985.284	< 0.001
	Based on trimmed mean	107.171	2	31,298	< 0.001

Table B.47 ANOVA test – Education level

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	594.329	2	297.165	181.168	< 0.001
Within Groups	51,337.275	31,298	1.640		
Total	51,931.605	31,300			

Table B.48 Robust Tests of Equality of Means – Education level

	Statistic[a]	df1	df2	Sig.
Welch	197.081	2	881.071	< 0.001
Brown-Forsythe	196.019	2	1,300.390	< 0.001

a. Asymptotically F distributed.

Table B.49 Post-hoc Games Howell test – Education level

(I) Education level	(J) Education level	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Low and other education level	Medium education level	-.050	.069	.753	-.21	.11
	High education level	.270*	.068	< 0.001	.11	.43
Medium education level	Low and other education level	.050	.069	.753	-.11	.21
	High education level	.320*	.016	< 0.001	.28	.36
High education level	Low and other education level	-.270*	.068	< 0.001	-.43	-.11
	Medium education level	-.320*	.016	< 0.001	-.36	-.28

*. The mean difference is significant at the 0.05 level.

B.5.3 Results age – One-way ANOVA

Table B.50 Descriptives individual productivity – Age

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
< 30 year	2,735	7.40	1.330	.025	7.35	7.45	1	10
31 - 40 year	5,245	7.52	1.384	.019	7.48	7.56	1	10
41 - 50 year	7,387	7.68	1.304	.015	7.65	7.71	1	10
51 - 60 year	11,261	7.84	1.220	.011	7.82	7.86	1	10
> 60 year	4,673	7.85	1.225	.018	7.81	7.88	1	10
Total	31,301	7.71	1.288	.007	7.70	7.72	1	10

Table B.51 Test of homogeneity of variances – Education level

		Levene Statistic	df1	df2	Sig.
Individual productivity	Based on Mean	59.226	4	31,296	< 0.001
	Based on Median	41.167	4	31,296	< 0.001
	Based on Median and with adjusted df	41.167	4	30,731.060	< 0.001
	Based on trimmed mean	65.206	4	31,296	< 0.001

Table B.52 ANOVA test – Education level

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	735.956	4	183.989	112.473	< 0.001
Within Groups	51,195.649	31,296	1.636		
Total	51,931.605	31,300			

Table B.53 Robust Tests of Equality of Means – Education level

	Statistic[a]	df1	df2	Sig.
Welch	108.213	4	11,192.743	< 0.001
Brown-Forsythe	109.248	4	21,647.270	< 0.001

a. Asymptotically F distributed.

Table B.54 Post-hoc Games Howell test – Education level

(I) Age	(J) Age	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
< 30 year	31 - 40 year	-.120*	.032	.002	-.21	-.03
	41 - 50 year	-.282*	.030	< 0.001	-.36	-.20
	51 - 60 year	-.440*	.028	< 0.001	-.52	-.36
	> 60 year	-.447*	.031	< 0.001	-.53	-.36
31 - 40 year	< 30 year	.120*	.032	.002	.03	.21
	41 - 50 year	-.162*	.024	< 0.001	-.23	-.10
	51 - 60 year	-.320*	.022	< 0.001	-.38	-.26
	> 60 year	-.327*	.026	< 0.001	-.40	-.26
41 - 50 year	< 30 year	.282*	.030	< 0.001	.20	.36
	31 - 40 year	.162*	.024	< 0.001	.10	.23
	51 - 60 year	-.158*	.019	< 0.001	-.21	-.11
	> 60 year	-.166*	.023	< 0.001	-.23	-.10
51 - 60 year	< 30 year	.440*	.028	< 0.001	.36	.52
	31 - 40 year	.320*	.022	< 0.001	.26	.38
	41 - 50 year	.158*	.019	< 0.001	.11	.21
	> 60 year	-.008	.021	.996	-.07	.05
> 60 year	< 30 year	.447*	.031	< 0.001	.36	.53
	31 - 40 year	.327*	.026	< 0.001	.26	.40
	41 - 50 year	.166*	.023	< 0.001	.10	.23
	51 - 60 year	.008	.021	.996	-.05	.07

*. The mean difference is significant at the 0.05 level.

B.5.4 Results gender – independent-samples t-test

Table B.55 Group statistics – Gender

	Gender	N	Mean	Std. Deviation	Std. Error Mean
Individual productivity	Male and other	14,837	7.60	1.343	.011
	Female	16,464	7.81	1.227	.010

Table B.56 Independent samples test – Gender

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Individual productivity	Equal variances assumed	149.935	< 0.001	-14.988	31,299	< 0.001	-.218	.015	-.246	-.189
	Equal variances not assumed			-14.919	30,172.550	< 0.001	-.218	.015	-.246	-.189

B.5.5 Results job function – independent-samples t-test

Table B.57 Group statistics – Job function

	Job function	N	Mean	Std. Deviation	Std. Error Mean
Individual productivity	Manager	2,234	7.85	1.132	.024
	Employee	29,067	7.70	1.299	.008

Table B.58 Independent samples test – Job function

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Individual productivity	Equal variances assumed	76.640	< 0.001	5.263	31,299	< 0.001	.149	.028	.093	.204
	Equal variances not assumed			5.918	2,705.250	< 0.001	.149	.025	.099	.198

B.5.6 Regression analysis additional tables – Individual control variables

Table B.59 Model summary linear regression analysis individual productivity and variables of the physical home work environment

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.192[a]	.037	.036	1.264	.037	99.310	12	31,288	< 0.001

a. Predictors: (Constant), Employee, Single-parent households with children living at home, Low and other education level, Otherwise, 31 - 40 year, Female, Single household, Medium education level, > 60 year, 41 - 50 year, Couple with children living at home, 51 - 60 year

Table B.60 ANOVA[a] linear regression analysis individual productivity and variables of the physical home work environment

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1,905.441	12	158.787	99.310	< 0.001[b]
	Residual	50,026.164	31,288	1.599		
	Total	51,931.605	31,300			

a. Dependent Variable: Individual productivity
b. Predictors: (Constant), Employee, Single-parent households with children living at home, Low and other education level, Otherwise, 31 - 40 year, Female, Single household, Medium education level, > 60 year, 41 - 50 year, Couple with children living at home, 51 - 60 year

B.6 INTEGRAL PATH ANALYSIS

Figure B.11 Screenshot path model Amos

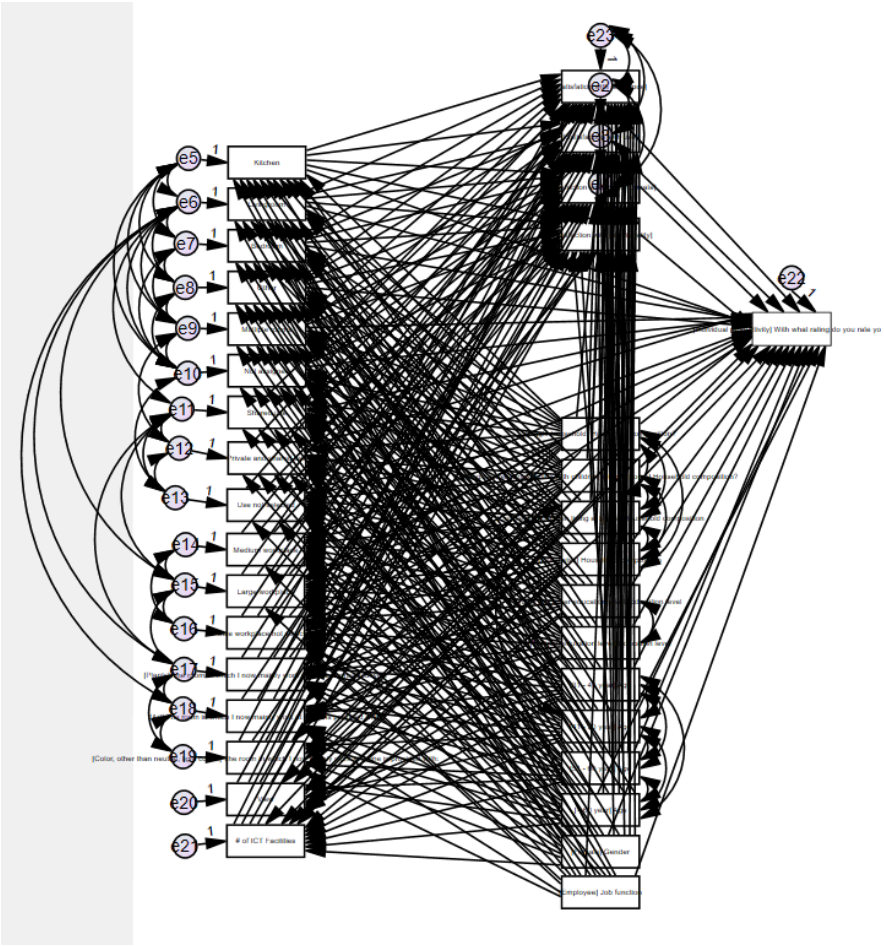

Table B.62 Goodness-of-Fit Indices for the path model

Parameters	Score
Number of parameters	427
Chi square	21,834.25*
Degree of freedom	168
Goodness of fit index (GFI)	.961
Adjusted goodness of fit index	.861
Comparative fit index (CFI)	.921
Increment fit index (IFI)	.921
Root mean square error of approximation (RMSEA)	.065

* p < .001

Table B.63 Standardized total effects path model – Physical home work environment

Standardized Total Effects

	(Work room)	Livingroom	Kitchen	Multiple rooms	Other room	Bedroom	Function not assigned/ no answer	(Private use)	Shared use	Both private and shared use	Use not assigned/ no answer	(Small size workplace)	Medium size workplace	Large size workplace	Size no answer	# of ICT facilities	Plants	Art	Color	View
Sat. with ambiance		-0.116	-0.01	-0.046	-0.086	-0.103	-0.044		-0.088	0.009	-0.001		0.132	0.2	0.044	0.118	0.143	0.106	0.092	0.275
Sat. privacy and concentration		-0.231	-0.1	-0.091	-0.075	-0.075	-0.086		-0.286	0.04	-0.07		0.049	0.088	0.027	0.089	0.028	0.039	0.056	0.067
Sat. indoor climate		0.001	0.042	0.005	-0.074	-0.047	-0.016		-0.042	0.005	-0.006		0.074	0.137	0.041	0.078	0.081	0.05	0.074	0.132
Sat. functionality		-0.202	-0.075	-0.102	-0.086	-0.113	-0.051		-0.113	0.022	-0.036		0.073	0.137	0.042	0.232	0.053	0.046	0.061	0.079
Individual productivity		-0.097	-0.029	-0.033	-0.04	-0.057	-0.045		-0.088	0.005	-0.041		0.033	0.084	0.036	0.071	0.034	0.032	0.039	0.049

Standardized Direct Effects

	(Work room)	Livingroom	Kitchen	Multiple rooms	Other room	Bedroom	Function not assigned/ no answer	(Private use)	Shared use	Both private and shared use	Use not assigned/ no answer	(Small size workplace)	Medium size workplace	Large size workplace	Size no answer	# of ICT facilities	Plants	Art	Color	View
Sat. with ambiance		-0.116	-0.01	-0.046	-0.086	-0.103	-0.044		-0.088	0.009	-0.001		0.132	0.2	0.044	0.118	0.143	0.106	0.092	0.275
Sat. privacy and concentration		-0.231	-0.1	-0.091	-0.075	-0.075	-0.086		-0.286	0.04	-0.07		0.049	0.088	0.027	0.089	0.028	0.039	0.056	0.067
Sat. indoor climate		0.001	0.042	0.005	-0.074	-0.047	-0.016		-0.042	0.005	-0.006		0.074	0.137	0.041	0.078	0.081	0.05	0.074	0.132
Sat. functionality		-0.202	-0.075	-0.102	-0.086	-0.113	-0.051		-0.113	0.022	-0.036		0.073	0.137	0.042	0.232	0.053	0.046	0.061	0.079
Individual productivity		0.016	0.012	0.013	0.007	-0.006	-0.005		0.035	-0.013	-0.012		-0.009	0.012	0.015	0	0	0	0	-0.018

Standardized Indirect Effects

	(Work room)	Livingroom	Kitchen	Multiple rooms	Other room	Bedroom	Function not assigned/ no answer	(Private use)	Shared use	Both private and shared use	Use not assigned/ no answer	(Small size workplace)	Medium size workplace	Large size workplace	Size no answer	# of ICT facilities	Plants	Art	Color	View
Individual productivity		-0.113	-0.042	-0.047	-0.047	-0.051	-0.041		-0.122	0.017	-0.028		0.042	0.072	0.02	0.071	0.034	0.032	0.039	0.067

Legend

Value > 0.1
Value between 0 - 0.1
Value between -0.1 - 0
Value < -0.1

Table B.64 Standardized total and direct effects path model – Satisfaction with the home work environment

Standardized Total Effects

	Sat. with ambiance	Sat. privacy and concentration	Sat. indoor climate	Sat. functionality
Individual productivity	0.107	0.347	0.044	0.102

Standardized Direct Effects

	Sat. with ambiance	Sat. privacy and concentration	Sat. indoor climate	Sat. functionality
Individual productivity	0.107	0.347	0.044	0.102

Legend

Value > 0.1	
Value between 0 - 0.1	
Value between -0.1 - 0	
Value < -0.1	

Table B.65 Standardized total effects path model – Individual control variables

	(Couples without children)	Single-parents with children	Couple with children	Single household	Otherwise	Low and other education level	Medium education level	(High education level)	(< 30 year)	31 - 40 year	41 - 50 year	51 - 60 year	> 60 year	(Male and other)	Female	(Manager)	Employee
(Work room)																	
Livingroom		0.09	-0.027	0.167	-0.024	0.025	0.114			-0.05	-0.06	-0.072	-0.064		0.059		0.004
Kitchen		0.025	0.017	-0.004	-0.015	0.003	0.026			-0.008	-0.013	-0.02	-0.037		0.05		0.002
Multiple rooms		0.01	0.051	-0.023	-0.005	0.002	-0.025			-0.014	-0.049	-0.107	-0.091		0.003		-0.032
Other room		0.002	0.08	-0.026	-0.002	0.005	-0.017			0.001	0.029	0.006	0.007		-0.007		0.009
Bedroom		0.019	0.065	-0.009	0.191	0.004	0.001			-0.035	-0.038	-0.051	-0.032		-0.013		0.013
Function not assigned/no answer		0.014	0.015	0.044	0.02	0	0.017			0.002	-0.007	-0.007	0.023		-0.008		-0.003
(Private use)																	
Shared use		0.073	0.09	-0.224	-0.112	0.011	0.043			-0.035	-0.05	-0.108	-0.085		0.011		0.006
Both private and shared use		0.013	0.07	-0.043	-0.023	-0.009	-0.016			0.001	0.002	-0.037	-0.026		-0.016		-0.017
Use not assigned/no answer		0.016	-0.005	0.828	0.362	-0.004	0.014			0.001	0	-0.005	0.006		0.003		0.002
(Small size workplace)																	
Medium size workplace		-0.051	-0.035	-0.053	0.007	-0.023	-0.075			-0.007	-0.018	-0.016	-0.005		-0.028		0.005
Large size workplace		0.063	0.011	0.053	-0.022	0.013	0.072			0.017	0.032	0.048	0.03		0.068		-0.02
Size no answer		0.01	-0.016	0.086	0.067	0.021	0.063			-0.008	-0.018	-0.045	-0.04		0.012		-0.001
# of ICT facilities		-0.032	0.028	-0.106	-0.002	-0.021	-0.048			0.045	0.118	0.144	0.135		-0.077		0
Plants		0.029	-0.075	0.048	-0.036	-0.002	0.027			-0.055	-0.09	-0.123	-0.105		0.107		0
Art		-0.018	-0.105	0.026	-0.027	-0.025	-0.107			0.02	0.064	0.097	0.09		0.032		-0.031
Color		0.003	-0.047	0.007	-0.024	0	0			-0.007	0.011	0.049	0.044		0.045		-0.017
View		0	-0.032	-0.004	-0.031	-0.02	-0.009			0.031	0.056	0.08	0.076		0		0
Sat. with ambiance		-0.048	-0.11	-0.045	-0.039	-0.018	0.015			0.064	0.152	0.22	0.171		0.078		-0.023
Sat. privacy and concentration		-0.08	-0.191	0.055	-0.033	-0.005	0.01			0.063	0.106	0.204	0.159		0.023		-0.006
Sat. indoor climate		-0.01	-0.055	-0.006	-0.018	-0.005	0.057			0.08	0.135	0.193	0.16		0.084		-0.007
Sat. functionality		-0.058	-0.08	-0.046	-0.018	-0.002	0.046			0.075	0.142	0.183	0.145		0.018		-0.006
Individual productivity		-0.031	-0.064	-0.055	-0.014	0.014	0.084			0.051	0.107	0.169	0.128		0.104		-0.037

Legend
Value > 0.1
Value between 0 - 0.1
Value between -0.1 - 0
Value < -0.1

Table B.66 Standardized direct effects path model – Individual control variables

	(Couples without children)	Single-parents with children	Couple with children	Single household	Otherwise	Low and other education level	Medium education level	(High education level)	(< 30 year)	31 - 40 year	41 - 50 year	51 - 60 year	> 60 year	(Male and other)	Female	(Manager)	Employee
(Work room)																	
Livingroom		0.09	-0.027	0.167	-0.024	0.025	0.114			-0.05	-0.06	-0.072	-0.064		0.059		0.004
Kitchen		0.025	0.017	-0.004	-0.015	0.003	0.026			-0.008	-0.013	-0.02	-0.037		0.05		0.002
Multiple rooms		0.01	0.051	-0.023	-0.005	0.002	-0.025			-0.014	-0.049	-0.107	-0.091		0.003		-0.032
Other room		0.002	0.08	-0.026	-0.002	0.005	-0.017			0.001	0.029	0.006	0.007		-0.007		0.009
Bedroom		0.019	0.065	-0.009	0.191	0.004	0.001			-0.035	-0.038	-0.051	-0.032		-0.013		0.013
Function not assigned/no answer		0.014	0.015	0.044	0.02	0	0.017			0.002	-0.007	-0.007	0.023		-0.008		-0.003
(Private use)																	
Shared use		0.073	0.09	-0.224	-0.112	0.011	0.043			-0.035	-0.05	-0.108	-0.085		0.011		0.006
Both private and shared use		0.013	0.07	-0.043	-0.023	-0.009	-0.016			0.001	0.002	-0.037	-0.026		-0.016		-0.017
Use not assigned/no answer		0.016	-0.005	0.828	0.362	-0.004	0.014			0.001	0	-0.005	0.006		0.003		0.002
(Small size workplace)																	
Medium size workplace		-0.051	-0.035	-0.053	0.007	-0.023	-0.075			-0.007	-0.018	-0.016	-0.005		-0.028		0.005
Large size workplace		0.063	0.011	0.053	-0.022	0.013	0.072			0.017	0.032	0.048	0.03		0.068		-0.02
Size no answer		0.01	-0.016	0.086	0.067	0.021	0.063			-0.008	-0.018	-0.045	-0.04		0.012		-0.001
# of ICT facilities		-0.032	0.028	-0.106	-0.002	-0.021	-0.048			0.045	0.118	0.144	0.135		-0.077		0
Plants		0.029	-0.075	0.048	-0.036	-0.002	0.027			-0.055	-0.09	-0.123	-0.105		0.107		0
Art		-0.018	-0.105	0.026	-0.027	-0.025	-0.107			0.02	0.064	0.097	0.09		0.032		-0.031
Color		0.003	-0.047	0.007	-0.024	0	0			-0.007	0.011	0.049	0.044		0.045		-0.017
View		0	-0.032	-0.004	-0.031	-0.02	-0.009			0.031	0.056	0.08	0.076		0		0
Sat. with ambiance		-0.033	-0.055	-0.05	-0.012	-0.003	0.039			0.042	0.109	0.151	0.111		0.06		-0.013
Sat. privacy and concentration		-0.032	-0.146	0.09	-0.025	0.008	0.055			0.031	0.055	0.118	0.088		0.039		0
Sat. indoor climate		-0.011	-0.025	-0.015	0	0.001	0.058			0.073	0.118	0.165	0.137		0.066		0
Sat. functionality		-0.024	-0.047	0.004	0.006	0.013	0.081			0.043	0.083	0.094	0.069		0.034		0
Individual productivity		0.003	0.021	-0.051	0.012	0.016	0.066			0.014	0.037	0.054	0.04		0.078		-0.031

Legend
Value > 0.1
Value between 0 - 0.1
Value between -0.1 - 0
Value < -0.1

Table B.67 Standardized indirect effects path model – Individual control variables

	(Couples without children)	Single-parents with children	Couple with children	Single household	Otherwise	Low and other education level	Medium education level	(High education level)	(< 30 year)	31 - 40 year	41 - 50 year	51 - 60 year	> 60 year	(Male and other)	Female	(Manager)	Employee
Sat. with ambiance		-0.015	-0.055	0.005	-0.028	-0.015	-0.024			0.022	0.043	0.07	0.06		0.018		-0.01
Sat. privacy and concentration		-0.048	-0.044	-0.035	-0.008	-0.014	-0.045			0.032	0.052	0.086	0.071		-0.016		-0.006
Sat. indoor climate		0.001	-0.03	0.009	-0.018	-0.006	-0.001			0.008	0.017	0.029	0.024		0.018		-0.007
Sat. functionality		-0.034	-0.034	-0.049	-0.024	-0.014	-0.036			0.032	0.059	0.088	0.076		-0.015		-0.006
Individual productivity		-0.034	-0.085	-0.004	-0.027	-0.002	0.018			0.037	0.07	0.114	0.089		0.025		-0.006

Legend
Value > 0.1
Value between 0 - 0.1
Value between -0.1 - 0
Value < -0.1

Figure B.12 Bargraph results path model – Total, indirect, and direct effect all variables on productivity

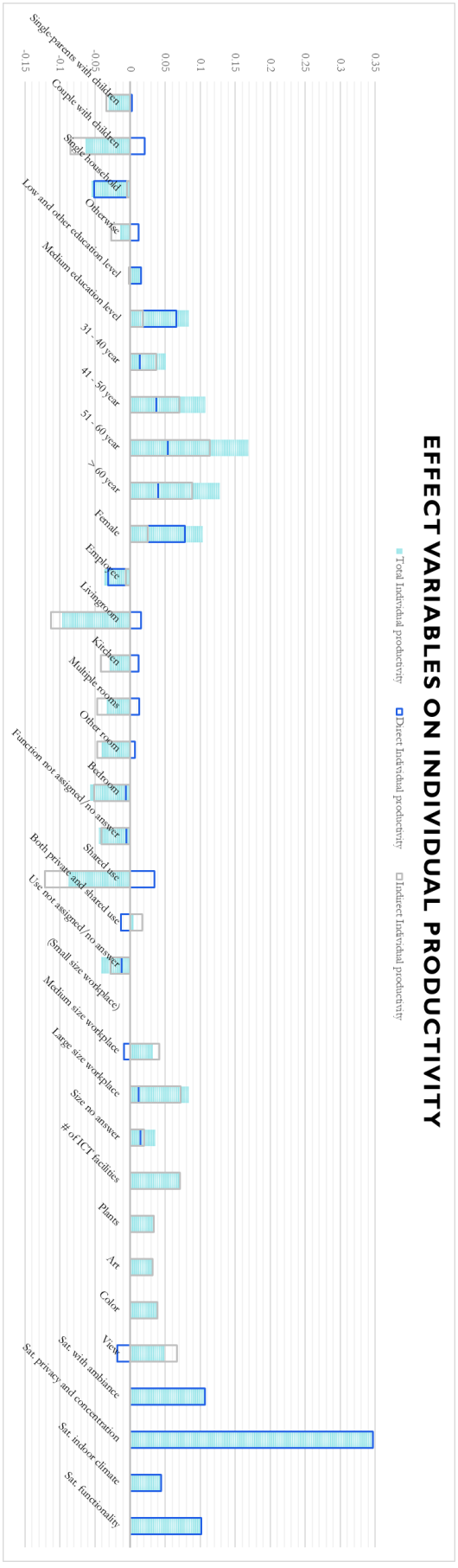

Figure B.13 Results path model – Household composition and original function

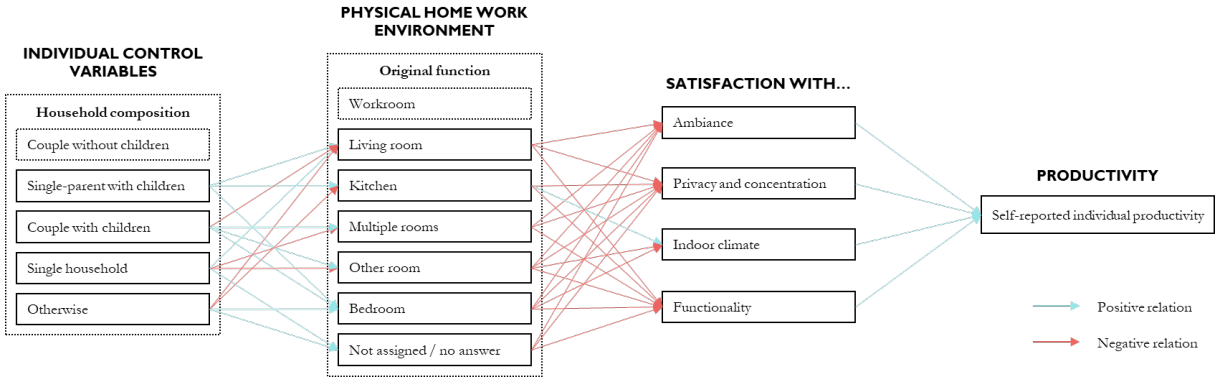

Figure B.14 Results path model – Age and original function

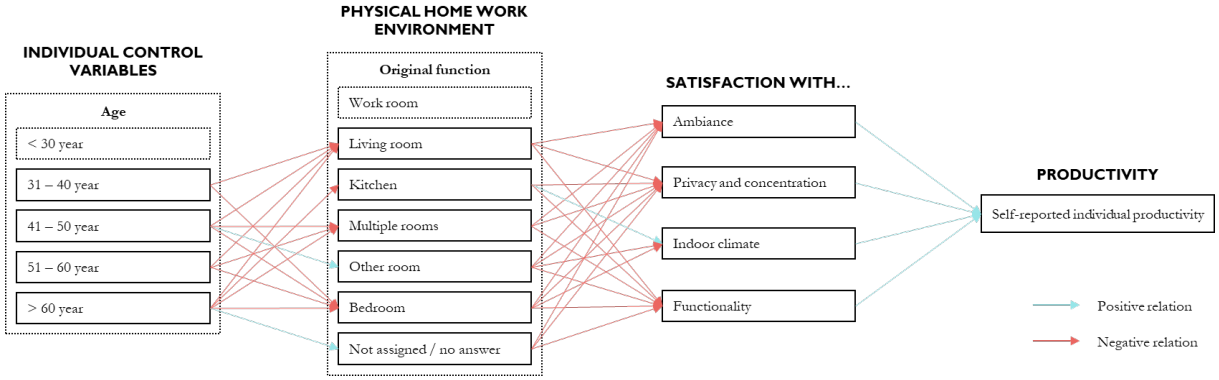

Figure B.15 Results path model – Education level and original function

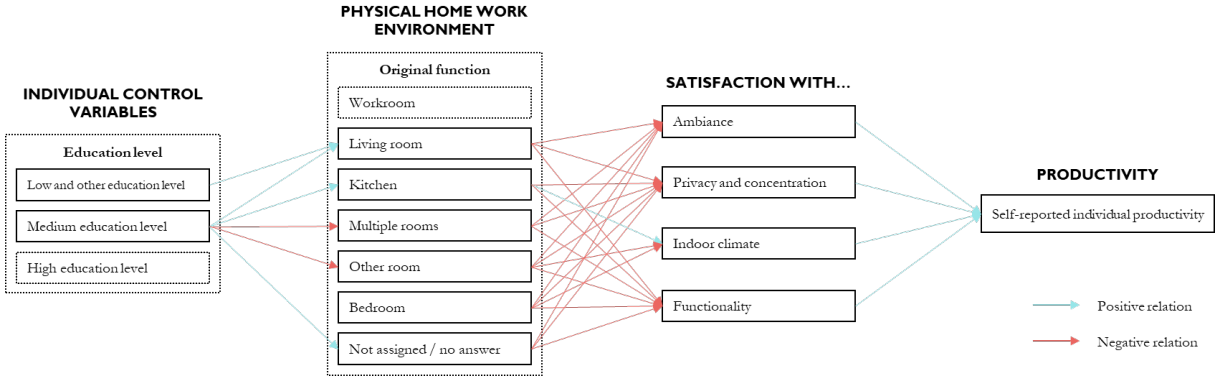

Figure B.16 Results path model – Gender and original function

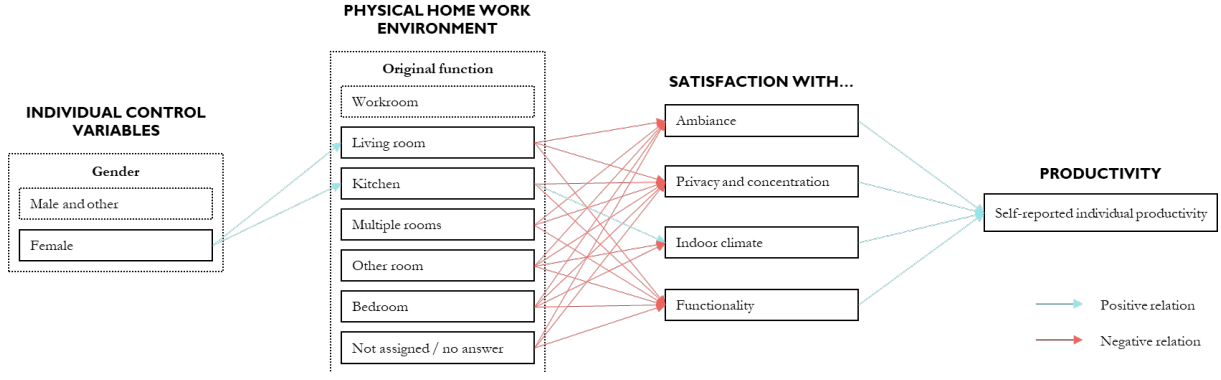

Figure B.17 Results path model – Job function and original function

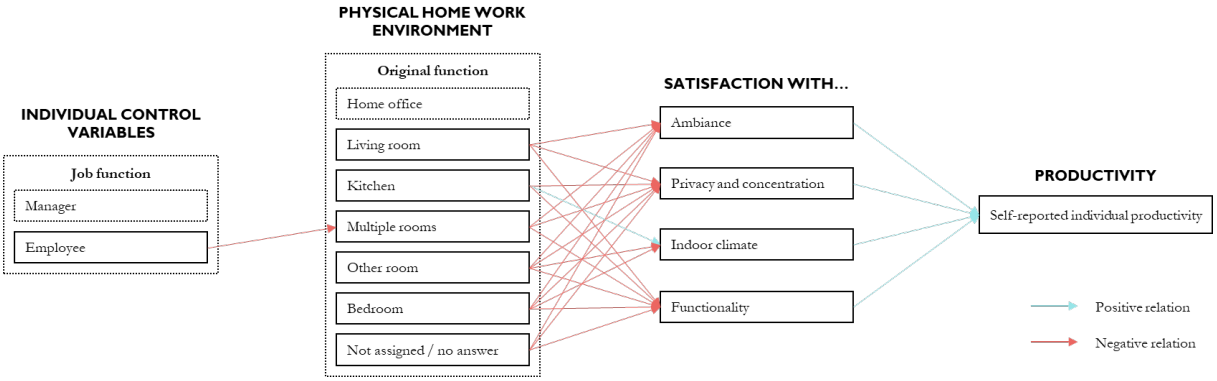

Figure B.18 Results path model – Household composition and size

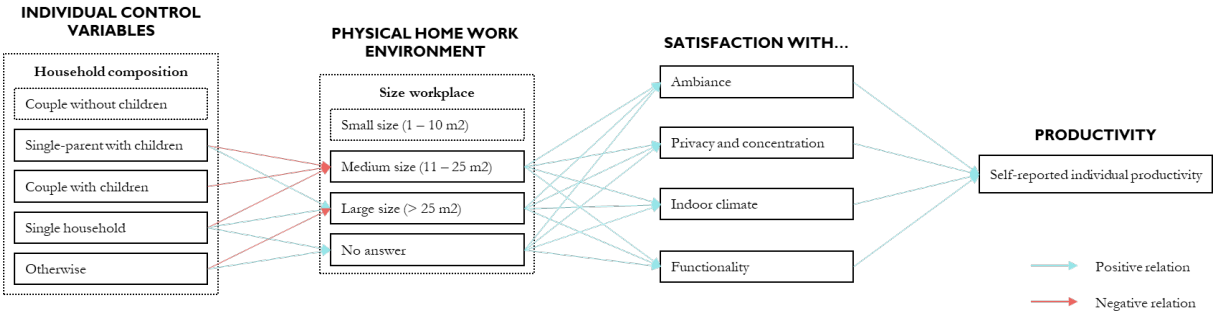

Figure B.19 Results path model – Age and size

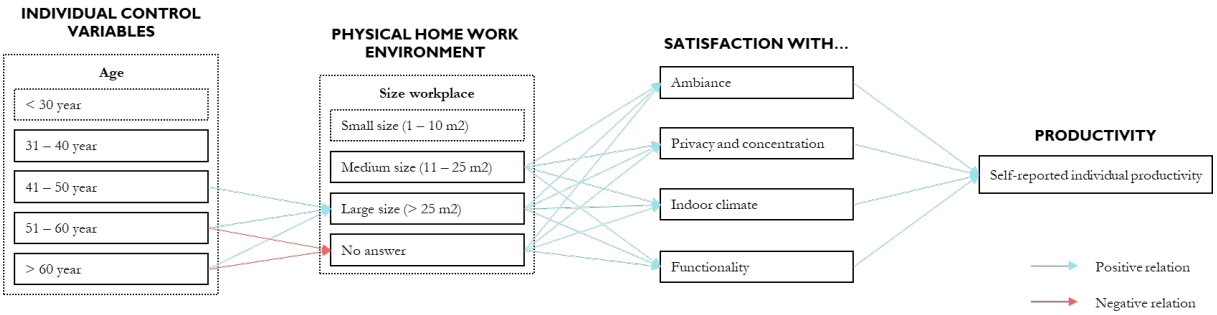

Figure B.20 Results path model – Education level and size

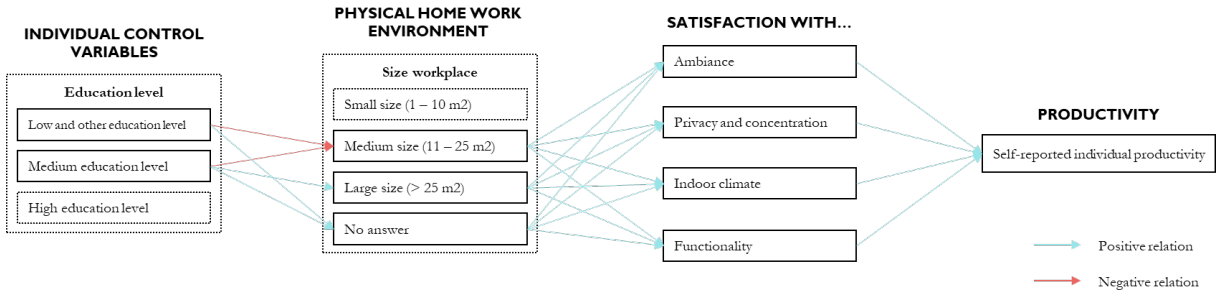

Figure B.21 Results path model – Gender and size

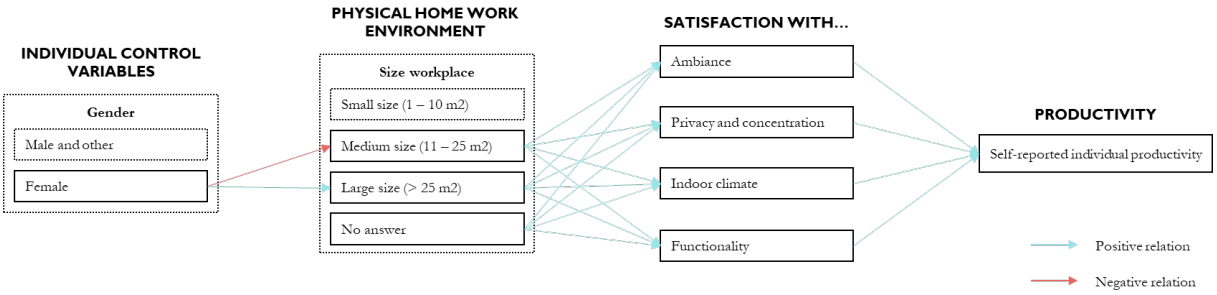

Figure B.22 Results path model – Job function and size

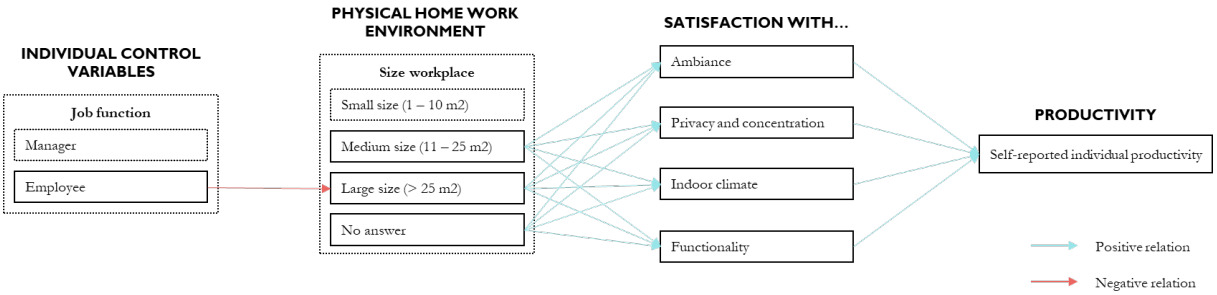

Figure B.23 Results path model – Household composition and use

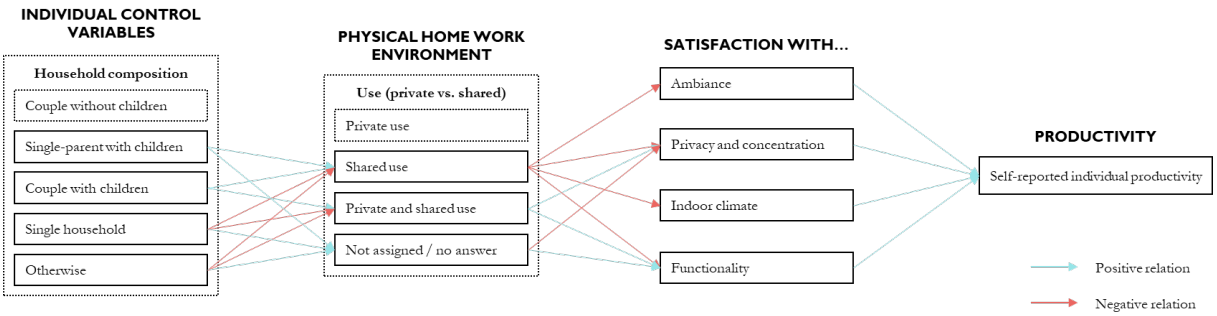

Figure B.24 Results path model – Age and use

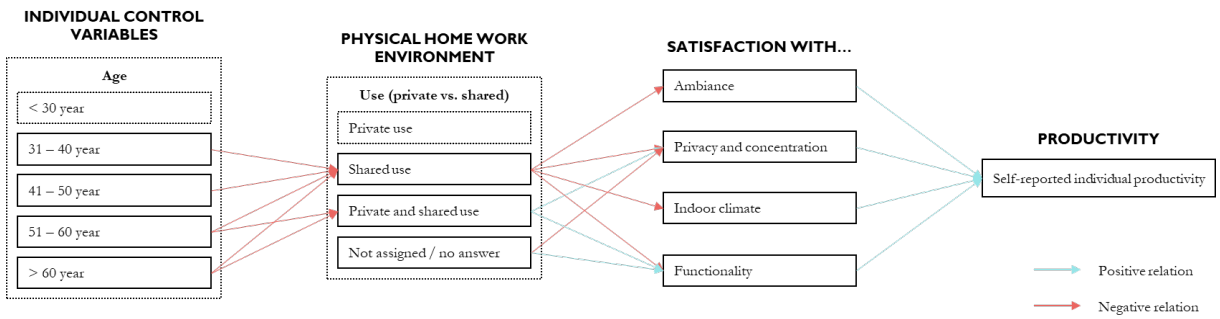

Figure B.25 Results path model – Education level and use

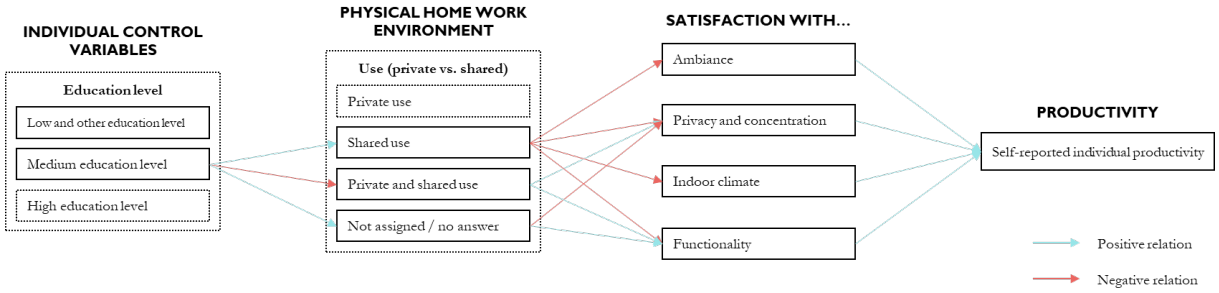

Figure B.26 Results path model – Gender and use

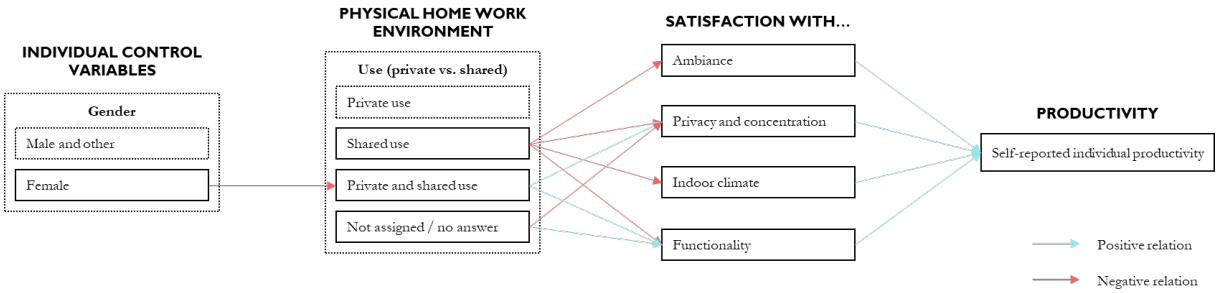

Figure B.27 Results path model – Job function and use

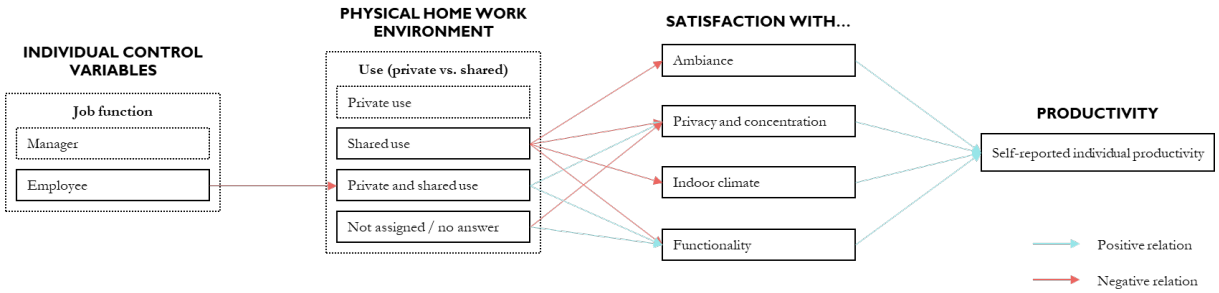

Figure B.28 Results path model – Household composition, ambient factors, ICT facilities, and view

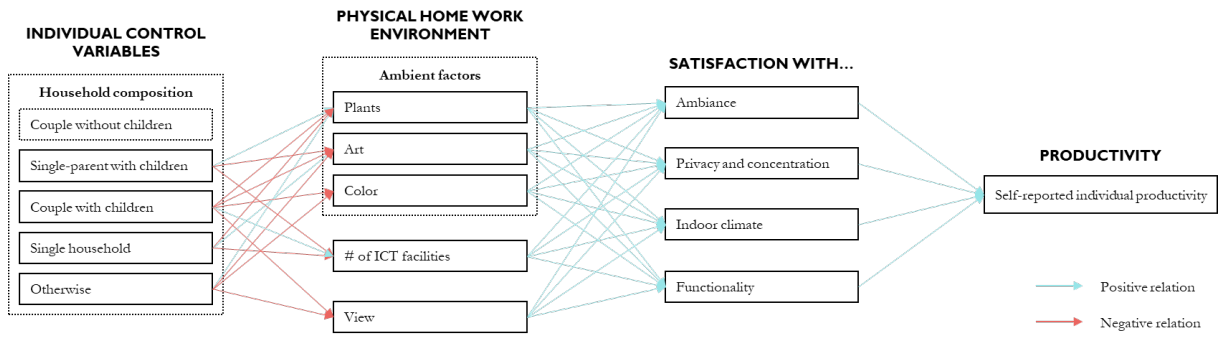

Figure B.29 Results path model – Age, ambient factors, ICT facilities, and view

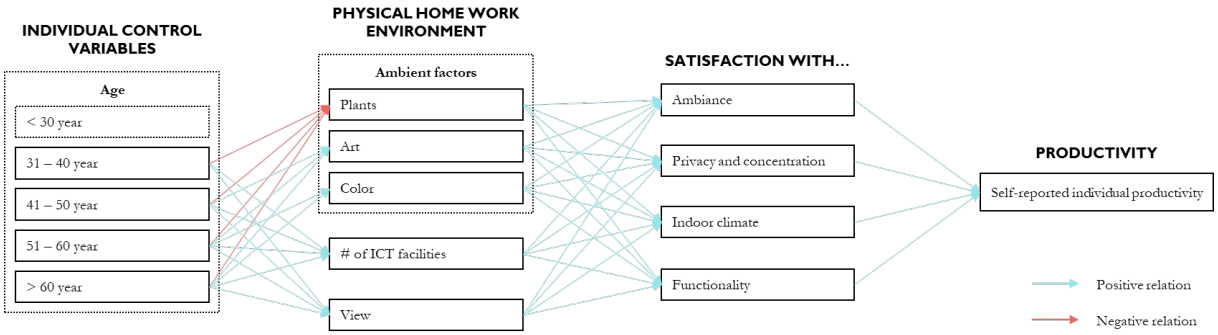

Figure B.30 Results path model – Education level, ambient factors, ICT facilities, and view

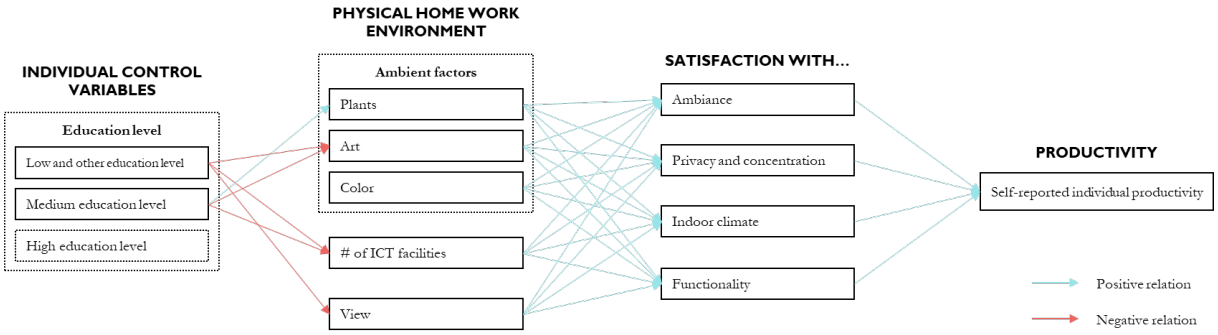

Figure B.31 Results path model – Gender, ambient factors, ICT facilities, and view

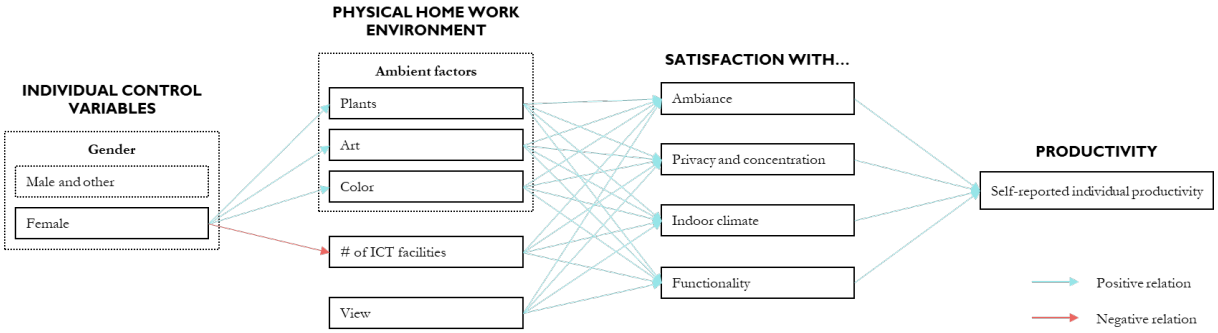

Figure B.32 Results path model – Job function, ambient factors, ICT facilities, and view

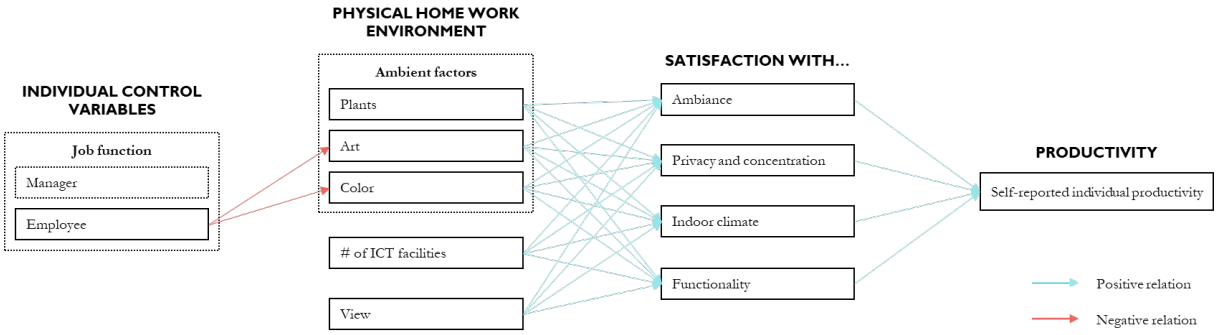

Figure B.33 Results path model – Household composition and satisfaction

Figure B.34 Results path model – Age and satisfaction

Figure B.35 Results path model – Education level and satisfaction

Figure B.36 Results path model – Gender and satisfaction

Figure B.37 Results path model – Job function and satisfaction

APPENDIX C REFLECTION

The track Management in the Built Environment (MBE), of the master program Architecture, Urbanism and Building Sciences, partly focuses on Real Estate Management (REM). REM looks into the use of real estate to support organizational goals. This could be, for example, renting a new office building, or renovating an office to increase the productivity of employees. In the case of this research, the focus is not on the 'normal' office, but on the homeworking office. However, both the office and the homeworking office are strongly related, because either one of the two offices is used during working hours. This use depends on the policy of the particular organization, their support for homeworking, but also the preferences of employees.

Many people I talked to throughout my research were surprised when I told them about my research topic because they were not aware that this was a topic related to 'Management in the Built Environment'. For them, it felt like sociologic research which does not fit a study at a 'technical university'. But the sociology behind the built environment is exactly what interests me, the built environment can simply not exist without people using it.

C.1 RELEVANCE

It is impossible to predict the future. However, because almost everyone is working from home now during Covid-19, policies, and preferences can and probably will change in the future. What is exciting about this topic is that almost all people can identify themselves with working from home. This emphasizes the social relevance of the study; it is of interest to a lot of people and easy to relate to. This also means that everybody has an opinion about the topic and is happy to share this with you.

From a scientific point of view, it is of importance to outline the influence of the home work environment on productivity. A lot has already been researched on homeworking as a phenomenon in itself but not in the context of the physical home work environment. It was found that it was easier to concentrate at home because at the office there is a lot of distraction from colleagues. What is different in this situation, compared to former studies, is that people had to work almost all their time at home. This meant that not only the concentrated work is conducted at home, but also team-related activities, such as meetings, are held online. Besides, the difference in the physical home work environment could be researched as every home situation had to provide a home workplace during Covid-19.

C.2 METHODOLOGY

Two phases can be distinguished in the research methodology, namely the literature review and the quantitative research.

C.2.1 Literature review

First, a systematic literature review was conducted to gather all the information and research that was already done on homeworking in relation to productivity. This resulted in many articles that had to be structured per theme. The phenomenon of homeworking is not only researched in relation to productivity, but also to more social/psychological outcomes such as well-being and commitment. As these are also interesting topics to look at, it was hard to keep the scope as narrow as possible.

Next to homeworking and productivity, the work environment and productivity were researched as well. This gave a lot of extra information to filter during the literature review. Therefore, it was decided to mostly focus on the literature reviews that were conducted on the work environment, such as Croon et al. (2005). This gave a clear overview to apply to the (physical) home work environment.

Secondly, the theories that were found in the literature were most of the time not designed specifically for homeworking and/or the home work environment. The discussed theories focused on the environment itself in relation to people, e.g. the P-E fit theory and the JD-R model. Therefore, it had to be applied to the context of this research.

Last, the questionnaire from WWH research was not made available until the literature review was almost completed. This was done deliberately so that the literature review was not (unconsciously) influenced beforehand, as normally a questionnaire would be designed based on the literature review. However, the disadvantage of this approach was that at the beginning it was hard to determine the focus of the research. This could have been more efficient in terms of time and in-depth literature search if the survey had been made available earlier in the process.

C.2.2 Quantitative research

The output of the literature review was a theoretical model on the influence of the home work environment on productivity. This theoretical model had to be adjusted to align with the dataset that was provided by WWH. It was a big advantage that there was already an extensive dataset, of more than 30,000 respondents, available at the start of the second phase of the research. This allowed doing comprehensive statistical research, including bivariate analyses, regression analysis, and an integral path model.

A disadvantage was that first the dataset had to be made suitable for the conceptual model. This took a lot of time in the process of the second phase of the research. Some questions had to be excluded from the dataset and other questions had to be adjusted to fit the variables. In the end, it was not possible to use all the data provided, because of the scope of the research. As discussed in section 8.2, within the dataset a lot of research can still be conducted in the future.

So, on the one hand, the existing provided time to perform extensive analysis. On the other hand, it also took time to prepare the data for these analyses.

C.3 PERSONAL REFLECTION

This section describes my personal experience throughout the last academic year (2020 – 2021) on writing this thesis and executing the research. Therefore, it is written in a personal way.

C.3.1 Towards the P2

Throughout the summer I already started talking to peers about interesting research topics for my thesis. As we were (and are) in the middle of the Covid-19 pandemic, I found it interesting to look at homeworking. What is the experience of homeworking? How does it affect employees? What is the future of the office going to look like? These were some (major and broad) questions that interested me. In the first week of the academic year, in September, the 'graduation laboratory' forces the student to come up with ideas on their thesis topic and discuss them with teachers. This was a very fruitful week and I came in contact with my first mentor, that was involved in the WWH research. This research was closely related to my interest and on top of that, I was lucky to use their dataset for my research.

During the first weeks, I started orienting on the subject of homeworking. In these weeks it was of importance to define the scope of the thesis and see where my detailed interest was. At first, I was under the impression to look into the future of working from home. However, I found out quite soon that it is simply not possible to look into a glass globe and predict the future. Quite ironically Covid-19 is one of the major examples of this. However, a lot has been written on the topic of homeworking and therefore I found it hard to decide what was (and more importantly was not) relevant for my research. Besides, previous research shows that implementing homeworking is not as easy as thought and therefore my focus for this research shifted to the influence of the home work environment on productivity during homeworking.

The literature review took up a lot of time and energy. I would like to have a structure when doing things, like writing. However, as a lot was already written on the topic, both on homeworking itself and on the work environment, a structure was hard to find. This was then also difficult for my mentors on giving feedback as not a lot was written throughout the first semester. Only at the end, just before the P2, the literature review took its shape, which was right in time.

C.3.2 Towards the P4

After the P2 it was hard for me to get started again. The reason for this was that on the one hand, I had to start with a new phase of the research, namely the statistical analysis, and on the other hand I still had to

finish the previous phase. The literature review so far was extensive, but still not complete. As explained in Section 1.3, the scope of the research and the literature that comes along with it was very broad. What helped to get me going again was the fact that I started my internship at Aestate / ontrafelexperts. Although the internship mainly took place online, I got a structure in my week by, for example, seeing others (online) every Tuesday and Thursday talking about their daily activities and well-being.

For this research, it was chosen to do extensive statistical analysis research. Within the statistical analysis, I only followed two small courses, one during my bachelor program, and one during this academic year. This meant that my knowledge of statistics and the use of SPSS was minimal. Therefore, it was hard for me to start this particular phase of the research.

On top of that, the data I received from WWH research was quite large, not only in the number of respondents but more importantly in the number of questions asked on the topic of the physical home work environment. The first step was to get to know the data as the questionnaires were already developed a half-year before I even started the graduation laboratory.

I found out that this was easier said than done. This was because certain questions had to be recoded to fit within the conceptual model, but during this process, I was still figuring out what to do and how to do it. So, a lot of trial and error was conducted before I got a 'grip' on the data. Luckily I got a lot of guidance throughout this process on how to conduct the analyses and how to read and interpret the outcomes.

Another challenge at the end of the process was to determine where to stop with the analyses. Especially because the data set was so big a lot of research on specific topics could be performed. However, it also has to fit within the timeframe of this thesis. Next to the analysis also the report has to be written and conclusions have to be drawn. As I am a planning type of person, it was hard for me that towards the P4 I did not always know about determining the amount of time some parts of the research took. So, throughout this thesis, a lot has been learned about just going with the flow, as not many things go the way they are planned during research.

MSc Architecture, Urbanism and Building Sciences
Delft University of Technology