Activity-based Flexible Office work environments
Design and implementation processes and outcomes
LINDA ROLFÖ
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Case 2 – IT service and support providers
Architect: Enter arkitekter
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Activity-based Flexible Office work environments

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Akademisk avhandling som med tillstånd av KTH i Stockholm framlägges till offentlig granskning för avläggande av teknisk doktorsexamen fredagen den 14 december kl. 13:00 i sal T1, KTH, Hälsovägen 11, Huddinge.
Abstract

Background: In recent years, there has been a reported increase in organizations relocating to Activity-based Flexible Offices (A-FOs) worldwide. The idea of A-FOs is to offer work conditions suitable for the workforce’s tasks and individual preferences. Benefits of the A-FO include employee autonomy, privacy and intra- and intra-team communication. However, there are reports within Swedish media on reduced performance, increased dissatisfaction, injustice, and workplace avoidance amongst employees occupying A-FOs. Added to which empirical research supporting A-FOs claimed benefits are scarce with inconsistent results.

Aim: The aim of this thesis is to explore and investigate perceptions of workspace, work conditions, work environment satisfaction, and perceived performance in A-FOs (aim of Studies I-V). Additionally, the sub-aims are to explore and investigate associations with underlying factors such as design and implementation process factors including methods suggestions (aims of Studies II, IV & VI), physical workspace factors (aim of Study III), desk-sharing and speech policies (aim of Study IV), and organizational preconditions (aim of Study V). This thesis aims at integrating the contributions of each paper and making the whole greater than the sum of its parts.

Method: A problem centered, pragmatic approach guided the methodological choices. Two in-depth longitudinal case (n=66 & 46) and two cross-sectional (n=202 & 105) studies were conducted at five single floor A-FOs. A mixed method approach was adopted comprising of six questionnaires, 105 individual interviews, documentation of plan layouts, photographs, planning documents and observations. A third cross-sectional study with 7 additional cases was conducted on 473-715 questionnaire responses.

Results & discussion: The results showed that work environment satisfaction and perceived performance can increase after relocation to A-FOs. Reported contributing design and implementation process factors included meaningful objectives for the employees, allocation of time and financial resources, having an organizational focus, employee empowerment, and a methodological approach. A methods framework divided into A-FO design stages is presented that can facilitate the design process of A-FOs. Reported contributing workspace design factors included ample desk-sharing ratios and workspace diversity. Desk-sharing and speech rules were identified: when to remove belongings, allowance to occupy the same workstation in open-plan and enclosed areas on consecutive days, and allocations of areas where speaking on the phone, and verbal interaction with colleagues and interruptions are allowed or forbidden. Organizational preconditions, such as innovative work tasks and an open-plan office type prior to relocation were associated with preference for the A-FO.

Conclusion: Design and implementation factors, workspace factors, application of rules and organizational preconditions are possible predictors of work conditions, work environment satisfaction, and perceived performance. A-FOs can be perceived as noisy workplaces that create extra work, decrease interaction as well as increase uncertainty on how to act within the office. However, A-FOs can also be preferred above other office types and be perceived with high work environment satisfaction and perceived performance. This thesis has stressed the importance of a holistic sociotechnical perspective during A-FO implementations, and the importance of employee involvement and empowerment, workspace diversity and desk-sharing policies.
**Keywords**
Activity-based working, ABW, New ways of working (NWW), hot-desking, clean desk, office policies, workspace, office layout, office design, office planning process, organizational change, conceptual framework for office design, office planning
Sammanfattning

**Bakgrund:** Under senare år har andelen företag som flyttar till aktivitetsbaserade kontor ökat över hela världen för att bättre stödja nya sätt att arbeta. Det aktivitetsbaserade kontoret (ABW) föreslås medge hög arbetsmiljötillfredsställelse och prestation genom att tillhandahålla arbetsförhållanden som passar olika arbetsuppgifter och individuella preferenser. Exempelvis kan autonomi, avskiljdhet och kommunikation främjas. Dock rapporterar svensk media om medarbeares låga prestation, missnöje och upplevelse av orättvisa i ABWs och att medarbetare undviker sin arbetsplats.

**Syfte:** Denna avhandling syftar till att utforska och undersöka arbetsförhållanden, medarbeares tillfredsställelse av arbetsmiljön och prestation i aktivitetsbaserade kontor, samt deras associationer till underliggande faktorer såsom processfaktorer, utformningsfaktorer, regler och organisatoriska förutsättningar. Avhandlingen avser att integrera artikelbidragen och att helheten ska vara större än summan av delarna.

**Metod:** En problemcentrerad, pragmatisk ansats har väglett de metodologiska valen. Grundliga longitudinella fallstudier och genomsnittsstudier genomfördes hos organisationer med aktivitetsbaserade kontor på ett våningsplan. En mixed method-ansats användes bestående av 6 enkätutskick, 105 intervjuer, dokumentation av planritningar, fotografier och planeringsdokument, samt observationer. En tredje tvärsnittsstudie genomfördes med ytterligare 7 fall med total 473-715 enkätsvar.

**Resultat & diskussion:** Resultaten visade att arbetsmiljötillfredsställelse och upplevd prestation kan öka efter flytt till ABW. Faktorer inom planeringsprocessen, såsom meningsfulla mål för medarbetarna, tilldelning av tid och finansiella resurser, fokus kring organisatoriska förändringar, medarbeares delaktighet och ett metodiskt tillvägagångssätt föreslogs relatera till goda utfall. För att underlätta i planeringsprocessen presenterades ett ramverk med metoder indelade i kontors olika planeringsfaser. Föreslagna utformningsfaktorer var att medge låg täckningsgrad av arbetsplatser och varierade akustiska arbetsmiljöer. Resultaten pekade på att regler behöver diskuteras och tydligt uttryckas, till exempel om medarbetarna får använda samma arbetsplats i öppna och avskärmade ytor flera dagar i rad och var medarbetarna får prata med varandra i telefon och var man får avbryta varandra för att ställa frågor. Den organisatoriska kontexten, såsom hög frekvens av innovativa arbetsuppgifter, stark kultur och att ha ett öppet kontor innan förändringen föreslogs också relatera till hög arbetsmiljötillfredsställelse i ABWs.

**Konklusion:** Planeringsfaktorer, utformningsfaktorer, tillämpning av regler och organisatoriska förutsättningar är möjliga prediktorer för arbetsförhållanden, arbetsmiljötillfredsställelse och upplevd prestation. ABWs kan medge oljud, skapa extra arbete, minska interaktion och skapa osäkerhet kring hur man bör agera. Dock kan ABWs föredras framför andra kontorstyper och upplevas medge hög prestation och arbetsmiljötillfredsställelse. Denna avhandling betonar vikten av ett sociotekniskt helhetsperspektiv under planering och implementering av ABWs och den vikten av medarbeares involvering och påverkansmöjligheter, mångfald i typer av arbetsmiljöer och tydliga förhållningsregler kring delandet av arbetsplatser.
Nyckelord
Aktivitetsbaserade kontor, ABW, Nya sätt att arbeta (NWW), flexibelt arbete, förhållningsregler, kontorsutformning, organisationsförändring, konceptuellt ramverk för kontorsplanering, planeringsprocessen
Preface

The first years working on the thesis I was placed in a small open-plan office with four workstations. I was promised to have my own cell office at the end of my studies. Fair enough. I was at the office most of the time and I often had the room for myself. Actually, often the whole office for myself. I had nice colleagues, but I felt we had few common denominators. For a short while a guest researcher from another part of the world was allocated to the room. His culture and etiquette differed from mine. I realized that open-plan offices was not my cup of tea.

News! KTH Flemingsberg was relocating to a whole new building. The Ergonomics Department was allocated to a large open-plan office. Having made literature reviews of office types, I was not excited. What happened to the promise of having my own cell office? We were all worried. Most upsetting was the assignment of workstations. Was employee position or amount of time spent in the office the decisive factor for confiscating workstations closest to windows and corners of the new office? A democratic decision was changed. Emotions raged.

A large reference group for the new building evaporated in the middle of the process, for an unknown reason. Emotions raged. Nevertheless, I got to participate in/observe the top planning and relocation group for the school. I learnt about the importance of attendance of key stakeholders, and challenges with collaboration and making decisions without sufficient information at hand.

The relocation took place. A very nice, fresh and bright building. Nice colors and large spaces. It was, surprisingly enough, quite nice to ask questions easily, inspire and being inspired to stand, and getting energized by someone’s morning greeting. I perceived the communication within and cohesion of the group increased. Cohesion strong enough for starting weekly outdoor workouts together. Perhaps it was the office type, or perhaps some other reason for the increased cohesion to take place.

This is my personal experience of the workplace design process and the following outcomes. Extensive amount of emotions, territoriality, clashes, hierarchical struggles, decision-making complications, injustice, unexpected results, communication and group cohesion seem to be natural parts of the process. A complex and emotionally loaded process to say the least. And this journey was “only” relocation to an open-plan office. Relocation to Activity-based Flexible Offices with different workspace settings and sharing of workspaces, further complicates and amplifies the emotional journey. This increased my interest for the topic and left me with unanswered questions. How can research facilitate the journey and create good Activity-based Flexible Offices work environments?

Huddinge, September 2018

Linda Rolfö
List of appended papers

Paper I

Paper II

Paper III
Rolfö, L. & Bodin Danielsson, C. (Submitted manuscript). Plan layout, space ratios and interior design in Activity-based Flexible Offices

Paper IV
Babapour, M. & Rolfö, L (2018). Policies in Activity-based Flexible Offices -‘I am sloppy with clean-desking. We don’t really know the rules.’ Ergonomics doi.org/10.1080/00140139.2018.1516805

Paper V

Paper VI
Contributions from the authors

**Paper I:** Rolfö is the corresponding author. She designed, analyzed and wrote the paper. Jahncke (third author) designed and collected the first cycle of questionnaire data in 2011, and assisted in the longitudinal data analysis and writing of manuscript. Eklund supported in manuscript writing.

**Paper II:** Rolfö is the corresponding author, no co-authors.

**Paper III:** Rolfö is the corresponding author. Bodin Danielsson conducted the professional evaluation of blueprints. She also contributed with references, wrote some sections of the paper and gave feedback on the manuscript.

**Paper IV:** Babapour is the corresponding author. Data was collected jointly by Babapour and Rolfö: one case jointly by the authors, two cases by Rolfö, and one case by Babapour. The analyses, and writing and editing of the manuscript was conducted jointly by Babapour and Rolfö in close collaboration.

**Paper V:** Rolfö is the corresponding author. She designed, analyzed and wrote the paper. Rolfö collected data from case 1-4 and 7 (case 8 in thesis description). Jahncke, Slunga Järvholm, Öhrn and Babapour collected data from the other cases. Feedback on manuscript was given by the other authors.

**Paper VI:** Rolfö is the corresponding author. She designed, analyzed and wrote the paper. Rolfö and Eklund conducted the course intervention jointly. Eklund contributed in writing the introduction of the manuscript, and gave feedback on the rest of the manuscript.
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**Introduction**

According to research studies there has been a worldwide increase in organizations relocating to Activity-based Flexible Offices (A-FOs) in recent years to support new ways of working (Kim, Candido, Thomas, & de Dear, 2016; Seddigh, 2015; Vos & van der Voordt, 2002). Common objectives for implementing A-FOs are reducing overhead costs, and increasing flexibility, innovation and productivity (de Been & Beijer, 2014; Hirst, 2011; Kim et al., 2016; Morrison & Macky, 2017).

The idea behind A-FOs is to offer a variety of workspaces to support different work activities and individual environmental preferences (Wohlers & Hertel, 2016). A second distinguishing feature of the A-FO concept is the sharing of workspaces and workstations (Wohlers & Hertel, 2016). Office occupiers choose physical setting and workstation on a first come first served basis, and clear the workstation of their belongings after usage (Knight & Haslam, 2010). Hence, employees are not assigned to a specific work station. Aims of the A-FO are to provide work conditions such as privacy, autonomy and inter- and intra-team communication (Appel-Meulenbroek, Kemperman, Kleijn, & Hendriks, 2015), work environment satisfaction, health (Bodin Danielsson & Bodin, 2008) and performance (Vos & van der Voordt, 2002).

However, research literature and media list a number of problems with A-FOs which include; use of the same workstation and desk claiming by employees, the best workplaces in the office being repeatedly occupied by the same people, conflict between colleagues, an absence of employees’ sense of security through the loss of their assigned workstation, high noise levels, expenditure of time on excess operations, discussions around increased risks of infection cause by desk sharing, and problems associated with tasks involving confidential information (Englund, 2015; Hirst, 2011; Wilhelmson, 2015). Implementations are often resisted by employees (Damschroder et al., 2009) and organizations frequently have limited experience of designing new facilities. A limited amount of research on A-FOs reports on both supported and inhibited work conditions, positive and negative employee satisfaction, and performance outcomes after relocation to A-FOs.

An improved understanding of the relationship between design process factors, workspace solutions, usage solutions and work conditions associated with A-FO implementations is needed for providing healthy and productive office work environments.
‘We shape our buildings, and afterwards, our buildings shape us’

– Churchill, 1944

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Case 2 – IT service and support providers
Architect: Enter arkitekter
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Background

2.1 Emergence of the Activity-based Flexible Office (A-FO)

The advancement of information and communication technology (ICT) in recent decades has changed the external context of organizations (de Croon, Sluiter, Kuijer, & Frings-Dresen, 2005; Lee & Brand, 2005). This has led to new competitors, shorter product life cycles, greater speed for new innovations and customer demands, cost effectiveness and higher quality (Horgen, 1999). Organizations need to respond to these new circumstances by rethinking their business mission and strategy, changing work processes, turning to less hierarchical forms, and become more flexible (Horgen, 1999). New ways of working (NWW) is one approach to new work processes, which refers to temporal and spatial flexibility (Nijp, Beckers, van de Voorde, Geurts, & Kompier, 2016). ICT advancement allows many knowledge workers to work time and place independent, for example working from home (Nijp et al., 2016). Spatial flexibility is also applied to new types of offices (e.g. van der Voordt, 2004). The work processes in new offices are no longer bound to paper logistics, which traditional offices were designed for (Danielsson, 2014). In recent years, more research has been published on organizations that have designed and relocated to flexible offices such as Activity-based Flexible Offices (Vos and van der Voordt 2002; Appel-Meulenkoek et al, 2011; Seddigh et al., 2014). The Activity-based Flexible Office (A-FO) concept originates from Scandinavian experiments on ideas with non-territorial offices (free seating/office spaces) in the 1980-90’s (Bodin Danielsson, 2014). In the 90’s, Eric Veldhoen visited Scandinavia, discovered, implemented and successfully launched the concept in his own companies in the Netherlands under the name Activity-Based Working. The concept has since spread all over the world (Bodin Danielsson, 2014).

The most common office concept today is the open-plan office (Kaarlela-Tuomaala, Helenius, Keskinen, & Hongisto, 2009). Open-plan offices are rooms shared by more than four people (Danielsson and Bodin, 2008). However, the latest survey from the Swedish work environment authority shows that 14% of Swedish office workers occupied an A-FO already in 2015 (Arbetsmiljöverket, 2015).

2.2 Definition of the A-FO

Bodin Danielsson and Bodin (2008) defines seven office types; the cell office, the shared office (2-3 employees), the small, medium and large open-plan offices, flex offices and the combi-offices. The Activity-based Flexible Office (A-FO) is included in the flex office category. In Sweden the A-FO is referred to as aktivitetsbaserade kontor [activity-based offices] or ABW (Hultberg, 2018). Within the research literature many different terms and concepts are discussed of the A-FO, including but not limited to;
multiple space offices, activity-based offices, innovative office, open space flexible offices, flexible offices, flex offices, non-territorial offices and hot-desking offices (Bjerrum & Bødker, 2003; Brunia, de Been, & van der Voordt, 2016; De Paoli, Arge, & Hunnes Blakstad, 2013; Kim et al., 2016; Knight & Haslam, 2010; Lahtinen, Ruohomäki, Haapakangas, & Reijula, 2015; Meijer, Frings-Dresen, & Sluiter, 2009). The definitions and the difference between the concepts are not always clear. In this thesis the A-FO is defined and distinguished by two features; (1) workspace diversity and (2) non-territorial desk-sharing. To highlight both of these distinguishing features the term Activity-based Flexible Office (A-FO) has been employed throughout this thesis. This approach to terminology being consistent with some of the more recent publications within the field where the term is also used (e.g. Wohlers & Hertel, 2016).

Workspace diversity: Different from the flexible office or hot-desking office, the A-FO offers a variety of settings to support different work activities (Appel-Meulenbroek, Groenen, & Janssen, 2011) and environmental preferences (Wohlers & Hertel, 2016). Hence, activity does not refer to physical activity but for example work tasks. Normally, it is based on open-plan and additional back-up spaces designated with different speech levels for concentrated and collaborative work. Examples of back-up spaces are supportive facilities for individual work, telephone conversations or skype meetings (de Been & Beijer, 2014). Workspace has a profound impact on concentration and collaboration (Alker et al., 2015) and office plan layout set the agenda for the overall architectural experience of the office (Bodin Danielsson, 2015). However, the physical workspace in A-FOs varies from one organization to another (Bodin Danielsson & Bodin, 2008; Wohlers & Hertel, 2016). Despite previous studies on workplace impact on work conditions, there are limited number of studies that investigate plan layouts, amount of space, number of areas, enclosed back-up spaces for possibility of privacy, workstation arrangements and desk-sharing ratios and their alignment with work conditions, work environment satisfaction and performance.

Non-territorial desk-sharing: In A-FOs employees share workstations and workspaces on a first-come-first-served basis (Knight & Haslam, 2010). Satisfactory furniture and IT equipment are commonly provided on all workstations (Appel-Meulenbroek et al., 2011). Moreover, normally the A-FO is dimensioned for 70 % of the workforce (Bodin Danielsson & Bodin, 2008) counting the desk-sharing ratio (desks equipped with screen(s), keyboard and mouse, divided by the number of office occupiers). Normally clean desk policies are used to coordinate the sharing and ensure workstation rotation across units and teams (Bjerrum & Bødker, 2003; Meijer et al., 2009). More specific desk-sharing rules can be applied, for example on frequency of changing workstation, where the rules and policies are determined by the organization. In some organizations employees are expected to clear their desks every time they leave the workstation for more than one hour (Hirst, 2011), and in other organizations the limit is a few hours (e.g. De Been and Beijer, 2014). Nesting tendencies (repeated use of the same workstation) found in A-FOs (Elsbach, 2003; Hirst, 2011) indicate that desk-sharing policies have not been established or are being violated. Moreover, speech policies that ensure the provision of shared spaces for concentrated work have been shown in earlier studies to be disregarded (e.g. Appel-Meulenbroek et al., 2011). Despite rules being integral components of A-FOs, few studies have explored desk-sharing rules, employee compliance with workspace and speech policies, or investigated the consequences of these rules and policies on work conditions.
2.3 Objectives for A-FO designs and new ways of working implementations

Reasons for implementing the A-FO, put forward in research literature, are to improve utilization of space, decrease facility costs and improve sustainability where an organization can reduce its carbon footprint (Appel-Meulenbroek et al., 2015; Brunia et al., 2016; Elsbach, 2003; Hirst, 2011; Van Meel, Martens, & van Ree, 2010). On average fixed workstations are used 50% of the time in traditional offices (van Koetsveld & Kamperman, 2011). In addition to direct cost savings the A-FO increases flexibility for future office use (de Been & Beijer, 2014). Non-assigned workstations facilitate relocation of staff if organizations expand, downsize or change team structure (Kim et al., 2016). Moreover, the A-FO aims to increase efficiency and performance of employees (Appel-Meulenbroek et al., 2015; de Been & Beijer, 2014) by providing spaces for colleagues to sit together as well as spaces for individual work (Appel-Meulenbroek et al., 2011; Brunnberg, 2000; de Been & Beijer, 2014). The dynamics and opportunity to establish new contacts across departments support interaction, sharing of knowledge within the organization and innovation (Brunia et al., 2016; de Been & Beijer, 2014; Nijp et al., 2016; van der Voordt, 2004). In order to reduce negative effects on employee health, wellbeing and performance found in open-plan offices (Richardson et al., 2017), A-FOs are designed with back-up rooms to provide privacy and confidentiality of information (de Been, Beijer, & den Hollander, 2015; Gerdenitsch, Korunka, & Hertel, 2017). An additional reason is to attract and retain personnel (de Been et al., 2015; Nijp et al., 2016) by increasing employee satisfaction and productivity through autonomy and control of the work environment (Kim et al., 2016). The philosophy of activity-based working is to make work more enjoyable for the organization and the employees (van Koetsveld & Kamperman, 2011). Moreover, the A-FO can be a means to gain a positive image among external clients (Appel-Meulenbroek et al., 2015; de Been & Beijer, 2014). The architectural design denotes a message about the organization (Bodin Danielsson, 2014). Key organizations that are dominant in respective fields can set an example in how a good, modern and efficient organization should be designed, where this implementation of change can create competitive pressures on other organizations to implement the same changes (Damschroder et al., 2009; Jacobsen, 2013). Microsoft, being a dominant organization in Sweden, initiated the implementation of an A-FO in 2011 (Lidström & Bolter, 2016) and was ranked as no. 1 in the Great place to work® Sverige [Sweden] competition based on employee surveys and evaluations (Mynewdesk, 2011). Put simply, the A-FO projects an image of being modern and forward thinking (Morrison & Macky, 2017). In sum, reasons for implementing the A-FO are many and vary between organizations.

2.4 Design and implementation processes of A-FOs

A study with naturally occurring quasi-field experiment concluded that office redesign is an effective way to execute organizational change (McElroy & Morrow, 2010). However, according to a literature review, about two thirds of organizations’ efforts to accomplish change are unsuccessful (Burnes, 2004a). A-FO concept failures are claimed, by an observation and survey case study, to be the consequence of design process failures (Appel-Meulenbroek et al., 2011). It has been found by a study with nine cases that A-FO implementations lack a systematic process (Bjerrum & Bødker, 2003).

Workplace design processes are considered complex (e.g. Horgen, 1999). Besides the decisions that all office design and redesign projects demand, such as deciding location of a new office, additional characteristics specific for A-FO need to be addressed and decided upon. These can include; office use and specification of associated policies,
layout, appearance and filing system (Van Meel et al., 2010). The question of how employee participation influences the outcomes of organizational interventions has been extensively researched (Garrigou, Daniellou, Carballeda, & Ruaud, 1995; Vink, Koningsveld, & Molenbroek, 2006). However, in what way employees can be involved, and specifically in A-FO change processes are scarcely researched. Limited support for A-FO implementations are provided by research. A recent longitudinal case study suggests more research on exploration of the implementation process of A-FOs is needed (Gerdenitsch et al., 2017).

Occupational health specialists are suggested to be tasked with the design and implementation of workplace designs (Broberg & Hermund, 2004) and A-FOs (Morrison & Macky, 2017). As change agents they are able to facilitate and mediate opinions across the organization from a work environment perspective (Broberg & Hermund, 2004) with the goal to promote health and safety (Swedish work environment law 1977:1160, §1). Nevertheless occupational health specialists are not seen as natural partners, and are seldom involved and get access to workplace design processes (Broberg & Hermund, 2004). Thus the younger generation have limited knowledge and experience of using systematic workplace design methods.

2.5 A-FO work conditions
Work conditions influence employee effort to conduct work and maintain health (Vischer, 2008). Only a limited amount of studies (especially in 2014 when the thesis project was initiated) have examined whether A-FOs provide mental and psychosocial work conditions that improve satisfaction, health and performance (Wohlers & Hertel, 2016) and the results are inconsistent (de Been & Beijer, 2014; Gorgievski, van der Voordt, van Herpen, & van Akkeren, 2010; Niijp et al., 2016; Wohlers & Hertel, 2016). Central concepts reported in office research literature include autonomy, mental work conditions, privacy, territoriality and communication. These also extend to emotion work conditions connected to interpersonal relations (de Croon et al., 2005).

**Autonomy:** In A-FOs employees have autonomy to choose when, where and how to work with freedom to choose their own schedule, place outside and within offices, and communication medium (Demerouti, Derks, L. ten Brummelhuis, & Bakker, 2014; Wohlers & Hertel, 2016). Autonomy, or decision latitude, refers to employees’ potential control over his or her tasks and conduct during the working day (Karasek, 1979). In a multiple case questionnaire study it was found that employees in A-FOs can control their exposure to disruptions, distractions and interaction (Lee & Brand, 2005). A research report found that privacy control is positively related to work environment satisfaction (Marquardt, Veitch, & Charles, 2002). Moreover, according to a literature review on office workspace, empowerment is another form of control, which can be increased by employee involvement in workspace design decisions (Vischer, 2008).

**Mental work conditions:** Employees in A-FOs should be able to, by choosing quiet workspaces, avoid distractions (Gerdenitsch et al., 2017) such as irrelevant speech and speech with high Speech Transmission Index (level of intelligibility of speech) found in open-plan offices by experimental and questionnaire studies (Jahncke, Hongisto, & Virjonen, 2013; Smith-Jackson & Klein, 2009). Longitudinal single case, and multiple case cross-sectional studies suggest that there are fewer distractions (Gerdenitsch et al., 2017; Seddigh, Berntson, Bodin Danielson, & Westerlund, 2014) or no difference (Morrison & Macky, 2017) after relocation to A-FOs than in open-plan offices. Compared to cell offices, higher cognitive stress is reported in flex offices (Seddigh et
Mental working demands are perhaps not limited to distractions and avoiding disruptions. The active seating arrangements associated with A-FOs involves the need to find suitable workplaces every day or several times per day (Morrison & Macky, 2017), adjusting workstations, finding colleagues and getting acclimatised to the different areas of the office (Brunnberg, 2000; van der Voordt, 2004; Wolfeld, 2010), which can also be mentally demanding.

Privacy: Privacy is defined as an individual’s need for regulating interaction with other people (Altman, 1977). Privacy can be divided into auditive, visual, informative and territorial privacy (Appel-Meulenbroek et al., 2011; van der Voordt & Van Meel, 2002). Informative privacy is defined as the information about oneself that is seen by others (Appel-Meulenbroek et al., 2011). A 20 case evaluation study with questionnaires and interviews found that employees evaluate privacy less positively in A-FOs than in cell offices and shared room offices (de Been & Beijer, 2014). The similarity of openness of the main work environment in A-FOs and open-plan offices suggest similar privacy effects (Wohlers & Hertel, 2016) and feelings of crowdedness (Maher & von Hippel, 2005). Crowding is a subjective psychological response to limited space (Stokols, 1972). Open-plan offices have shown lowered auditory privacy (Jahncke et al., 2013; Jahncke, Hygge, Halin, Green, & Dimberg, 2011; Kim & de Dear, 2013; Sundstrom, Burt, & Kamp, 1980), and lowered visual and informative privacy (Brennan, Chugh, & Kline, 2002; Sundstrom et al., 1980; Vischer, 2008) compared to cell offices.

The A-FO is a non-territorial office where workers have limited possibility to personalize and mark boundaries of their surroundings, and display one’s identity due to lack of desk ownership, according to a interview and observation study (Elsbach, 2003). Territoriality, both on individual and group level, is a function to maintain privacy and is defined as a self-other boundary regulation mechanism (Brown, 2009). It expresses a sense of ownership and is represented by the space for one’s work and place in the organization (Vischer, 2008). A-FOs are known to decrease feelings of identity due to limited possibilities for personalization and desk ownership (Appel-Meulenbroek et al., 2011). However, in a database survey it was found that spatial factors play a more significant role for appraisal of the A-FOs than desk ownership (Kim et al., 2016).

Communication and cooperation: The spatial configuration is considered an important influencer of connections (Sailer & McCulloh, 2012) and the open environment, which normally dominates the A-FO, is assumed to facilitate communication, interaction (Morrison & Macky, 2017) and spur intra-team (within group) collaborations (Wohlers & Hertel, 2016). The visibility, proximity of colleagues (Brunia et al., 2016) and flexible seating is intended to create better collegial and supervisory support, and more collegial friendship (Morrison & Macky, 2017) through overhearing opportunities (Haynes, 2008), and interaction across teams by spontaneous informal interactions (Appel-Meulenbroek et al., 2015; Wohlers & Hertel, 2016). Interaction across teams and networking within organizations have been shown to spur innovation (Pittaway, Robertson, Munir, Denyer, & Neely, 2005). However, findings from a longitudinal research study with 31 employees suggest that open-plan office occupants try to withdraw to private areas if possible or work from home (Kaarlela-Tuomaala et al., 2009). Moreover, in a longitudinal field study with 21 participants relocating from cell offices to open-plan offices, it was found that team member relations worsened, confidentiality of communication, and communication in general, decreased in the open-plan office (Brennan et al., 2002). de Croon and
colleagues’ literature review from 2005 conclude that the effect of workplace openness on communication is inconsistent.

*Emotional work conditions:* Emotional work conditions, i.e. interpersonal relations is related to communication (de Croon et al., 2005). The scarce A-FO literature investigating interpersonal relations, show worsened interpersonal relations compared to cell offices but no difference compared to open-plan offices, according to the literature review from 2005 (de Croon et al., 2005). A survey with 1000 participants found that an unfavourable physical working environment in A-FOs may result in increased social distraction and emotionally demanding interactions (Morrison & Macky, 2017). More research is needed on interpersonal relations such as atmosphere and sense of coherence.

### 2.6 Work environment satisfaction and performance in A-FOs

Work environment satisfaction is defined in this thesis as to how satisfied a person feels with respect to the physical and psychosocial work environment, which includes, but is not limited to, satisfaction with office plan layout, ambience, interior design, autonomy, mental work conditions, privacy, communication and interpersonal relations. Preference, such as office type preference, is an indicator on environmental satisfaction (Waldman, 1997). Job satisfaction and performance has been found by several studies to be influenced by the physical office setting (Danielsson, 2005; Sundstrom & Sundstrom, 1986; Vischer, 2007). Job satisfaction is an indicator of human well-being (De Jonge & Schaufeli, 1998) and has been linked to long-term health and performance (de Croon et al., 2005). Satisfaction has been found to be implicitly related with productivity through, amongst other things, absenteeism and intention to leave the organization (Hardy, Woods, & Wall, 2003).

Productivity is defined as the ratio between input and output (van der Voordt, 2004), However, partly due to the diversity of tasks that knowledge workers perform, measuring productivity of knowledge workers is challenging (Hongisto, 2005; Vos & van der Voordt, 2002). In this thesis results are based on perceived performance. Performance is defined by actions that worker’s engage in that strives towards achieving the organization’s goals (J. Campbell, 2013). If employees feel they cannot perform optimally, they may feel less motivation and job satisfaction (Bergström, Miller, & Hornej, 2015). Vischer (2008) distinguishes between supportive and unsupportive working environments as to which degree office workers can conserve their energy and attention for their tasks.

The performance and satisfaction of employees in A-FOs show mixed results, especially whether compared to open-plan offices or cell offices. Fewer distractions and reduced noise level (provided by e.g. back-up rooms), facilitated communication, and increased autonomy, speaks for increased performance and satisfaction in A-FOs (e.g. Hoegl & Proserpio, 2004; Seddigh et al., 2014; Wohlers & Hertel, 2016). Contrarily, lack of privacy, territoriality and personalization is related with decreased performance and satisfaction (e.g. van der Voordt, 2004). A linear regression analysis with 239 respondents in four A-FOs found that satisfaction with the physical environment, privacy and communication had the strongest positive associations with self-rated productivity and well-being at work. (Haapakangas, Hallman, Mathiassen, & Jahncke, 2018). Kim and colleagues (2016) found in their database survey on A-FOs that perceived productivity is related to interaction with colleagues, office layout, personalization of workspace, and storage space for belongings. According to a survey
with factor analyses and an experiment study, lack of privacy and increased noise levels are key sources of dissatisfaction in A-FOs (Morrison & Macky, 2017) and reduce performance in open-plan offices (Jahncke & Halin, 2012).

Other factors related to healthy workplaces, satisfaction and performance are, according to books on office design, the provision of good ambient conditions such as access to natural light, good ventilation, furniture and temperature (Sundstrom & Sundstrom, 1986; Toivanen, 2015). In open-plan offices, which the A-FO resemble in terms of openness of main working environment, lowered satisfaction with ambient conditions comprising lighting, noise, temperature and ventilation, was found when compared with cell offices in a database study (Kim & de Dear, 2013). Database and large survey studies on ambient conditions in A-FO give mixed results on air flow, temperature and lighting (de Been et al., 2015; Kim et al., 2016).

Other variables associated with work environment satisfaction of A-FOs are organizational preconditions such as office type prior relocation, internal organizational context, and work tasks and activities (de Been et al., 2015; Riratanaphong & van der Voordt, 2012; Wohlers & Hertel, 2016). Employees relocating from open-plan offices to A-FOs are suggested to be more accustomed to the open character of A-FOs (Riratanaphong & van der Voordt, 2012). Further, organizations with hierarchical or bureaucratic structures are suggested to be less suited for A-FOs (Wohlers & Hertel, 2016). Also activities may differ in terms of duration, frequency and importance (Tabak, 2008). Secrecy tasks and handling confidential information are suggested to obstruct the implementation of A-FOs (SKL, 2014). The way office type prior to relocation, organizational context, and nature of work are associated with satisfaction with A-FOs needs more research (Morrison & Macky, 2017; Wohlers & Hertel, 2016). In summary, there is a wide range of possible influencers related to work environment satisfaction and perceived performance in A-FOs, and the findings thus far have been inconsistent.

2.7 Summary

With the A-FO concept new work environments and organization of work are introduced. However, only a limited amount of studies specify both variety in settings and non-territorial desk-sharing. Workspace features such as layout, desk-sharing ratios, interior design, and the application of rules varies from one organization to another. Yet, office plan layouts or specifications of spaces are seldom provided in descriptions of A-FO research. Moreover, whether employees actually adapt to flexible working is seldom specified. Despite concept variations, flexible office concepts are clustered in large surveys and databases, and compared to other office types. Hence, research is scarce and results are inconsistent whether the A-FO achieve the intended benefits around improving work conditions such as autonomy, mental working conditions, privacy and communication, as well as satisfaction and performance.

A tendency of applying a general concept solution without prosecuting a comprehensive design process has been found. There is little published support for guiding systematic and work environment focused A-FO implementations, and work environment specialists are not seen as natural partners in workplace design processes. To contribute with knowledge and improved understanding of the relationship between design process factors, organizational preconditions, workspace solutions, usage solutions and work conditions of A-FOs are important for supporting systematic creation of satisfactory and productive A-FO work environments.
‘In general it has improved. However the cohesion between two individuals can have decreased since you don’t sit together as often as before.’

– Case 2, Interviewee 32
**Aim**

The **overall aim** of this thesis is to explore and investigate perceptions of workspace, work conditions, work environment satisfaction, and perceived performance in A-FOs, and explore and investigate associations with underlying factors.

The sub-aims are:

1. To explore work environment satisfaction and perceived performance in A-FOs, and changes in perceptions of workspaces and work conditions following relocation from open-plan based offices.

   The research started with an explorative phase according to sub-aim 1. During that phase, sub-aims 2-5 evolved:

2. To identify design and implementation processes factors and investigate their associations with work environment satisfaction and perceived performance, including suggestions of methods that can facilitate the process.

3. To investigate the alignment of workspace factors and perceptions of work conditions, work environment satisfaction and perceived performance.

4. To identify rules and policies, and explore compliance with rules and their possible influence on perceptions of work conditions.

5. To investigate organizational preconditions that correlate with preference for A-FOs.
The thesis is based on six studies (papers) and five cases. The studies’ contribution of respective research questions is presented in Table 1.

Table 1:  The studies contributions to the sub-aims of the thesis.

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<td>5 – Organizational preconditions</td>
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3.1 Delimitations
The results are not based on profit or productivity, but perceived performance. Organisations’ adoption of office designs that incorporate less enclosed, more open, workspaces are related to cost savings (Brennan et al., 2002). However, there is limited information about the extent of profit compared with the costs of office designs that incorporate more enclosed workspaces (Brill, Weidemann, & Associates, 2001). Quantities and qualities of knowledge workers are challenging to compare across cases from various sectors and there can be a wide range of reasons for output variations, extending beyond impacts from relocation to the A-FO. Today, there is no universal measure of output due to context specific quality and quantity (Davenport, 2005). Hence, the output in this thesis is focused on performance, rather than productivity. Examples of objective performance measures (i.e. productivity measures), are quantifiable output measures and absenteeism. None of the cases in my thesis could, however, provide any objective performance measures.

To limit the scope, the thesis will not focus on office location but rather the associations of office’s and office’s use with work conditions, performance and satisfaction. Physical work conditions, such as walking time and sitting patterns has been elaborated on in a recent study (Hallman, Mathiassen, & Jahncke, 2017) and will not be further studied in this thesis. Focus does not include mechanisms behind medical effects on humans (e.g. how chemicals and working postures affect human occupants in an office). Moreover, although IT-systems for knowledge workers (e.g. computers, intranets and printers) are important for A-FOs to work, this thesis does not focus on specific IT solutions and IT use in A-FOs. A final delimitation within this thesis centers on leadership which is recognized as an important factor in change management within the literature (Kotter, 1995). However, as leadership by itself represents such a large body of research it was not included in the outset of this thesis.
‘Nothing was left to chance. As a company, they took the process very seriously.’

– Case 2, Interviewee 42
Theoretical framework
In order to understand how factors in A-FO contexts relate to each other and their associations with overall satisfaction and perceived performance, a transdisciplinary and applied comprehensive perspective was used with human factors and ergonomics as an umbrella discipline. Within the ergonomics discipline there is an extensive amount of ergonomics and human factors models and methods (Karltun et al., 2017) such as socio-technical systems perspectives and HTO-models (Human, Technology, Organization). The theoretical framework is further based on change theories, and job demand-resource theory found in the psychology field.

4.1 Ergonomics
Ergonomics evolved with the purpose to prevent injuries and accidents by design (Helander, 2005). The term ergonomics originates from the Greek words “ergo” meaning work and “nomos” meaning rules (MacLeod, 1998). Human Factors is the equivalent term previously used in North America (Wilson & Corlett, 1995). According to the IEA International Ergonomics Association (2018):

*Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data, and other methods to design in order to optimize human well-being and overall system performance*

Hence, ergonomics has dual and combined purposes: benefits for the individual such as health and wellbeing, as well as benefits for the organization such as company performance (Eklund, 2003). Moreover, ergonomics is an applied science that focuses on designing work systems to fit people, in contrast to for example industrial and organizational psychology which focuses on selecting people to fit work systems (Hendrick & Kleiner, 2016). Hence ergonomics means adapting the system, i.e. work environment, to fit human physiological, psychological and social preconditions (Bohgard, 2008).

4.2 The physical and psychosocial work environment
According to the World Health Organization work environment is an umbrella term for biological, medical, psychological, social and technical factors in the work
situation or the surrounding conditions in the workplace that affect the employee (Arbetsgivarverket, 2018). A distinction is commonly made between (1) physical work environment, including ambient factors and working postures, and (2) psychosocial work environment including relations between workers, and workers and management (Zanderin, 2005).

The physical work environment, or physical setting, can be divided into space configuration (i.e. plan layout), physical ambiance, and interior design (Porras & Robertson, 1992). The plan layout concerns the shape and amount of space and relative locations, including openness of space (Porras & Robertson, 1992). The physical ambience regards quantity and quality of ambience such as lighting, temperature, sound and air (Porras & Robertson, 1992). The Swedish work environment law (1977:1160, §4) calls on the workplace to be designed with satisfactory ambient factors. The interior design regards the quality, design and style of furniture, decorations, walls, ceilings and floors (Porras & Robertson, 1992).

The term psychosocial refers to how humans develop and form in interaction with their surroundings (Thylefors, 2008). The AFS 2015:4 Organisational and social work environment (The Swedish Work Environment Authority, 2015) stresses the employer’s responsibility for providing a good organizational and social work environment. One of the most central models for the psychosocial work environment is the job demands-resource (JD-R) model (Bakker & Demerouti, 2007). According to the model work conditions can be divided into job resources and job demands. Job resources and demands can be psychological, social, organizational and physical aspects of the job. Job demands referes to aspects that require costs in terms of sustained physical, cognitite and/or emotional skills or efforts (Bakker & Demerouti, 2007). Job resources refer to aspects that are functional in achieveing work goals, reduces physiological and psychological costs and job demands, and stimulate personal learning and development (Bakker & Demerouti, 2007). Examples of job resources are autonomy, collegial support and feedback. The job resources acts as a buffer for preventing strain when job demands are high (Bakker & Demerouti, 2007). The model suggests that when job demands are high and job resources are limited, job strain develops. Moreover, it suggests that if job resources are high, work engagement will be high, irrespective whether job demands are high or low.

4.3 The socio-technical systems perspective
4.3.1 Socio-technical systems compositions

The ergonomics discipline has to a great extent included the socio-technical systems theory (Karltn, Karltn, Berglund, & Eklund, 2017). The sociotechnical systems perspective was developed in the 1940s and 1950s in the United Kingdom by Trist and Bamforth (Hendrick and Kleiner, 2016) and concerns optimization of a work system’s performance by transforming the interdependent technological and personnel sub-systems. A more comprehensive version of the sociotechnical system used today is comprised of four interdependent parts: (1) the technological, (2) the personnel, (3) the organizational, and (4) the external environment sub-systems (Hendrick, 2007; Hendrick & Kleiner, 2016). Another similar version of the sociotechnical system theory with focus on organizational development is presented by Porras and Robertson in 1992 (Figure 1). The model presents four categories: (1) organizing arrangements (formal organizational elements such as structure and policies), (2) social factors (individual and group characteristics such as culture and management style), (3) physical settings (such as plan layout and physical ambience), and (4) technology
(factors that transforms organizational inputs to outputs, such as tools, IT, job flow and job design). Porras and Robertson (1992) define the work setting as the environment in which people work and which determines people’s actions. For a social system to work it must attain the goals of the organization, adapt to the environment, integrate the activities of the people (e.g. resolution of conflicts), and occupy essential roles in the organization (Cherns, 1976). These functions are requirements for the social system to survive and will be met whether or not they are designed for (Cherns, 1976).

Figure 1: Model of the sociotechnical system in organizational development by Porras and Robertson (1992).

4.3.2 The A-FO from a sociotechnical systems perspective
A-FOs are sociotechnical systems comprised of the sub-systems presented by Hendrick, 2007. The A-FO provides different work environments (environmental sub-system), provides rules to abolish desk assignment (organizational sub-system), provides advanced IT developments (technological sub-system), and lets the employee choose, depending on the work activity and personal preferences (personnel sub-system), where and how to work. The “how” in this case is referred to as in group or in isolation, having formal or informal meetings, by sharing screens, conducting side-by-side work or using skype etc. In other words, the A-FO can support employees with different work flow types: employees can sit together to contribute and be supported by each other, and they can also perform tasks in isolation and contribute in a sequential or reciprocal work flow. The flexibility of work flow design in the A-FO is intended to decrease lead times in information exchange and increase efficiency in performance of activities (Morrison & Macky, 2017). The abolishment of assigned desks in A-FOs is intended to increase the dynamics of the work flow and information exchange, and decrease lead times across units and departments. From a sociotechnical systems perspective, the introduction of A-FO contexts and flexible work involves fundamental changes in each of the sub-systems as well as the interaction between the sub-systems.

4.3.3 Participation
At the core of the principles of the sociotechnical systems perspective is participation and open interaction between employees and groups (Smith & Sainfort, 1989).
Management, being ultimately responsible for the work environment, are dependent on employee participation in order to make the best decisions (Gustavsen, 2011). It has even been claimed that all employees must participate for advantages to be achieved (Nielsen and Randall, 2013). The Work environment law (1977:1160) highlights that the employee shall be given the opportunity to participate in the design and development of his/her work and work situation. Active involvement of employees and other stakeholders in workplace design reveals latent needs of the organization (Horgen, 1999) and promotes health goals (Kuorinka & Patry, 1995).

However, design processes entail conflicts (Cherns, 1987) as it activates different perspectives, needs, interests, expectations, feelings and perceptions of reality (Cherns, 1987; Jacobsen, 2013) from employees and other stakeholders. Moreover, the language differs between employees and design professionals such as engineers and architects (Garrigou et al., 1995). The process often involves power struggles, non-reliable information, lack of motivation and competence, and refusals (Garrigou et al., 1995). Cherns (1987) states that everyone cannot be satisfied. For cooperation and compatibility of participants to take place a level of mutual trust must exist (Gustavsen, 2011) and principles and values with respect for individual differences must be applied (Cherns, 1987). For change to take place employees and other stakeholders must have the same objective and reach decisions by consensus, not by negotiation and power struggles (Cherns, 1987).

4.4 Work activity

The sociotechnical systems approach has integrated organizational design and job design perspectives (Smith & Sainfort, 1989). Regarding job design, Daniellou (2005) distinguishes between tasks and activities through what needs to be done (tasks) and what workers really do (activities). Besides performing tasks, employees take part in a number of other activities such as partaking in social relationships (Daniellou, 2005). Similar to the personnel sub-system in the sociotechnical systems theory, Daniellou (2005) stresses that human activity cannot be explained without also considering interactional, social and cultural factors.

The core of the A-FO design is, as the name implies, the human work activity. The focus on the activity, being the core of all tasks in organizations, to produce added value of the system (Karltun et al., 2017) is evident in the A-FO design. For example, the environment should be designed for work activities conducted by employees and employees should choose environment depending on the work activity (Appel-Meulenbroek et al., 2011). The human work activity is the primary focus of analyses in the HTO model by Eklund (2003) and Karltun et al. (2017). The acronym stands for Humans, Technology and Organization (Rollenhagen, 1995). The HTO concept was coined during the 1980’s in Swedish nuclear power industry in order to reduce risk of accidents and improve safety (Eklund, 2003). Several examples of the HTO concept also include the environment dimension (Eklund, 2003; Hägström & Lindroos, 2016). The HTO model provides an intersectional perspective of A-FO dimensions: the multifaceted work environments, portable and flexible technology, and flexible organization provided in order to support a variation of human work activities. The environmental preferences for each individual (the ‘H’) when choosing workplace is also central in the A-FO concept (e.g. temperature, lighting, social interactions).
4.5 Change of sociotechnical systems
Relocation to a new workplace is a major change (Scott & Jaffe, 1988) affecting all parts of the sociotechnical sub-systems and their interaction. Implementing A-FOS involve technological change (which will not be discussed further), organizational and personnel change (ways of working), and environmental change (workplace development). Organizations are social systems comprised of groups of humans that are under constant change (Jacobsen, 2013). Since organizations comprise of individuals, motivation to learn and change of individual actions are required for planned organizational change to occur (Burnes, 2004b; Damschroder et al., 2009; Jacobsen, 2013; Porras & Robertson, 1992).

4.5.1 Change of the Organizational Sub-system
In general, organizations seek stability and predictability in order to refine and reproduce actions and establish rules in turn to increase productivity, efficiency and a sense of security and belonging (Jacobsen, 2013). Hence, change is an interference which requires a felt need or urgency to take place (Burnes, 2004b; Damschroder et al., 2009; Jacobsen, 2013; Kotter, 1995; Nielsen & Randall, 2013). Motives for organizational change or interventions can be to (1) reach new goals or solve a problem, (2) organic growth of organizations, (3) competition for resources, (4) power struggles and conflicts in interests, and (5) coincidences (Jacobsen, 2013; Nielsen & Randall, 2013; van de Ven & Poole, 1995). A vision should be created and communicated that guides the organizational change (Kotter, 1995). The vision comprises of core values, purpose and mission of the organization, and a description of the mission (Porras & Robertson, 1992). The vision for organizational change is highlighted in the model (Figure 1) by Porras and Robertson (1992).

Rules and procedures are common mechanisms being designed in work systems to influence coordination and control among the sociotechnical sub-systems (Hendrick & Kleiner, 2016). Policies consist of formal rules that are made up in advance that outlines methods so that employees can adopt correct behavior when executing an activity (Porras & Robertson, 1992). They describe how a system should be working (Porras & Robertson, 1992). Organizational policies, practices and norms need to be changed in order to create change of individual actions (Burnes, 2004b).

4.5.2 Change of the Environment Sub-system
The greatest opportunity for employees and management to work proactively and transform and influence the work environment to the lowest costs (Figure 2) is in the design stage of new work places and work systems (Broberg, Hermund, Broberg, & Hermund, 2007; Eklund & Daniellou, 1991). The workplace design process (construction planning and management) is divided into product specification, production and product use (Hansson, Olander, Landin, Aulin, & Persson, 2015). The product specification phase regards whether a change is needed, investigation of types of needs, budget and timeline (Hansson et al., 2015; Jacobsen, 2013). The production stage regards development of an idea by specifying the needs and convert them into functional requirements so that they are manageable by actors involved in the construction process (Hansson et al., 2015; Jacobsen, 2013). Thus, the desired product is decided, although details are specified later on in the process (Hansson et al., 2015). Responsibility, payment and contract plan is decided, based on chosen contract type. Next is the design stage where different configurations are studied, and architectural drawing of plan layouts are delivered. Production may start before the product specification stage is finished. In the production stage production adjustments are
made to the design and design details are set (Hansson, 2015). The final stage involves product use and evaluation (Hansson et al., 2015; Jacobsen, 2013).

The design process is complex and involves iterations (Damschroder et al., 2009; Garrigou et al., 1995). Organizations have limited experience of designing new buildings since they rarely relocate. The complexity may cause work environmental aspects to be forgotten. Moreover, decisions are at times (necessarily) taken early in the process without complete background information (Horgen, 1999). Decisions made early in the process will incuse and permeate the rest of the process, and the finished product (Figure 2) (Hansson et al., 2015; Schein, 2004). If previous stages have not been completely executed this may lead to dissolving of decisions (Horgen et al., 1999) in order to progressively balance economy, time and function. Often this leads to uncertainties, extra orders, changes that demand re-design, delays, poor results and extra costs (Hansson et al., 2015). Cherns (1987), recommends specifications of tasks, allocation of tasks to jobs and roles, and methods to obtain objectives to be as limited to the absolutely essential (Cherns, 1987). The more specifications, the more options are closed (Cherns, 1987).

A work system perspective used for workplace design or redesign (Figure 3) is presented by Horgen and colleagues (1999). In the SOFT-model the design is influenced and comprised by four arrangements: the spatial, the organizational, the financial and the technological dimension. In contrast to the other socio-technical systems theories (section 4.3.1), this model stresses the financial dimension. Finance can be interpreted in two different ways: as performance of the work system, such as productivity, absenteeism, and accidents, but also as the monetary boundaries of the workspace design project. The four elements have impact on the daily work and work environment, and are interdependent. Even though merely one of the elements triggers a workspace redesign, the other elements will be affected. The model also highlights common division of professional responsibilities: architect (space), management (organization), the economic department (finance), and the IT support (technology). These professions have different values, professional language and frameworks (Horgen et al, 1999). However, none of them are as specialized as work environment professionals on the interaction between employees and the work environment.
Work environment practitioners, such as ergonomists, have been suggested as facilitators and process leaders for participatory workplace changes (Broberg & Hermund, 2004; Broberg et al., 2007; Garrigou et al., 1995; Kuorinka & Patry, 1995; Seim & Broberg, 2010; Seim, Broberg, & Andersen, 2014). Work environment practitioners pursue a work environment agenda (Broberg & Hermund, 2004), have shown the ability to help in translating languages between stakeholders, uncover employees’ subconscious strategies (Garrigou et al., 1995), mobilizing different types of contextual knowledge, and give advice in processes (Broberg & Hermund, 2004).

4.5.3 Change of the Personnel Sub-system
The human, or personnel sub-system refers to workers’ professional and psychosocial characteristics (Hendrick, 2007). Workplace and organizational designs influence employees’ goals, motivation and wellbeing at work (Smith & Sainfort, 1989). Change of work systems, such as implementing new ways of working, must take place at the group and individual personnel level to be effective (Burnes, 2004b; Hendrick, 2007). For sustainment of changes of individual actions, group norms and routines need to be transformed (Burnes, 2004b). Moreover, to create change a transition period is needed to leave the old ways and create a new culture (Kotter, 1995; Scott & Jaffe, 1988). Employees need to get engaged in a process in order to commit to the change of their actions (Burnes, 2004b).

4.6 Process evaluation
Relocations to A-FOs comprise multiple interacting components (as stressed in section 4.3-4.5). Implementation failures of interventions can either be due to design weaknesses (e.g. workplace design weaknesses), implementation weaknesses or contextual circumstances (Moore et al., 2015). Process evaluations can investigate whether the intervention is delivered as intended, adapted according to the context and reaches the intended audience (Moore et al., 2015; Nielsen & Randall, 2013). A model for evaluating organization-level interventions is presented by Nielsen & Randall (2013). Central aspects in this model are drivers of change, participation,
management and consultant roles, and communication and information (Nielsen & Randall, 2013). Further, the context may act as a barrier of facilitator to its implementation (Moore et al., 2015). An intervention may have different outcomes due to contextual factors even though the implementation process is replicated (Moore et al., 2015). The aim of process evaluation can be to provide feedback for improving interventions, replicate interventions with fewer mistakes, interpret the outcomes of the interventions, and conclude on transferability of intervention studies (Moore et al., 2015; Nielsen & Randall, 2013).

4.7 A-FO models
There are three office models, including A-FOs as office concepts, which links office variables to satisfaction and performance. In all three models, satisfaction and performance are short or long-term outcomes of a large number of factors. Most factors are found in two, but few are included in all three models. Only one of them includes the design and implementation processes and none of them specifically addresses policies and rules.

The model of de Croon and colleagues (2005) starts with differentiating office concepts. Office location, layout and use are features that determine the office concept. The office concept features affect work conditions such as cognitive workload, communication, privacy, autonomy and interpersonal relations. The office concept and the work conditions are linked to short-term reactions such as job satisfaction, which in turn is linked to long-term reactions such as health and performance. Next, the model of Wohlers and Hertel (2016) introduces A-FO features (e.g. openness of main work environment, desk-sharing and ICT) that affect work conditions (e.g. territoriality, privacy, autonomy and proximity), which in turn affect short (e.g. strain and ownership) and long-term work-related consequences (e.g. performance and satisfaction). Besides the A-FO features there are task-related, person-related and organization-related moderators. In the model of Rirathadanaphong and van der Voordt (2012) the office concept is but one factor incorporated in “place before change”. Satisfaction and performance are the effects of the combination of place prior to change, the implementation process, and place after change. Moderating factors both prior and after change are people, processes, preconditions and external context.

4.8 Summary
This thesis is based upon the ergonomic framework as A-FOs are systems comprised of humans and other elements such as the physical setting. Other reasons are that the ergonomics framework concerns both understanding the connections of and designing the elements in this system, and aims at obtaining human well-being and system performance. It is increasingly apparent that the work environment correlates with performance (e.g. Sundstrom & Sundstrom, 1986) and well-being at work (Haapakangas et al., 2018).

The entire work system needs to be well designed for optimal performance (Carayon et al., 2006). Ergonomics is a transdisciplinary scientific discipline with a holistic view which is needed in work systems design such as A-FO design. Focus in ergonomics systems’ perspectives (just like any system perspective) are on the interaction between the systems’ components (Hendrick, 2007; Wilson, 2014). The introduction of A-FO contexts and flexible work involves fundamental changes in the environmental, organizational, technological, and personnel sub-systems as well as the interaction between the sub-systems.
The design processes of A-FOs are complex. Change of work systems must involve employees to be effective but employees are deeply attached to their ways of working (Scott & Jaffe, 1988). Psychological safety from loss and humiliation needs to be created for acceptance of new actions (Burnes, 2004b). Besides employees, the design process have a number of other stakeholders with different responsibilities and interests. The process involves analysis of the situation, identifying alternative solutions, and choosing the best fit. Three models are presented including a large number of factors influencing satisfaction and performance in A-FOs. The design process is rarely mentioned in these models and none of them addresses policies and rules specifically.
‘One is not left with a bad workstation. Instead, I can choose where to sit.’

— Case 3, Interviewee 5
Methods

5.1 Research approach

Ergonomics as a research discipline is an applied science, and calls for a pragmatic paradigm. The pragmatic paradigm is a practical and applied research philosophy where the research question is of primary importance and should guide methodological choices (Creswell & Plano Clark, 2018). The overall aim of this thesis is to explore and investigate perceptions of work conditions, work environment satisfaction, and perceived performance in A-FOs, and associations with underlying factors. To explore means to search, learn about and discover (Cambridge University Press [Def. 1], 2018) in order to solve an ambiguous or unstated problem (Miles and Huberman, 1994). To investigate means to examine something carefully to discover the truth (Cambridge University Press [Def. 2], 2018). An implicit aim of this thesis is to contribute with knowledge that facilitates the design, and the design process of A-FOs. Both the explicit and implicit aims have a problem centered, pragmatic approach which has guided the methodological choices of this thesis. Moreover, the pragmatic paradigm in contrast to post positivism and constructivism, which are associated with quantitative and qualitative approaches respectively, values both quantitative and qualitative knowledge. The sub-aim of the thesis includes to identify factors, which means to recognize or be able to name something (Cambridge University Press [Def. 3], 2018). The explorative, investigating and identifying aims calls for a mixed method approach.

5.2 Study design

The study design comprised longitudinal single-case and cross-case approaches, as well as syntheses/conceptualization (Table 2).

<table>
<thead>
<tr>
<th>Study design</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-case study</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Cross-case study</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Synthesis</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
5.2.1 Longitudinal single-cases

The initial Studies (I-II) used a single-case longitudinal study design in order to explore (1) design and implementation processes and (2) perceived change in work conditions, work environment satisfaction and perceived performance after relocation from other open-plan based offices to A-FOs (open-plan based offices refers in this thesis to offices where the majority of the employees occupied open-plan offices and a minority occupied cell offices or shared offices). The case study is appropriate research strategy for contemporary research (Yin, 2003) to collect detailed information (Merriam, 2009) by asking questions focusing on “how” and “why” (Miles & Huberman, 1994; Yin, 2003). As for A-FOs being real life contexts, case studies are recommended when boundaries between a real-life context and phenomenon are not clearly evident (Yin, 2013). By its nature longitudinal study approaches allow assessment of the relationship between two variables over time (Howitt & Cramer, 2011). The longitudinal studies in this thesis comprised of two repeated measures (Table 7); the first baseline measurements were taken from participants three and 45 months prior to their relocation from open-plan based offices, with one follow-up measurement two and nine months after relocation in A-FO settings. Study II describes a case study that comprised five data collection periods and an intervention period (Figure 4), which are compared and described in a conference paper by Rolfö, Eliasson and Eklund (2017). However, only one data collection period prior, and one data collection period post relocation of this case are included in this thesis.

5.2.2 Cross-cases

The subsequent Studies (III-V) applied a cross-case approach in order to compare factors and associations with work environment satisfaction, perceived performance and preference for the A-FO (identified in the previous case studies). As pointed out by Miles and Huberman (1994), the cross-case analyses can deepen the understanding of a phenomenon in similar settings, and investigate whether findings of single case studies makes sense beyond the specific case. The factors identified in the single-case studies that needed cross-validation were (1) the design process, (2) the workspace, (3) the application of rules, and (4) organizational preconditions such as work tasks.

5.2.3 Syntheses

In order to integrate the contributions of each paper and making the whole greater than the sum of its parts, the thesis work was inspired by strawberry analysis (Presthus & Bygstad, 2014) and Carney’s Ladder of Analytical Abstraction (Miles & Huberman, 1994). The thesis work was completed with syntheses of frameworks. Based on the empirical research Studies (I-V), literature searches on methods and interventions, and organizational, sociotechnical, ergonomic and office theories, two frameworks were developed; (1) a general conceptual model with process factors, organizational factors, workspace parameters, work conditions and overall outcomes in A-FOs, and (2) a methods framework to facilitate the design and implementation processes of offices. The methods framework was evaluated by work environment professionals during course evaluations (study VI).
Table 3: The Studies’ contribution and included cases to the research sub-aims of the thesis. The Studies with black text are the main studies for answering the research question. The Studies with grey text partly covers the research questions. Sub-aim I is explored in three Studies (I, II and V). Study I explores Case 1. Study II explores Case 2. Both cases explore changes in perceptions following relocation. Study V explores differences in work environment satisfaction between cases 1-4 and 6-12 in terms of preference for the A-FO. Sub-aim 2 identifies process factors in three Studies (II, IV and VI). Study II identifies process factors in Case 2. Study IV compares five central process factors between cases 1-3 and 5. A more detailed description of case 2’s process are found in a conference paper by Rolfö, Eliasson and Eklund (2017). Study VI suggests methods that can facilitate the process, which are used in a course for work environment professionals. For sub-aim 3, Study III investigated workspace factors in cases 1-4. For sub-aim 4, Study IV investigates rules in cases 1-3 and 5. For sub-aim 5 all cases apart from case 4 were investigated on organizational preconditions.

<table>
<thead>
<tr>
<th>Sub-aims</th>
<th>Case Organizations/Research subjects</th>
<th>Participants in course</th>
</tr>
</thead>
<tbody>
<tr>
<td>To explore work environment satisfaction and perceived performance in A-FOs, and <strong>changes in perceptions</strong> of workspaces and work conditions following relocation from open-plan based offices.</td>
<td>I &amp; V II &amp; V V V V</td>
<td></td>
</tr>
<tr>
<td>To identify design and implementation <strong>processes factors</strong> and investigate their associations with work environment satisfaction and perceived performance, including suggestions of <strong>methods</strong> that can facilitate the process.</td>
<td>IV II &amp; IV IV IV</td>
<td>VI</td>
</tr>
<tr>
<td>To investigate the alignment of <strong>workspace factors</strong> and perceptions of work conditions, work environment satisfaction and perceived performance.</td>
<td>III III III III</td>
<td></td>
</tr>
<tr>
<td>To identify <strong>rules and policies</strong>, explore compliance with rules and their possible influence on perceptions of work conditions.</td>
<td>IV IV IV IV</td>
<td></td>
</tr>
<tr>
<td>To investigate <strong>organizational preconditions</strong> that correlate with preference for A-FOs.</td>
<td>V V V V V</td>
<td></td>
</tr>
</tbody>
</table>
5.3 Cases

The target population was all A-FO occupiers in Sweden. The thesis’ five first studies (Studies I-V) constitute five separate case studies drawn from twelve organizations (C1-12) with a total of 792 A-FO occupiers. The Studies’ contribution to the sub-aims of the thesis and cases included in the different studies are shown in Table 3. The cases differ in organization type (public, municipality, private and non-profitable organization), organization size (12-226) and gender proportions (Table 4). Most of the studies in this thesis are, however, based on a sample of five Swedish organizations shown in Table 5 with a total of 184 A-FO occupiers (response rate 0.86%). Case 1 was a private insurance company relocating two departments with 79 employees and approximately 20 consultants. Case 2 was a private IT service and support provider relocating all employees to a new building (approx. 50 employees). Case 3 was a non-profitable health and safety knowledge and training provider with 40 employees. Case 4 was a private IT, telecom and technique consulting provider relocating approximately 160 employees and Case 5 was a private company in a science park with 13 employees. All cases had either recently relocated to a single floor A-FO or anticipated a relocation to a single floor A-FO in the near future.

For the first single-case study (Study I), case 1 (C1) was chosen because their employees had completed a questionnaire of perceptions of their current office type (an open-plan office) 45 months earlier, which enabled a comparison over time. Moreover, the case was chosen for being typical (cf. Denscombe, 2014) in the sense that the company’s premises were perceived as overcrowded and located in a city. A redesign of the premises were perceived as a better option than to relocate to a less central location. Hence the company strived towards higher space efficiency. In addition, the company’s ambition according to their internal assessment document, aimed to modernize its ways of working and encourage interaction, as commonly described as objectives for A-FO implementations.

For Study II, C2 was chosen for being far from typical in a positive sense and thus could be learnt from. An atypical case can be chosen for studying contrasts with the norm (Denscombe, 2014). C2 had high ambitions and strived towards winning the competition Great place to work® Sverige [Sweden] based on employee evaluations (after relocation the case in Study II was ranked number 5 in the Great place to work® Sverige [Sweden] competition for small organizations). Moreover, after relocation they doubled their revenue with retained profitability within two years (Undfors, 2017). The company’s main aim was not to save space and cut costs. Moreover, they involved the employees and researchers before deciding on office type. Hence the early phases of the design process could be studied.

For two of the cross-case comparisons (Studies III-IV), cases 3-5 were chosen as they gave a mix of organization sizes, professions and work tasks (Table 5). C1 and C4 were large organizations with more than 250 employees, however only parts relocated to A-FOs. C2 grew to over 50 employees during the study period, hence became a medium sized organization. C3 and C5 were small organizations. Information and communication technology (ICT) and ICT development work dominated and most employees performed only digital work (apart from C1 where paper work occurred frequently). C1-5 allowed working away from the office except C3. The cases rebuilt a floor in their own facility (C1), a floor in another facility (C3, C4), relocated to a part of a new facility (C5), or created a whole new facility (C2). Observe that when reading
Table 4: Case demographics for the 12 case organizations included in thesis. All cases but C5 were part of Study V. Studies I-IV were based on C1-5. Quest. distrb refers to the number of months after relocation the investigations take place.

<table>
<thead>
<tr>
<th>Case</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
<th>C6</th>
<th>C7</th>
<th>C8</th>
<th>C9</th>
<th>C10</th>
<th>C11</th>
<th>C12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organization type</td>
<td>Private</td>
<td>Private</td>
<td>Non-prof</td>
<td>Private</td>
<td>Private</td>
<td>Private</td>
<td>Municipality</td>
<td>Municipality</td>
<td>Public</td>
<td>Public</td>
<td>Public</td>
<td>Public</td>
</tr>
<tr>
<td>Quest. distrb. (months)</td>
<td>3</td>
<td>9</td>
<td>2</td>
<td>6</td>
<td>2</td>
<td>6</td>
<td>18</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Company size at office</td>
<td>100</td>
<td>50</td>
<td>40</td>
<td>160</td>
<td>13</td>
<td>65</td>
<td>179</td>
<td>158</td>
<td>144</td>
<td>98</td>
<td>46</td>
<td>226</td>
</tr>
<tr>
<td>Questionnaire invitations</td>
<td>79</td>
<td>50</td>
<td>40</td>
<td>33</td>
<td>N/A</td>
<td>65</td>
<td>179</td>
<td>158</td>
<td>144</td>
<td>98</td>
<td>46</td>
<td>226</td>
</tr>
<tr>
<td>Respondents</td>
<td>66</td>
<td>46</td>
<td>36</td>
<td>24</td>
<td>12*</td>
<td>40</td>
<td>152</td>
<td>91</td>
<td>85</td>
<td>57</td>
<td>35</td>
<td>148</td>
</tr>
<tr>
<td>Females/Males</td>
<td>32/34</td>
<td>6/40</td>
<td>28/8</td>
<td>17/7</td>
<td>7/5</td>
<td>23/17</td>
<td>50/102</td>
<td>71/20</td>
<td>25/60</td>
<td>23/34</td>
<td>24/11</td>
<td>67/81</td>
</tr>
<tr>
<td>Response rate</td>
<td>84%</td>
<td>92%</td>
<td>90%</td>
<td>73%</td>
<td>N/A</td>
<td>58%</td>
<td>85%</td>
<td>58%</td>
<td>64%</td>
<td>60%</td>
<td>76%</td>
<td>66%</td>
</tr>
</tbody>
</table>

* Interviews

Table 5: Case demographics for the 5 cases studied in-depth with type of company, professions, number of employees relocated and office type before relocation.

<table>
<thead>
<tr>
<th>Cases</th>
<th>Case 1 (C1)</th>
<th>Case 2 (C2)</th>
<th>Case 3 (C3)</th>
<th>Case 4 (C4)</th>
<th>Case 5 (C5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inclusion in studies</td>
<td>Studies I, III-V</td>
<td>Studies II-V</td>
<td>Studies III-V</td>
<td>Study III &amp; V</td>
<td>Study IV</td>
</tr>
<tr>
<td>Type of company</td>
<td>Insurance company</td>
<td>IT service and support providers</td>
<td>Health &amp; safety knowledge and training provider</td>
<td>IT, telecom &amp; technique consulting provider</td>
<td>Science park</td>
</tr>
<tr>
<td>Professions</td>
<td>Leadership</td>
<td>Leadership</td>
<td>Leadership</td>
<td>Leadership</td>
<td>Leadership</td>
</tr>
<tr>
<td></td>
<td>Administration</td>
<td>Administration</td>
<td>Administration</td>
<td>Finance</td>
<td>Administration</td>
</tr>
<tr>
<td></td>
<td>Project management</td>
<td>Project management</td>
<td>Project management</td>
<td>IT support</td>
<td>Project management</td>
</tr>
<tr>
<td></td>
<td>Consultant agents</td>
<td>In-house IT and telephone support</td>
<td>Communication</td>
<td>Sales</td>
<td>Communication</td>
</tr>
<tr>
<td></td>
<td>IT development</td>
<td>IT development</td>
<td>Educations</td>
<td>Customer service</td>
<td>Data analysts</td>
</tr>
<tr>
<td></td>
<td>Business development</td>
<td>Business development</td>
<td></td>
<td></td>
<td>Business development</td>
</tr>
<tr>
<td>No. of employees relocated</td>
<td>79 (2 units) + approx. 20 consultants</td>
<td>50 (entire company)</td>
<td>40 (entire company)</td>
<td>160 (entire company)</td>
<td>13 (entire company) + approx. 30 external stakeholders</td>
</tr>
<tr>
<td>Office type before relocation</td>
<td>Large open-plan</td>
<td>Cell offices</td>
<td>Large open-plan</td>
<td>Large Open-plan</td>
<td>Cell offices</td>
</tr>
</tbody>
</table>
paper IV, case 1 and 3 are interchanged, hence C3 in the thesis refers to C1 in the papers, and vice versa. Study VI was based, besides C1-4, on 7 additional cases (C6-12 in Table 4), chosen by other Swedish research groups. C7-8 belonged to the municipality and C9-12 belonged to the same public organization. Moreover, management granted access for data collection.

For the sample of the course (Study VI), the course was advertised towards health and safety engineers and ergonomists interested in the design and implementation processes through mass mailing from respective trade unions and an Occupation Health Services (OHS) research newsletter. All people interested in the course were included until the course was full. The participants were mainly health and safety engineers and ergonomists from OHS, but also other professions from the defense, county council, academia and construction planning.

5.4 Data collection methods

A convergent mixed methods design (cf. Creswell & Plano Clark, 2018) was used to collect and analyse quantitative and qualitative data that was merged, compared and interpreted (all apart from Study V which was based on quantitative methods) in order to add meaning to results, and cross-validate results (Nielsen & Randall, 2013). A mixed methods approach provides a more comprehensive understanding and helps answering questions that cannot be answered by one data source alone, and the limitations of one method can be offset by the strengths of the other (Creswell & Plano Clark, 2018). For example, qualitative data may supplement, validate and interpret quantitative data (Miles & Huberman, 1994). Moreover, the combination of qualitative and quantitative methods initiates new thinking, develops analysis and elaboration, and may confirm each other (Miles & Huberman, 1994).

Quantitative data is recommended when addressing clearly specified research questions and when there is good-quality theory (Howitt & Cramer, 2011). An extensive body of previous literature on other office types regarding how work environment affects work conditions, satisfaction and performance, has guided specification of quantitative data collection parameters in this thesis. In contrast, qualitative data is used to deepen the knowledge about a study context, explore, describe, spring explanations that go beyond primary conceptions and support revision of and generating new frameworks (Lantz, 2013; Miles & Huberman, 1994). Moreover, qualitative data may capture perceptions, prejudgments, and assumptions and provide convincing citations that give meaning to results (Miles & Huberman, 1994).

The quantitative data collection comprised questionnaires, interviews and observations. The large dataset of interviews (105 employees) enabled quantification of data. Quantitative data was collected in order to describe cases and compare cases in terms of frequencies, averages and distributions of questionnaire and interviewee responses as well as exploring correlations (cf. Denscombe, 2014). The qualitative data collection comprised individual interviews, documentation and observations and was collected in order to describe, explore and provide explanations for actions in and perceptions of the A-FO.
5.4.1 Questionnaires

In most of the studies questionnaires were used in order to capture changes in perceptions of the offices’ work environment and ability to compare perceptions of the outcomes between offices (Table 6). Most of the studies (Studies I-III & V) were based on the same questionnaire (Appendix A). An advantage of using questionnaires is the ability to collect large amounts of data comprised of information about peoples’ attitudes (Denscombe, 2014). The questionnaire included parameters on plan layout, acoustics, interior design, mental demands, privacy, communication, interpersonal relations, demographics, work environments satisfaction and performance parameters. The questionnaire was based on questions from (1) validated questionnaires such as Copenhagen Psychosocial Questionnaire (Pejtersen, Kristensen, Borg, & Bjorner, 2010), Ledarskap och organisering för hälsa och produktion - LOHP (Fagerlind Ståhl, 2015; Gustavsson et al., 2011) and Scale of Work Engagement and Burnout - SWEBO (Hultell & Gustavsson, 2010), (2) theses on office research (Moberg, 1997; Seddigh, 2015) and (3) other Swedish researchers’, besides (4) 13 self formulated questions. Four of the own face-validated questions were inspired by questions from the validated questionnaires. The questionnaire was face validated by seven persons. Face validity is a type of validity measurement that, based on the appearance of the items, investigates whether the scale measures what it claims to measure (Howitt & Cramer, 2011).

The questionnaire evolved during the thesis progress due to for example new research literature results. All questions were not posed to all organizations due to some project managers’ requests of reducing response time. The questionnaire sizes varied between 80-140 questions. The post-relocation questionnaires were longer as they included aspects only relevant for working in the A-FO and perceived change of different parameters from their previous office to the present office. In total, 69 questions were included in the studies (Appendix A). A mix of ratio, interval, nominal and ordinal scaled questions were included. Most response categories were on 5- and 7-point bipolar rating scales. Most ordinal response categories were Likert scales (e.g. always, often, sometimes, seldom, never) replicated from the validated questionnaires mentioned above. Comments were optional for every question.
Table 7: Specification of data collection methods including response rates for the in-depth studied cases.

<table>
<thead>
<tr>
<th>Cases</th>
<th>Case 1 (C1)</th>
<th>Case 2 (C2)</th>
<th>Case 3 (C3)</th>
<th>Case 4 (C4)</th>
<th>Case 5 (C5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time of measurement</td>
<td>Prior Post</td>
<td>Prior Post</td>
<td>Post</td>
<td>Post</td>
<td>Post</td>
</tr>
<tr>
<td>No. of workers*</td>
<td>484 (office) approx. 100 (dep)</td>
<td>44 (org) 50 (org)</td>
<td>40 (org)</td>
<td>approx.160 (office)</td>
<td>12 (org)</td>
</tr>
<tr>
<td>Questionnaires</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Months prior &amp; after move</td>
<td>~45 3</td>
<td>3 9</td>
<td>2</td>
<td>6</td>
<td>N/A</td>
</tr>
<tr>
<td>Emp. receiving quest.</td>
<td>484 79</td>
<td>44 50</td>
<td>40</td>
<td>33</td>
<td>N/A</td>
</tr>
<tr>
<td>No. of responses</td>
<td>317 66</td>
<td>38 46</td>
<td>36</td>
<td>24</td>
<td>N/A</td>
</tr>
<tr>
<td>Response rate</td>
<td>65% 84**</td>
<td>86% 92%</td>
<td>90%</td>
<td>73%</td>
<td>N/A</td>
</tr>
<tr>
<td>Interviews</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of int. (female/male)</td>
<td>26 (10/16)</td>
<td>43 (5/38)</td>
<td>24 (20/4)</td>
<td>N/A</td>
<td>12 (7/5)</td>
</tr>
<tr>
<td>Int.’ age, mean (min-max)</td>
<td>43 (31-60)</td>
<td>38 (23-61)</td>
<td>50 (37-65)</td>
<td>N/A</td>
<td>47 (27-65)</td>
</tr>
<tr>
<td>No. of months after relocation</td>
<td>3</td>
<td>9</td>
<td>2.5</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td>On-site &amp; structured</td>
<td>On-site &amp; structured</td>
<td>On-site &amp; structured</td>
<td>On-site</td>
<td>On-site &amp; structured</td>
</tr>
<tr>
<td>No. of days</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>

*C1 and C4 were large companies comprising many offices. The offices or departments relocating to A-FOs of these companies were included in this thesis. C3-5 included whole organizations.

** For C1, the response rate was 86% for the post-relocation questionnaire, out of all participants who had filled in the pre-relocation questionnaire and relocated to the A-FO.

Figure 4: Timeline for the pre- and post-relocation data collection methods.
In most studies questionnaires were distributed to all employees relocating to A-FOs (Table 7). For study III, C4 included only employees that had participated in another study. For numbers of employees receiving the questionnaire and response rates see Table 5. Management informed the employees before emails were sent out with the questionnaire. Over a two-week period the employees could fill in the questionnaires. Participation was voluntary. Confidential treatment of data was guaranteed and the responses were electronically sent directly to the researchers.

Study I was also based on an open-plan questionnaire distributed by other researchers in 2011. In Study VI a course evaluation questionnaire was used in order to evaluate the methods’ framework. A paper-based version was distributed to all course participants at the end of the course and a web-based questionnaire for a one year follow-up. The study included seven respectively three questions from the baseline and follow-up questionnaires, such as “will/have you use(d) the methods framework?” and “will/have you use(d) the methods?”

5.4.2 Interviews
Most Studies (I-IV) included semi-structured individual interviews from four of the cases (C1-C3 & C5). Interviews as a data collection method are recommended when aiming to understand motives, feelings, experiences and ways of thinking and acting (Trost, 1997). Interviews can also help in interrogating in how factors are interconnected (Denscombe, 2014). A total of 105 semi-structured individual interviews were conducted with the organizations’ employees. Interviews were chosen as data collection method in order to explore changes and compare how (1) design and implementation processes, (2) background information with position and work activities, (3) workspace and office use, and (4) strengths and weakness regarding work conditions and overall outcomes were perceived by the employees in the different cases (see interview guide, Appendix B). The interviews also enabled follow up on questionnaire results.

The interviews were conducted between 2-9 months after relocation (Table 7) to grasp results soon after relocation as well as results after longer settlement. Signing up for participation was voluntary and made through a list located in the office lounge or via the organization’s intranet. The interviews were conducted in enclosed meeting rooms at respective organizations’ premises. A few exceptions were conducted via telephone. The interviews lasted between 15-60 minutes, averaging 30 minutes. As described in literature on semi-structured interviews, a clear list of issues to be addressed was used, but the order of the issues was flexible to let the interviewee develop ideas and elaborate on topics (cf. Denscombe, 2014). Plan layouts were provided as boundary objects in the majority of the interviews (cf. Broberg, 2010).

In addition to these semi-structured employee interviews, less structured in-depth interviews were conducted with responsible process managers. As pointed out by Denscombe (2014) interviews can be chosen as data collection method to give particular insights based on key players’ position and experiences. In this thesis the interviews with the process managers aimed at deepening the knowledge on the design process, including timeline, activities and methods, stakeholder involvement
and reasons for the implementation of A-FOs. These interviews were held at the premises of the organization.

5.4.3 Documentation
Planning documents such as relocation objectives, rule documents, architectural drawings and internal project sites were collected to gain insights into design and implementation processes, documented rules, and plan layouts such as zone allocations and number of back-up spaces and meeting rooms. Documentation persists in a stable form, beyond the occasion it was created (Denscombe, 2014). Documentation is recommended to be used as evidence for something that is significant and useful (Denscombe, 2014). Architectural drawings of plan layouts can account for impact of physical characteristics of work systems (Carayon et al., 2006). Photographs were also taken in order to capture workstation occupancy and number of partition screens.

5.4.4 Observations
Observations were used as data collection method (Studies I-V) in order to follow-up on results from questionnaires, and investigate location of conversations and phone calls, workstation occupancy, and displays of nesting tendencies (e.g. territorial behaviours such as employees claiming desks within the A-FOs). Observations are used as data collection method when investigating natural contexts and what people do, rather than what they say they do (Denscombe, 2014). The observations duration varied between 1-4 workdays. They were conducted on the busiest day(s) of the week according to process managers. The observations comprised of on-site direct observations (Studies I-IV) and systematic observations (Studies I, II & IV). The on-site observations included individual observations and walkthroughs with the process managers who highlighted problems and advantages of the office areas, locations of conversations and phone calls, workstation occupancy and displays of nesting tendencies. The systematic observations included field notes and observation schedules of number of occupied, reserved and available workstations, flow of employees, and location of phone calls and conversations at approximately 30-minute intervals. Observation schedules have the benefit of specifying what and how things are to be measured, being consistent and end in quantitative data in terms of counts and frequencies (Denscombe, 2014).

5.4.5 Literature search for syntheses
Collection of data for the creation of the A-FO conceptual model and methods framework mainly consisted of literature search. For the conceptual model focusing on associations with work conditions, satisfaction and performance (Study II) the literature review in Ergonomics Abstract and Primo was based on de Croon and colleagues’ (2005) literature search, including choice of search terms in the title and/or abstract. Additional search terms that have appeared in recent years, such as Activity-based Flexible Offices, activity-based working/offices, new offices, non-territorial offices, flexible offices, flexi-desking and hot-desking were added to the search. Moreover, backward snowballing (Jalali & Wohlin, 2012) was used in Google Scholar from reference lists of the identified articles. This method was used until saturation was perceived. Furthermore, ergonomics principles, socio-technique,
work science and organizational change, on which the conceptual framework is based, were studied through courses, seminars, scientific articles, and books.

For the methods framework (Study VI) literature searches were conducted to identify design and implementation methods. Inclusion criteria were: (1) relevant for workplace design processes, and (2) easy to learn and apply for safety and health engineers and ergonomists. The framework itself was inspired by student literature on bygglekning projektering (eng. Construction management) by Hansson et al. (2015), product development, planning offices spaces (Van Meel et al., 2010), and Danish research on ergonomists’ participation in workplace change projects (eg. Broberg & Hermund, 2004; Seim & Broberg, 2010).

5.5 Data analysis

5.5.1 Questionnaire analyses

The questionnaire data was analyzed longitudinally and cross-sectionally (Table 8) in SPSS version 19.0 in order to describe distributions, changes in perceptions over time, compare perceptions between cases and explore correlations. The level of significance was set to 0.05 for all analyses. Complete or almost complete questionnaire responses were included in the data sets. Due to the mix of ratio, interval, nominal and ordinal scaled questions in the questionnaire non-parametric tests were predominantly used.

Table 8: Overview of the statistical methods and number of questions analyzed in the Studies using questionnaires. Study IV was not based on questionnaires.

<table>
<thead>
<tr>
<th>Study</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Longitudinal</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency analysis (pre- and post-relocation)</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paired Wilcoxon signed rank test</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repeated measures ANOVA (GLM) / paired T-tests (within subjects design)</td>
<td>25</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cross-sectional</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One-sample Wilcoxon signed rank test</td>
<td>12 (11 retro)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency analysis</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Chi-square test</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kruskal-Wallis pairwise comparison/ One-way ANOVA</td>
<td>30</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spearman’s coefficient of rank correlation</td>
<td>12</td>
<td></td>
<td></td>
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</tbody>
</table>

**Study I and II**: In order to explore perceptions of work conditions, work environment satisfaction and perceived performance in A-FOs, including changes in perceptions following relocation from open-plan based offices, longitudinal data analyses were performed on the single case studies (Studies I and II).

Repeated measures ANOVA/paired T-Tests with time (pre versus post) was used with a panel study design in both single case studies (Studies I & II). A panel study involves a group of matched individuals who are studied at several points using the same measures and has great potential to facilitate in revealing causality (Howitt & Cramer, 2011). Independent variables were perceptions of workspace, work conditions, work environment satisfaction and perceived performance.
Study I was complemented with retrospective studies with ordinal questions concerning perceived change with communication and performance (e.g. “Compared to before relocation is it easier or more difficult to...”). This enabled comparison of pre- and post-relocation of satisfaction with various parameters. Retrospective studies ask respondents questions from a past perspective and may be affected by the present (Howitt & Cramer, 2011). In order to investigate whether the responses on the retrospective questions were normally distributed one-sample Wilcoxon signed rank test were performed recommended for non-parametric data (M. Campbell, Machin, & Walters, 2010). This non-matched longitudinal study sample is capable of showing general changes over time, however cannot make strong claims about causality (Howitt & Cramer, 2011). Further, the post-relocation questionnaire included questions that only concerned aspects relevant for office use in the A-FOs (e.g. time finding a workstation). These data were analysed using frequency analysis.

Study II was complemented with frequency analysis and paired Wilcoxon signed rank tests for the ordinal and ratio scales. Independent variables included communication, perceived performance and work environment satisfaction. Time was set as dependent variable.

**Study III & V:** The cross-sectional studies using questionnaires (Studies III & V) were conducted in order to investigate workspace factors, organizational preconditions and work conditions in the different cases and compare the outcomes.

The frequency analyses and chi-square test comprised questions on office type preference to provide the readers with information on the employees’ general attitude towards their offices (Studies III & V), and mean percentage of working time employees spent in the office (Study III). Chi-square tests are recommended for nominal, ordinal, interval and ratio scales (Denscombe, 2014).

In Study III, to compare the independent variables of perceptions of workspace factors, work conditions, work environment satisfaction and perceived performance between the organizations (dependent variable), Kruskal-Wallis pairwise comparisons were used, with adjustment for multiple tests. For these analyses most questions comprised 7-point nominal scales, but also some 5-point ordinal scales and categorical scales (office type preference/occupancy). In Study V, to investigate whether preference for the A-FO differed between the cases, office type preference was used as independent variable and organization was used as dependent variable in an ANOVA. The ANOVA was complemented with a Kruskal-Wallis pairwise comparison in the thesis to confirm the results with a non-parametric tests.

In two of the Studies (II & VI) correlations were performed. In order to investigate correlations of employee empowerment with work environment satisfaction and perceived performance, linear regression analysis was performed in Study II. This parametric test was complemented with the non-parametric test Spearman’s coefficient of rank correlation for the thesis to confirm the results. In order to investigate whether work tasks, office type and office type preference prior to relocation correlated with preference for the A-FO after relocation, Spearman’s coefficient of rank correlation was conducted in Study VI. For Spearman’s coefficient
of rank correlation the response categories were merged into two categories (e.g. preference for the “A-FO”, and “other”).

5.5.2 Interview analyses
The interviews were initially analyzed in order to describe and explore feelings, experiences, perceived changes and ways of thinking and acting within each A-FO. Later, the interviews were analyzed in order to explore and explain phenomena by examining and specifying how factors are inter-connected by comparing across cases (cf. Miles & Huberman, 1994).

The interviews were analyzed by content analysis in the qualitative data analysis tool QSR Nvivo. A content analysis may uncover hidden aspects that is being communicated and provides a means of quantifying the content in a clear way (Denscombe, 2014). The interviews from each case were transcribed verbatim and interviewees were de-identified. Secondly the transcripts were red iteratively while coding sentences or paragraphs, identifying categories using a bottom-up approach and excluding irrelevant data for the research questions. For the cross-case analysis based on interviews (Study IV) a top-down approach, inspired by the Job Demand-Resources Model (Bakker & Demerouti, 2007), was taken to further cluster data into work condition consequences. For most interview Studies (I, II & IV) the transcripts were reviewed to quantify the results by specifying approximate or exact proportions of phenomena. Moreover, quotes were selected to exemplify the identified codes. For the cross-case analysis (Study IV), cross-case displays were created to facilitate comparison and understanding of the whole (cf. cross-case analysis in Miles & Huberman, 1994).

5.5.3 Documentation analyses
The documentation analyses comprised review of plan layouts, photographs, planning documentations (e.g. rules statements), and e-mail correspondence with design process managers in order to identify user involvement in the design and implementation processes, actions within the office and realization of rules. The plan layouts, being produced during the planning stage, were updated in some of the Studies (II & V) by comparing them to photographs and making editions in Adobe Photoshop CC. From the plan layouts information regarding zone allocations, the number of workstations, individual back-up rooms and meeting rooms were retrieved, as well as numbers of square meters in the open-plan areas, measured with a scale bar. Dividing the numbers retrieved from the plan layouts with the number of employees, retrieved from e-mail documentation and interviews with process managers, space ratios were calculated. In study III a professional evaluation was also conducted by a practicing architect specialized in office design. The evaluation comprised analysis of axes and viewpoints, room functions, communications, activity nodes, room and passage sizes and placement of staircases, entrances, windows and support facilities.

5.5.4 Observation analyses
Field notes and observation schedules used in the systematic observations were reviewed and compiled to extract the number of available, reserved and occupied workstations, and the number of conversations in different zones. Half a day of
observations were excluded as the afternoon was not representative for a normal working day.

5.5.5 Syntheses of results
With a bottom-up approach, the affinity diagram (Karsak, Sozer, & Alptekin, 2003) was used to construct categories for both syntheses. For the model with factors associations with work conditions, satisfaction and performance in A-FOs (Study II) terms from sociotechnical, macroergonomic theories, intervention, organizational change and empirical research were condensed by synonym reduction. By categorization and several iterations six subgroupings evolved.

For the methods framework, the categories were reorganized through a top-down approach after inspiration from literature (e.g. construction management). Moreover, additional subgroups were created to facilitate choice of methods. The methods framework was then duplicated and altered to be applicable for industrial alternatively office settings. Both models were evaluated by academic professionals within the ergonomics discipline for final alterations, and the methods framework also by health and safety engineers and ergonomists.

5.6 Ethical considerations
For all studies conducted for this thesis the ethical commitment included gaining informed consent of each participant, voluntary participation and withdrawal of participation at any time without stating reasons. The information was treated with confidentiality. Questionnaire results were sent directly to the researchers. The respondents were de-identified with a response number. Management at respective organizations received the results on group level in a written report where care was applied to make sure data could not be tracked to specific individuals.

The work in this thesis has been granted ethical approval by the Regional Ethical Board in Stockholm (No: 2014/1180-31). For Study I the pre-relocation evaluation was granted by the Regional Ethical Boards in Uppsala (No: 2008/77). For study V additional ethical approvals were proposed for 5 cases by other researchers and granted by the Regional Ethical Boards in Uppsala (No: 2015/118), and in Umeå (No: 2014/226-31). For two of the cases the studies did not include questions sensitive to the individual such as issues about their health.
“Before it was ‘us’ and ‘them’. But since we meet each other more often we get enhanced understanding.”

– Case 2, Interviewee 26

Photograph:
Case 2 – IT service and support providers
Architect: Enter arkitekter
Photographer: Sara Landstedt
Results

6.1 Aim 1: Perceptions of A-FOs and perceived change from open-plan based offices

In order to explore work environment satisfaction and perceived performance in A-FOs, including changes in perceptions of the workspace and work conditions following relocation from open-plan based offices, two cases (C1-2) were evaluated in two Studies (I-II) and a cross-case comparison with 11 cases was conducted in Study V (Table 3).

6.1.1 Work environment satisfaction

The exploration showed that work environment satisfaction increased in both Study I and II (Table 9). For Study I, the Wilcoxon signed rank test showed that satisfaction with the physical work environment were significantly more positive than the neutral value (p=0.013). For Study II, the frequency analysis showed that percentage of employees who were satisfied with the physical work environment increased from 54 % prior relocation to 93 % after relocation.

Study V, which compared preference for the A-FO in 11 cases with varying proportions of females and males, showed a range between 13-92 % in preference for the A-FO over other office types. The comparison included the four cases (C1-4) studied in more detail in this thesis (Table 5). These four cases were among the top five cases in Study V on proportion of employees preferring the A-FO over other office types. Interviewee responses on contributors to work environment satisfaction in both Studies I and II were a pleasant work environment being bright and new, and for Study II also the work environment being functional. The majority of the employees in Study II highlighted the design and implementation processes as an underlying factor for the office being functional and generating high work environment satisfaction.

6.1.2 Perceived performance

The exploration of perceptions of a number of performance parameters showed different results for Studies I and II. In Study I the Wilcoxon signed rank test on
Table 9: Summary of results from Study I and Study II. ↑ = increased/improved, ↓ = decreased/deteriorated. NS = Not significant

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Study I (C1)</th>
<th>Study II (C2) n=28</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satisfied with physical work environment</td>
<td>88% (sign. from neutral), n=66</td>
<td>↑ From Pre 54% to Post 93 %</td>
</tr>
<tr>
<td>Preference for the A-FO</td>
<td>↑ Pre 16%, Post 47%, n=66</td>
<td>↑ From Pre 68% to Post 82%</td>
</tr>
<tr>
<td>Perceived performance</td>
<td>NS 2/2 questions</td>
<td>↑4/4 questions p= 0.004-0.042</td>
</tr>
<tr>
<td></td>
<td>Aesthetics</td>
<td>↑ p&lt;0.001, n=34</td>
</tr>
<tr>
<td></td>
<td>Outdoor view</td>
<td>↑ p&lt;0.001, n=34</td>
</tr>
<tr>
<td></td>
<td>Air quality</td>
<td>↑ p=0.002, n=34</td>
</tr>
<tr>
<td></td>
<td>Temperature</td>
<td>↑ p&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Amount of light</td>
<td>↑ p&lt;0.005</td>
</tr>
<tr>
<td></td>
<td>Noise</td>
<td>↑ 2/3 questions p=0.03-0.039, n=34</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NS 1/3 questions, n=34</td>
</tr>
<tr>
<td></td>
<td>Possibility to privacy</td>
<td>NS, n=34</td>
</tr>
<tr>
<td></td>
<td>Communication parameters</td>
<td>NS 4/5 questions, n=66</td>
</tr>
<tr>
<td></td>
<td></td>
<td>↓ 1/5 question p=0.014, n=66</td>
</tr>
</tbody>
</table>

Results indicated that retrospective ratings showed no significant difference in perceptions of change of any performance parameters. In Study II, the Wilcoxon signed rank test showed a significant increase in self-rated intra-team productivity, intra-team cooperation and reduced distractions. Perceived productivity of individual work did not change significantly in any of the cases. Interviewee responses in Study I reported on teams being split up, while in Study II interviewees (C2) highlighted proximity to colleagues, getting a holistic view of the organization and possibility to withdraw to quiet enclosed spaces.

6.1.3 Changes in perceptions of workspaces and work conditions

The exploration of perceptions of workspaces in Studies I and II showed that satisfaction with most workspace parameters increased in A-FOs such as ambient conditions (air quality/airflow, amount of light, noise) and interior design (e.g. aesthetics, visitor space), even though all did not significantly increase (Table 9). A noticeable difference between the Studies were the satisfaction rating on possibility of privacy (possibility to retreat to private areas for conversations, phone calls or quiet, concentrated work). For Study I the mean satisfaction rating pre-and post relocation slightly decreased according to the repeated measures ANOVA [F(1,235, 21.001)=212.321, p=0.83]. For Study II, the satisfaction ratings increased significantly (p=<0.001) from pre relocation (M=0.62, SD 1.32) to post relocation (M=1.15, SD=1.85). Interview results showed that inadequate numbers of workstations, nesting tendencies, and rule ambiguity were more prominent in Study I than in Study II. Negative interview responses in both Studies regarded finding work stations. Nevertheless, positive responses on autonomy to choose workplace and work setting was also mentioned in both Studies I and II.

Another noticeable difference between the results of Studies I and II were the sound parameters. The repeated measures ANOVA in Study I showed significant increase
in satisfaction with several acoustic parameters, for example auditory privacy (F (1, 34) = 8.55 MSE = 1.50, p < 0.01, ℓ² = 0.20). In Study II there was no significant increase. Negative interview responses in both Studies regarded noise levels.

A third noticeable difference between the results of Studies I and II were communication parameters. The one-sample Wilcoxon signed rank test showed no significant change in Study I except from a decrease in getting hold of co-workers. Interviewees complained about teams being scattered in the office. For Study II, the paired Wilcoxon signed rank test showed a significant satisfaction improvement in most communication parameters. Interviewees in Study II highlighted improved teamwork cohesion and interpersonal relations.

The results indicate a need for more studies comparing more A-FO organizations on workspace, work conditions, work environment satisfaction and perceived performance. Indications of possible influencing factors identified in the case studies (I & II) were (1) the design and implementation processes, (2) workspace parameters, such as the desk-sharing ratio, (3) office use, including nesting tendencies and rule ambiguities, and (4) organizational preconditions such as office type before relocation and work tasks. In Study II the flat organizational model and comradely culture of the company were also reported to influence the outcomes. These four areas were further explored and investigated in Studies II-VI.

6.2 Aim 2: Process factors and design process methods
To identify design and implementation processes factors and investigate their associations with work environment satisfaction and perceived performance, including suggestions of methods that can facilitate the process, three studies were performed: one case study investigating the design and implementation processes (Study II), a study comparing some of the identified design & implementation processes factors of four cases (Study IV), and a study including a literature search and providing a methods framework with methods for implementing new offices (Study VI).

6.2.1 Design and implementation processes factors – single case study
The interviewees in Study II suggested several process factors to be associated with the positive outcome ratings of their A-FO implementation:

- meaningful change objectives
- allocation of time and financial resources
- having an organizational and social focus
- employee participation and empowerment
- a comprehensive initial work analysis
- a methodological approach
- open and adequate communication
- management commitment
- hiring of competent consultants

Key objectives for the case in Study II were a long-term thinking regarding their values, and to improve the working life of the employees. That all office occupiers,
including management, adopted free seating was reported by the interviewees to be an important factor contributing to work environment satisfaction.

In Study II linear regression analysis results further showed strong significant positive correlations between the parameters employee empowerment in the design and implementation process and work environment satisfaction ($r_s=0.80$, $p=<0.001$, $n=24$) and individual productivity ($r_s=0.69$, $p < 0.001$, $n=24$). For this thesis the linear regression analysis was complemented with a Spearman’s rank of correlation test. The same results were found for the correlation coefficients ($r_s$) and significance values ($p$).

6.2.2 Design and implementation processes factors comparison – cross-case study

To further investigate some of the suggested design and implementation process factors, the factors were compared across four cases (C1-3 & C5) using planning documents, plan layout, and interviews with process managers in Study IV. The comparison showed that in two of the cases (C2-3, NOTE: C1 is C3 in paper manuscript) the employees had been involved in choosing office concept and deciding on rules, and workshops had been held on employees’ needs and activities where different perspectives, needs, expectations and solutions were presented. Also in these cases there had been a clear communication regarding rules. The other two cases (C1 and C5) did not involve the employees, and had a comparatively low extent of communication on rules. The cases with longer design and implementation processes duration, more employee involvement and clearer communication in the design and implementation process (C2-3) reported on better acceptance of the A-FO, decreased misuses of the workplaces, and had a unified mental model and understanding of reasons for complying with the rules. For example, some opposers agreed to the A-FO concept because of the participatory approach in office type choice where the majority of the employees approved of the concept.

6.2.3 Design process methods & methods framework

To identify suggestions of methods that can facilitate the process a conceptualized design process methods framework (Figure 5) for A-FO implementations was presented in Study VI. This methods framework included participatory methods, and methods to be used by work environment professionals. The methods included in the methods framework had been used by the studied cases or were identified through literature searches. Examples of methods are; workshops, excursions, workbooks, mock-ups, risk assessments and layout design games. The developed framework divides the design and implementation process into five iterative stages: (1) change drivers & vision, (2) analysis of the existing workplace, (3) conceptualization and visualization, (4) detailed planning, and (5) post-relocation evaluation. Moreover, the design process methods were divided into three categories to facilitate choice of methods: participatory methods, professional methods (for work environmental professionals) and communicative methods. The results from the one-year follow-up with the course evaluation questionnaire showed that 39 % of the respondents (former course participants) had used the framework, and 89 % responded to have used at least one of the methods from the framework (Study VI).
Methods for office design and implementation

<table>
<thead>
<tr>
<th>Change drivers &amp; Vision</th>
<th>Analysis</th>
<th>Conceptualization and visualization</th>
<th>Detailed planning</th>
<th>Post-relocation evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Explore the organisation’s purpose with the change, desired strategies, structures, work process and culture</td>
<td>- of the existing work/workplace, needs and activities</td>
<td>- match needs to concept</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workshops</td>
<td>34</td>
<td>Architectural drawing analysis</td>
<td>10</td>
<td>Improvement logging</td>
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<tr>
<td>Brainstorming</td>
<td>5</td>
<td>Flow simulation (flow in shoeboxes)</td>
<td>8</td>
<td>Feedback training</td>
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<tr>
<td>RoundRobin</td>
<td>40</td>
<td>Activity/work analysis</td>
<td>5,16,34</td>
<td>1:1 + Roleplay</td>
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<tr>
<td>Forming of workgroups</td>
<td>34</td>
<td>Design dialogs</td>
<td>15</td>
<td>Scenario analysis</td>
</tr>
<tr>
<td>Visit/Excursion/Photo Safari</td>
<td>7</td>
<td>Workbook</td>
<td>7,35</td>
<td>1:1 + Roleplay</td>
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<tr>
<td>Mood board</td>
<td>34</td>
<td>ErgoVSM</td>
<td>20</td>
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<td>SWAT</td>
<td>37</td>
<td>Usability analysis</td>
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<td>Scenario analysis</td>
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<td>Forming of workgroups for HR/IT</td>
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<tr>
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<td>Workshops</td>
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<th>Professional methods</th>
</tr>
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<tbody>
<tr>
<td>Risk assessment</td>
</tr>
<tr>
<td>Requirement specifications</td>
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<tr>
<td>Observations</td>
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<tr>
<td>Checklists?</td>
</tr>
<tr>
<td>Measurement of Speech transmission index (STI)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Communicative methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presentations/meetings</td>
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<tr>
<td>Newsletters</td>
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<tr>
<td>Intranet</td>
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</tbody>
</table>

Figure 5: A methods framework with references on participatory, professional and communicative methods in different phases of the office design process. The numbers correspond to the reference list in paper VI.
6.3 Aim 3: Workspace factors
To investigate the alignment of workspace factors and perceptions of work conditions, work environment satisfaction and perceived performance, a cross-case study was conducted (Study III) comparing four A-FO office sites (C1-4) based on interviews with process managers, document analyses (evaluation of photographs and plan layouts from blueprints) and observations. An overview of the cross-case comparisons for each case is presented in Table 10.

6.3.1 Work conditions
The combined results from the evaluation of plan layouts and Kruskal-Wallis pairwise comparisons (Study III) showed significant differences on work conditions between the cases. The combined results showed that mental work conditions and privacy were significantly higher in the offices of C2-3 that provided a diversity of acoustic settings (strictly quiet, semi-quiet, and interactive zones) and in the case with most ample ratios (C3): desk-sharing ratio (ratio = 0.9), meeting room ratio (0.13 rooms/employee), back-up room ratio (0.13 rooms/employee), and open-plan office area per employee (7.5 m²/employee). On average, the employees from this organization were present in the office 81% of the time (In Study IV the employees from this office reported good opportunities to choose a quiet area, shielding oneself from interruptions and avoiding distractions). This case had an office with two equally sized open-plan areas. These areas had different noise levels. Moreover, this office had the lowest number of workstations grouped in one area (maximum 16 workstations/area), and had a maximum of two workstations per row. Moreover both cases (C2-3) had back-up rooms close to the shared areas, and had no large corridors next to workstations.

Significantly higher satisfaction with communication and interpersonal relations were found in the case (C2) with the shortest distance between the quiet and interaction zones and with many workstations in close proximity to each other. This was also the case with significantly higher perceived intra-team productivity (one of four parameters of perceived performance) than the other cases.

The office with a desk-sharing ratio of 0.68 with an office presence of 92% (C1) was the same office investigated in Study I, which showed that employees perceived there were inadequate number of workstations, difficulties finding two workstations in proximity for collaboration, and nesting tendencies. In this office employees also perceived an unsuitable arrangement of workstations, which split the teams. Interviewees reported that employees left their belongings on a workstation while being elsewhere to make sure to get a workstation afterwards.

Results from the cross-case study (Study III) showed that employees from C4 were significantly less satisfied with the interior design than the other cases. According to observations this was also the most grey-scaled office with least colors.

6.3.2 Overall work environment satisfaction and perceived performance
Overall work environment satisfaction and perceived performance were highest in the cases (C2-3) that received highest satisfaction scores in most categories; plan layout, acoustics, interior design, communication, interpersonal relations, mental work conditions and privacy. Lowest satisfaction in most categories (workspace parameters, work conditions, overall work environment satisfaction and perceived
performance) was reported from the case with lowest desk-sharing ratio (0.61 workstations/employee), meeting room ratio (0.04 rooms/employee), back-up room ratio (0.06 rooms/employee) and open-plan surface area (3.5 m²/employee). Moreover, this was the case with highest number of workstations grouped in one space (maximum 45 workstations/space), had largest proportion of 3-4 workstations per row, had most and largest walkways next to workstations, offered low diversity of acoustic settings and had the whitest, least colored interior design.

The investigation of alignment of workspace factors and perceptions of work conditions, work environment satisfaction and perceived performance found that highest overall work environment satisfaction, perceived performance, mental work conditions and privacy, were reported from the offices of cases C2-3 that provided acoustic diversity, enclosed rooms close to the shared areas, and that avoided large corridors next to workstations. One of these cases also dominated in positive responses on acoustics, whereas the other office (C2) dominated in communication and interpersonal relations. The case with positive responses on acoustics provided most ample ratios, highest diversity of acoustic settings and fewest workstations per area. The office with positive responses on communication and interpersonal relations had acoustic zones and workstations in close proximity to each other.

6.4 Aim 4: Policies and rules
From case studies I-II the results indicated that behavioural rules specific for A-FOs might influence work conditions, work environment satisfaction and employee performance. To identify rules and policies, explore compliance with rules and their possible influence on perceptions of work conditions, 105 employee interviews, interviews with process managers, documentation and observations were analysed in a cross-case study (IV), comparing four A-FO sites (C1-3, & C5). Two types of policies were identified; desk-sharing policies and speech policies.

6.4.1 Desk-sharing policies
Three rules for enabling desk-sharing were identified:
(R1) **To remove belongings** (including duration for which the desks were allowed to be claimed but unattended)
(R2) **Restrictions on using the same workstation in open zones**
(R3) **Restrictions on using workstations in scarce zones**

To remove belongings (R1 i.e. clean desk policies) by the end of the day was the only common and unambiguous rule across the cases. R1 was mostly complied with in two of the cases (C2-3, Note: C3 is C1 in article manuscript and vice versa), while most instances of disregarding R1 were found in C5. The least defined and most ambiguous rules across the cases were R2-3; using the same desk on consecutive days in open, and in scarce zones. Most desk-sharing ambiguities were reported in C1. Repeated use of workstations were reported mostly from C1 and C5. The switching was perceived as too time- or resource demanding, uncalled for, or lacking negative individual or group consequences.
Employees across all cases reported on positive and negative consequences of the desk-sharing policies (Figure 6). More positive consequences of desk-sharing policies were reported in C2-3 than the other cases, especially on inter-team resources, as well as intra-team resources for C2 (e.g. more interaction) and mental resources for C3 (e.g. less mental demand from decluttered workspaces). Prominent negative consequences were difficulties in finding available workstations (C1-2), difficulties in finding and gathering colleagues (C1), extra work in terms of increased planning and setup time (C1 and C3), and limited access to printed documents (C5). Interviewees at C1 expressed uncertainties in how to act.

<table>
<thead>
<tr>
<th>Work conditions</th>
<th>Case 3</th>
<th>Case 2</th>
<th>Case 1</th>
<th>Case 5</th>
<th>Reported factors regarding consequences of desk-sharing rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autonomy</td>
<td>🟢</td>
<td>🟢</td>
<td>🟢</td>
<td>🟢</td>
<td>Opportunity to choose different workstations</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Difficulties in finding available workstations</td>
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<td></td>
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<td></td>
<td>Limited opportunities for personalization</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Social pressure for changing/choosing specific workstations</td>
</tr>
<tr>
<td>Mental resources</td>
<td>🟢</td>
<td></td>
<td>🟢</td>
<td>🟢</td>
<td>Decluttered workspaces</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Increased planning and setup time</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Limited access to printed documents</td>
</tr>
<tr>
<td>Intra-team</td>
<td>🟢</td>
<td>🟢</td>
<td>🟢</td>
<td>🟢</td>
<td>Increased access to team members and management</td>
</tr>
<tr>
<td>resources</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Facilitated spontaneous interactions</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Facilitated collaborations and side-by-side work</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Difficulties in finding and gathering colleagues</td>
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<td></td>
<td>Increased risk of isolation from team members</td>
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<td></td>
<td>Missing out on social activities</td>
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<td></td>
<td>Risk of feeling alone and unnoticed</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Difficulties in grasping colleague’s well-being</td>
</tr>
<tr>
<td>Inter-team</td>
<td>🟢</td>
<td>🟢</td>
<td>🟢</td>
<td>🟢</td>
<td>Increased inter-team interactions</td>
</tr>
<tr>
<td>resources</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Increased understanding of inter-team colleagues</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Decreased hierarchies</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lack of familiarity with the social surrounding</td>
</tr>
</tbody>
</table>

Figure 6: To which extent work conditions consequences of desk-sharing rules are reported in the cases C1-C3 & C5, compared in study V. Observe order of C1 and C3 (adjusted to thesis)

6.4.2 Speech policies

Two rules for allocation of zones for variation in speech levels were identified:

(R4) To interact verbally with colleagues in different zones
(R5) To speak on the phone in different zones

Three zones were distinguished in two of the cases: semi-quiet and interactive zones in C2-3 and an additional strictly quiet zone in C3. Employees in C2 expressed a need for a strictly quiet zone although it had been decided by the employees to allow phone conversations in the open area intended for focused work. In C2-3 interviewees reported that the majority complied with, but also that exceptions disregarded, the speech rules by interrupting and speaking in quiet zones. For the other two cases (C1 & C5) no speech zones were allocated and no speech rules were distinguished. However, ambiguities and different interpretations and extents of disregarding speech rules were reported. Need for clear speech policies were expressed.
All cases reported on positive and negative consequences of the speech rules (Figure 7). More positive work condition consequences of speech policies were reported from C2-3 than the other cases: opportunity to choose between speech zones, and shielding oneself from interruptions by colleagues in quiet zones, although some negative consequences also were unique for these two cases: missing out on important information and limitation on initiating conversations in quiet or semi-quiet zones. Most negative work condition consequences were reported in C5 including limited opportunity to choose between zones and shielding oneself from interruptions and conversations.

The results indicated that the A-FO concept enabled employees to switch workstation, however, did not prohibit repeated use on consecutive days. According to interview results, rules seemed to be crucial to provide a variety of environments, ensure positive work conditions, and make the flexible office concepts work. In cases with implicit and ambiguous policies, uncertainties, conflicting interpretations and disregarding of rules emerged, and a need for clearly defined rules was expressed. Hence, the results indicated that rules, discussed and decided on in the design and implementation processes, are important components to provide a variety of environments, ensure positive work conditions, and make the flexible office concepts work.

6.5 Aim 5: Organizational preconditions
In order to investigate organizational preconditions that correlate with preference for A-FOs (research aim 5) questionnaire results from 11 cases were analysed using Spearman’s coefficient of rank correlation test in Study V. The organizational preconditions investigated in the study were work tasks and office type before relocation. In addition employee attitudes towards the A-FO concept prior to relocation to A-FOs were investigated.

Results from the correlation analysis in Study V supported that preference for the A-FO correlated positively with frequent performance of tasks demanding innovation, and inversely with frequent performance of tasks demanding concentration, speaking on the phone and writing/generating tests. The correlation coefficient rs varied between 0.08-0.19. Frequent performance of tasks handling confidential information did not correlate with preference for the A-FO, nor did frequent performance of task involving memory demands, decision making, counting, overviewing multiple things, and learn and search for information.
The correlation analyses also showed that former open-plan offices occupiers preferred the A-FO to a significantly higher extent than former cell office occupiers ($r_s=0.19$). Strongest correlation was, however, found for employee preference pre- and post-relocation ($r_s=0.59$). In other words, if employees preferred the A-FO prior to relocation, they were more likely to prefer the A-FO after relocation. Approximately 1/5 (21 %) of the employees who were skeptical prior to relocation, started preferring the A-FO after relocation. In the opposite direction, 12% of the employees that had preferred the A-FO prior to relocation, started preferring other office types after relocation.

The results suggests that A-FOs seem to be designed for supporting frequent performance of innovation demanding tasks, rather than concentration demanding tasks. Moreover, preference for the A-FO after relocation correlated with preference for the A-FO prior relocation and open-plan office occupancy prior relocation. The A-FO synthesis presented in Study II (Figure 8) also highlights other internal as well as external organizational preconditions, such as structure, power conditions, regulations, stability and normative conditions.

### 6.6 Synthesis

The relationships between process factors, organizational context, office settings (workspace), work condition consequences in terms of demands and resources and overall outcomes are presented in a synthesis (Figure 8) from Study II. The synthesis is based on the empirical research findings from Studies I-VI showing that design and implementation factors, workspace factors, application of rules and organizational preconditions are associated with work conditions, work environment satisfaction, and perceived performance. The synthesis is further based on research literature. Besides empirical research findings in bold (1 Rolfö and Babapour Chafi, 2017; 2 Rolfö and Eklund, 2015; 3 Rolfö et al., 2017a; 4 Rolfö et al., 2017b), the synthesis is based on sociotechnical theories (5 Holden et al., 2015; 6 Porras and Robertson, 1992), Macroergonomic principles (7 Hendrick, 2007; 8 Hendrick and Kleiner, 2016), demands and resource theory (9 Bakker and Demerouti, 2007), intervention studies (10 Nielsen and Randall, 2013; 11 Nielsen et al., 2009; 12 Broberg, 2010), organizational change (13 Blake & Mouton, 1983; 14 Jacobsen, 2013; 15 Vink et al., 2006), A-FO models (16 de Croon et al., 2005; 17 Riratanaphong and Van Der Voordt, 2012; 18 Wohlers and Hertel, 2016), and office literature (18 Sundstrom & Sundstrom, 1986; 20 Davis et al., 2011; 21 de Been & Beijer, 2014; 22 Gerdenitsch et al., 2017; 23 Hongisto et al., 2016; 24 Nijp et al., 2016; 25 van Koetsveld & Kamperman, 2011). The work conditions being presumed mediators between the physical environment and satisfaction and performance are consistent with the A-FO models of de Croon et al. (2005) and Wohlers and Hertel (2016).
Table 10: Summary of results from cross-case analyses. Int= Interviews, Doc= Documentation, Que= Questionnaires, Obs= Observations. "+/−" = The case has better/worse results compared to other cases. NS= not significant, N/A= Not Available.

### Planning and design process

<table>
<thead>
<tr>
<th>Case 1 - Insurance company</th>
<th>Case 2 - IT service &amp; support</th>
<th>Case 3 - Health &amp; safety</th>
<th>Case 4 –IT &amp; telecom consult</th>
<th>Case 5 - Science park</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employee participation Int./Doc.</td>
<td>Low degree</td>
<td>Empowerment</td>
<td>Empowerment</td>
<td>N/A</td>
</tr>
<tr>
<td>Work analysis Int./Doc.</td>
<td>No in-depth</td>
<td>In-depth</td>
<td>In-depth</td>
<td>N/A</td>
</tr>
<tr>
<td>Comm. in design process Int./Doc.</td>
<td>Low degree</td>
<td>High degree</td>
<td>High degree</td>
<td>N/A</td>
</tr>
<tr>
<td>Planning duration Int./Doc.</td>
<td>0.75 years</td>
<td>2.5 years</td>
<td>1.5 years</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Rules and policies

<table>
<thead>
<tr>
<th></th>
<th>Case 1</th>
<th>Case 2</th>
<th>Case 3</th>
<th>Case 4</th>
<th>Case 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desk sharing ambiguities Int./Obs.</td>
<td>- Most ambiguities</td>
<td>+ Few ambiguities</td>
<td>+ Few ambiguities</td>
<td>N/A</td>
<td>+ Few ambiguities</td>
</tr>
<tr>
<td>Compliance/Nesting Int./Obs.</td>
<td>Nesting</td>
<td>+ Complied with desk-sharing</td>
<td>+ Complied with desk-sharing</td>
<td>N/A</td>
<td>Nesting</td>
</tr>
</tbody>
</table>

### Physical work environment

<table>
<thead>
<tr>
<th></th>
<th>Case 1</th>
<th>Case 2</th>
<th>Case 3</th>
<th>Case 4</th>
<th>Case 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diversity in acoustics Que./Doc.</td>
<td>- 1 zone</td>
<td>2 zones</td>
<td>+ 3 zones</td>
<td>2 zones</td>
<td>N/A</td>
</tr>
<tr>
<td>Desk-sharing ratios Doc./Que./Int.</td>
<td>- High ratios</td>
<td>(Ample ratios)</td>
<td>Ample ratios</td>
<td>- High ratios</td>
<td>N/A</td>
</tr>
<tr>
<td>Characteristics of envir. Doc./Obs.</td>
<td>Inappr. arrangement of workst.</td>
<td>Proximity of spaces</td>
<td>Clearly divided spaces</td>
<td>Grey and white colors</td>
<td>N/A</td>
</tr>
<tr>
<td>Acoustics Que./Doc./Obs.</td>
<td>- Lower satisfaction</td>
<td>- Lower satisfaction</td>
<td>+ Higher satisfaction</td>
<td>- Lower satisfaction</td>
<td>N/A</td>
</tr>
<tr>
<td>Interior design Que.</td>
<td>+ Higher satisfaction</td>
<td>+ Higher satisfaction</td>
<td>+ Higher satisfaction</td>
<td>- Lower satisfaction</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Working conditions

<table>
<thead>
<tr>
<th></th>
<th>Case 1</th>
<th>Case 2</th>
<th>Case 3</th>
<th>Case 4</th>
<th>Case 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autonomy Int.</td>
<td>Some choice of workstations</td>
<td>+ choice of workstations</td>
<td>+ choice of workstations</td>
<td>N/A</td>
<td>- Limited choice of workst.</td>
</tr>
<tr>
<td>Distraction Que./Int.</td>
<td>- High degree of distraction</td>
<td>+ Low degree of distraction</td>
<td>+ Low degree of distraction</td>
<td>- High degree of distraction</td>
<td>- High degree of distraction</td>
</tr>
<tr>
<td>Opportunities for privacy Que./Int./Doc.</td>
<td>- Few opportunities</td>
<td>+ Many opportunities</td>
<td>+ Many opportunities</td>
<td>- Few opportunities</td>
<td>N/A</td>
</tr>
<tr>
<td>Communication Que.</td>
<td>- Lower degree of satisfaction</td>
<td>+ Higher degree of satisfaction</td>
<td>- Lower degree of satisfaction</td>
<td>- Lower degree of satisfaction</td>
<td>N/A</td>
</tr>
<tr>
<td>Interpersonal relations Que.</td>
<td>- Lower degree of satisfaction</td>
<td>+ Higher degree of satisfaction</td>
<td>- Lower degree of satisfaction</td>
<td>- Lower degree of satisfaction</td>
<td>N/A</td>
</tr>
<tr>
<td>Risks of feeling isolation Int.</td>
<td>- Mentioned</td>
<td>No comments</td>
<td>- Mentioned</td>
<td>N/A</td>
<td>No comments</td>
</tr>
</tbody>
</table>

### Work environment (WE) satisfaction and performance

<table>
<thead>
<tr>
<th></th>
<th>Case 1</th>
<th>Case 2</th>
<th>Case 3</th>
<th>Case 4</th>
<th>Case 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sat. with physical WE Que.</td>
<td>NS</td>
<td>+ Higher satisfaction</td>
<td>NS</td>
<td>- Lower satisfaction</td>
<td>N/A</td>
</tr>
<tr>
<td>Preference for the A-FO Que.</td>
<td>NS</td>
<td>+ Higher preference</td>
<td>- Lower preference</td>
<td>NS</td>
<td>N/A</td>
</tr>
<tr>
<td>Perc. intra-team prod. Que.</td>
<td>- Intra team productivity</td>
<td>+ Intra team productivity</td>
<td>NS</td>
<td>NS</td>
<td>N/A</td>
</tr>
<tr>
<td>Office being optimally designed Que.</td>
<td>NS</td>
<td>NS</td>
<td>+ Higher assent</td>
<td>- Lower assent</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Figure 8: The relationships between process factors, organizational context, workspace, work condition consequences in terms of demands and resources, and overall outcomes such as satisfaction and performance. The synthesis is a modified version from Study II - a synthesis of thesis with references specified in section 6.6 Synthesis.
‘Sometimes you have to go four laps to find a spot in the middle of a team that speaks a lot. Because there are no free desks.’

– Case 1, Interviewee 12
Discussion
The overall aim of this thesis was to explore and investigate perceptions of workspace, work conditions, work environment satisfaction, and perceived performance in A-FOs, and explore and investigate associations with underlying factors. The synthesis of associations with work conditions, satisfaction and performance summarizes the thesis (Figure 8). The synthesis incorporates several factors suggested by the previous A-FO models and is discussed throughout this discussion chapter.

7.1 Aim 1: Perceptions of A-FOs and perceived change from open-plan based offices
The first aim of this thesis was to explore work environment satisfaction and perceived performance in A-FOs, and changes in perceptions of workspaces and work conditions (e.g. autonomy, mental working conditions, privacy and communication) following relocation from open-plan based offices.

7.1.1 Work environment satisfaction and perceived performance
The ergonomics definition suggests that Ergonomics can be a means to improving both human well-being and overall system performance. The results from the thesis show that work environment satisfaction, an indicator of human well-being (De Jonge & Schaufeli, 1998), and perceived performance can increase after a relocation to an A-FO, and the A-FO can be the most preferred office type amongst A-FO occupiers. However, Study V showed that the cases included in this thesis (C1-4) were amongst the top cases in terms of proportion of employees preferring the A-FO over other office types. This implies that the cases investigated in more detail in this thesis are perhaps more functional than many other studied cases of A-FOs in Sweden. The cases where only 0.13-0.19 % of the employees preferred the A-FO over other office types (Study V) indicate that a relocation to A-FOs can indeed generate dissatisfaction.

As suggested by the synthesis (Figure 8), underlying factors for positive outcomes can be the combination of having the right internal organizational preconditions
DISCUSSION

(Study V), sound design and implementation processes with employee empowerment (Studies II & V), a physical office solution that supports work and individual preferences (Study III), and rules that support work and clarify how to act in the A-FO (Study V). The cases with most satisfied employees were positive towards the concept before the change, and results show that employee participation in the design and implementation processes correlates with satisfaction and perceived performance. In other words, employees that were satisfied with the processes were in general satisfied with the work environment in A-FOs.

An attractive interior design has previously been pointed out as the major contributor to favorable outcomes in a descriptive article on A-FOs (Vos & van der Voordt, 2002). The results from the studies showed that workspace factors such as interior design likely improve after the change from open-plan based offices to A-FOs which is consistent with literature (Bodin Danielsson, 2015; de Been et al., 2015). Interestingly, according to job enrichment theory and office comfort theory environmental conditions are of less importance for satisfaction with work in comparison to psychological factors such as empowerment (Smith & Sainfort, 1989; Vischer, 2007).

For performance ratings the Wilcoxon signed rank test showed no significant difference in perceptions of change of any performance parameters in Study I, but a significant increase in self-rated efficiency of cooperation, and individual and intra-team productivity in Study II. A recent study using surveys showed that employees more often perceive their office to support pleasantness rather than ability to perform (Bodin Danielsson & Theorell, 2018). Employees’ self-assessment of productivity was shown in another study using surveys to be unaffected by whether or not occupants have a pre-assigned desk (Kim et al., 2016). A study based on 266 survey respondents showed that most people can cope quite well with new ways of working (Gorgievski et al., 2010). The thesis suggests that a relocation from an open-plan based office to an A-FO may generate high work environment satisfaction and perceived performance, but that it can achieve this under certain conditions.

7.1.2 Changes in perceptions of work conditions
Autonomy: Both in studies of this thesis (Studies I and III) and research literature (Demerouti et al., 2014; Lee & Brand, 2005), perceptions of autonomy has been suggested to increase in the A-FO by the provision of options of acoustic environments and opportunity to choose different workstations. However, complaints found in Study I and in a cross-case study by de Been and colleagues (2015) has also considered limited opportunity to choose suitable workstations due to work station occupancy. The interviewees reported that employees do not leave the open-plan areas for fear of missing out on important information, feel social pressure in choosing specific workstations, or cannot perform work tasks without the group (Study IV). Hence, there can be a trade-off between individual and group performance. The placement of the group may not have the appropriate work conditions for the individual to perform.

Study IV discussed the inherent conflict in the A-FO concept; non-territoriality versus autonomy. A single office setting type and workstation may be optimal for several or homogenous work tasks performed by an employee. If so the employee
may want to choose the same workstation on consecutive days as this is the best suited workstation for the tasks and preferences. In some organizations in this thesis the employees perceived there was autonomy to choose the same workstation in consecutive days (e.g. C2), while in other organizations there was, rather than autonomy, an implicit demand of the employees to alternate between workstations (e.g. C1 and C5). In the latter cases the extent of autonomy can be questioned. As stated in Study I the switching of workstations may be an extra demand that is not beneficial to performance.

Mental working conditions and privacy: Distraction was reduced after relocation to the A-FO in Study II, which is also consistent with literature (Gerdenitsch et al., 2017; Seddigh et al., 2014). Possibility to withdraw to private areas and auditory privacy improved in some but not in all cases (compare C1 and C2 in Studies I and II. Complaints on lack of privacy have been found in previous studies (Appel-Meulenbroek et al., 2011; Gorgievski et al., 2010; Morrison & Macky, 2017), despite provision of back-up rooms in A-FOs. More mental demands were found due to more planning, inconvenient transport and setup time, limited access to printed documents, and difficulties in finding colleagues and suitable workplaces, which is consistent with literature (cf. Brunnberg, 2000; de Been et al., 2015; Elsbach, 2003; Gorgievski et al., 2010; van der Voordt, 2004; Wolfeld, 2010).

Communication and interpersonal relations: A common objective for A-FO implementations is to improve inter- and intra-team communication (Morrison & Macky, 2017; Van Meel et al., 2010) and, in turn, to improve creativity, innovation and cross-fertilization (Boutellier, Ullman, Schreiber, & Naef, 2008; Van Meel et al., 2010) and interpersonal relations (de Croon et al., 2005). The results suggest that the A-FO and flexible working can be associated with high inter- and intra-team communication and positive interpersonal relations (Studies II-V) but also with low intra-team communication. The results are partly supported by a longitudinal interview study concluding that A-FOs support collaboration across teams (inter-team communication) but hampers teamwork (Wohlers & Hertel, 2018). In all cases using interviews as data collection method, interviewees reported on increased inter-team interactions. Informal conversations and possibilities of meeting other people have previously scored highly in a study using surveys on A-FOs (Gorgievski et al., 2010). A study using observations and a survey with 182 participants found, however, that few employees in A-FOs use desk-sharing to get to know new coworkers (Appel-Meulenbroek et al., 2011).

Positive intra-team communication was also mentioned in all cases: access to team members, facilitated spontaneous interactions and collaborations and side-by-side work (Study IV). Positive outcomes on communication and collaboration have also been found in an intervention study (Robertson, Huang, O’Neill, & Schleifer, 2008). Negative intra-team resources were found due to difficulties in locating and gathering colleagues, and increased risk of isolation from team members (Study V). Decrease of communication with colleagues and risk of less social bonding with colleagues have been found in a previous cross-case study (de Been et al., 2015).

Both statistical and interviewee results from Studies III and IV showed that employees can perceive improved interpersonal relations in A-FOs. This is
supported by A-FO studies that have found high perceived group cohesiveness (Lee & Brand, 2005) and sense of coherence (Robertson et al., 2008). It should be noted, however, that hot-desking open plan office occupiers have been found to conduct more uncooperative behavior compared to employees in cell offices according to a survey with 1000 participants (Morrison & Macky, 2017).

The layout and distance, with different acoustic settings in close proximity to each other, were aligned with satisfaction with communication in Study III, which is consistent with findings in a mixed method study (Conrath, 1973). Office layout have been found to influence the relationship between movements and interaction (Steen, Blombergsson, & Wiklander, 2005) and how knowledge is shared (Appel-Meulenbroek, de Vries, & Weggeman, 2017). Sharing a room and overhearing relates to how knowledge is shared. However, providing open-plan environments is likely not sufficient to produce more collaboration. Interaction is also associated with for example social conduct (Van Meel et al., 2010) and organizational re-structure (Lansdale, Parkin, Austin, & Baguley, 2011).

### 7.2 Aim 2: Process factors and design process methods

The second aim of the thesis was to identify design and implementation processes factors and investigate their associations with work environment satisfaction and perceived performance, including suggestions of methods that can facilitate the processes. In Study II interviewees perceived a number of process factors to influence work environment satisfaction and perceived performance.

#### 7.2.1 Change objectives

Having change objectives that are perceived as meaningful to the employees and that support employee wellbeing were identified as an important design process factor (Study II) which is supported by another study describing A-FO interventions (van Koetsveld & Kamperman, 2011). To not have an assigned desk and applying new ways of working involve unlearning of old values, norms or assumptions to learn something new, which is the most radical type of change (Jacobsen, 2013). Employees are attached to their already established ways of working (Scott & Jaffe, 1988). Radical changes require motivation i.e. meaningful change objectives, and thorough design and implementation processes to institute these objectives.

Reasons for and consequences of implementing A-FOs take place on many levels, from individual to organizational levels, and to some extent also on the societal level in terms of environmental impact regarding space utilization, reduction of paper and energy use (Alker et al., 2015). Objectives are previously discussed in section 2.3. An overview of change objectives is presented in Figure 9. The objective of A-FO implementations, often put forward in literature, is to decrease overhead costs and improve utilization of space (e.g. Kim et al., 2016; Wohlers & Hertel, 2018) which is beneficial for the organization. A case study of relocation to an A-FO, where the employees perceived that the real reasons for relocation was to reduce overhead costs, resulted in low level of employee satisfaction (Lahtinen et al., 2015). Meaningful change objectives for employees are, according to the Job Demand-Resource model, provision of job resources, such as an improved work environment for the employees, stimulation of personal growth, learning and development, and that are functional in achieving work goals (Hakanen, Schaufeli, & Ahola, 2008).
Hence, although economic reasons may trigger the change, the change objectives need to include benefits on the individual level.

A change to an A-FO is, like other change projects, easier to accept if it is perceived as meaningful and increases well-being of employees (Morrison & Macky, 2017; van Koetsveld & Kamperman, 2011), but also needs to be perceived as manageable and comprehensible (Antonovsky, 1996). If employees doubt a solution, its associated intervention will not succeed (Nielsen & Randall, 2013). That the change objectives should be clear are stressed in other A-FO studies (Brunia et al., 2016; Lahtinen et al., 2015; Ruohomäki, Lahtinen, & Reijula, 2015; Van Meel et al., 2010) and represented in one of the A-FO models (Riratanaphong & van der Voordt, 2012).

Figure 9: Objectives for A-FO implementations on individual, micro, meso, macro and chrono levels. Macro refers to impacts from society, and chrono refers to time aspects and development over time. The model is inspired by Dellve and Eriksson (2017) and a bio-ecological model from Bone (2015).

7.2.2 Time and financial resources
Allocation of time and financial resources in design and implementation processes was also associated by the interviewees with employee satisfaction in A-FOs (Studies II & IV). The importance of the financial dimension in workplace design projects is stressed in the SOFT-model by Horgen (1999). A report from Microsoft highlights that construction or reconstruction of a new workspace (e.g. facility) involves high project costs and requires financial investment rather than cutting costs (Ross, 2010). Motivation for change is more difficult if the organization does not show there is a problem needing to be remedied, such as poor results (Jacobsen, 2013) which might generate a perception of urgency which in turn can drive change (Burnes, 2004b; Damshroder et al., 2009). However a change is more likely to generate high level of employee satisfaction if employees believe there are enough resources to cope with change (Antonovsky, 1996).
Additional costs for A-FO implementations involve structural rebuilding, finish and layout, advanced ICT, adaptation and installation of equipment, implementation costs for consultants, meetings and workshops and office management (Vos & van der Voordt, 2002). Furnishing costs are approximately 75% higher in A-FOs than in open-plan and cell offices according to a descriptive article of A-FO (Vos & van der Voordt, 2002). Time and money needs to be spent on participation (Gorgievski et al., 2010) and conducting a comprehensive work analysis, which in turn improves customization of the A-FO to the organization’s work processes (Gerdenitsch et al., 2017). Sometimes organizations abandon key design concepts when faced with financial pressures (Kampschroer & Heerwagen, 2005). Further, properly functioning ICT is crucial to successful A-FO implementations (Vos & van der Voordt, 2002) which, in 2001, was a cost equal to facility costs according to a report (Brill et al., 2001). Allocation of time is important in the early design stages (Bodin Danielsson, 2014) and to provide a transition period to create a new culture (Kotter, 1995; Scott & Jaffe, 1988). Investment of resources on efforts to use the office as intended after implementation are also suggested as a key to the implementation of new ways of working. For example, orientation of new staff, training, adaptation of rules and creating a supportive culture needs to be invested in (Appel-Meulenbroek et al., 2011; Brunia et al., 2016; Gerdenitsch et al., 2017; Robertson et al., 2008). All in all, the results support that time and financial resources needs to be allocated to the design and implementation processes in order to generate positive outcomes, which is supported by previous literature.

7.2.3 Organizational and social focus
Employees from Study II reported on associations between applying organizational and social focus (beside the physical change) when implementing A-FOs and work environment satisfaction, which is supported by previous research (van Koetsveld & Kamperman, 2011). As suggested by the sociotechnical systems theories, the work system comprises organizational, technological, physical and personnel sub-systems that are interdependent (Hendrick, 2007). In order for the A-FO concept to work the results from the studies suggest changes in all sub-systems: (1) clean desk policies needs to be adopted (organization), (2) the workspace need to support different activities (work environment), (3) employees need to change actions and adapt to the new ways of working without assigned desk and where the task determines how and where to work (personnel) and (4) technology needs to support the flexible working (technology).

As the organizational dimension influences the other dimensions in the sociotechnical system (Hendrick, 2007), it needs to be discussed in the design and implementation processes. For example, policies can encourage or forbid teleworking (e.g. where employees have the opportunity to work from home or other locations away from the office). Study III showed that the frequency of teleworking was associated with the desk-sharing ratio and workspace solution, and the psychosocial work environment (e.g. feeling of coherence). Golden (2007) found in his questionnaire study that teleworking prevalence influences communication, job autonomy, and co-workers’ work activities and satisfaction. Policies on teleworking can also influence employees’ personal life, for example the flexibility in work schedules influence balance between work and home domains (Demerouti et al., 2014). However, Nijp and colleagues (2016) found in their longitudinal case study.
that new ways of working did not improve nor hinder work-non-work balance. Other organizational factors are the management style, control, responsibilities and reward system, which is further discussed by Aronsson and colleagues (2006) and Unionen (2013). The sociotechnical system’s perspective points out that a holistic viewpoint is needed between the individual and her work, groups and cooperation and the organization’s way to organize work. To merely focus on the physical change of the office and improvements of ICT (technology) is likely insufficient for the A-FO concept to work. The change to an A-FO may provoke a reframing on how the organization understands its work processes and thus become an incentive for organizational change.

7.2.4 Employee participation and empowerment
Employee participation and empowerment in the design and implementation processes were also associated with work environment satisfaction and perceived performance in A-FOs (Studies II & IV). In fact, statistical analysis showed that employee empowerment strongly correlated with the performance parameter individual productivity and work environment satisfaction (Study II). These correlations have been found in intervention and ergonomics studies (Dewulf & van Meel, 2004; Knight & Haslam, 2010; Meijer et al., 2009; Nielsen & Randall, 2013; Vink et al., 2006) but not specifically for implementations of A-FOs. Complaints of insufficient involvement and ability to give input has been found in a cross-case study by de Been and colleagues (2015). User involvement in Studies II and IV was found to facilitate mental preparation as well as creating, accepting and implementing a new workstyle and work system, which is consistent with results presented in the research literature (Carayon et al., 2006; Lindahl et al., 2005; Nielsen and Randall, 2013; van Koetsveld and Kamperman, 2011). In Study II, interviewees reported on their acceptance of a decision they did not agree with because the majority of their colleagues agreed with the decision (Study II). This is in accordance with Bies and Tyler (1993) survey on 141 employees, stating that if the decision making process is fair opposition is likely to be reduced.

A study by Rolfö, Eliasson and Eklund (2017) pointed to that when the employees participated in office type decision, work groups and workshops, different perspectives, needs, expectations and solutions were presented. It should be noted, however, that for employee participation to work, a level of mutual trust must exist (Gustavsen, 2011) where those involved respect each other (Cherns, 1987). Moreover, in the cases with high levels of employee satisfaction and perceived performance, the employees had participated and been empowered in issues highly relevant for the project, such as office type. Involving employees in only peripheral questions such as names on rooms to ensure that the work environment law is followed, may question the beneficial outcomes of participation. van Koetsveld & Kamperman (2011) suggests it may be better to even discourage employee involvement if the change objective of the A-FO implementation is to reduce costs, as this is purely in the interest of the organization. If employees are asked to participate but have no empowerment, they will become frustrated (Lahtinen et al., 2015). The objectives and limitations of user participation are recommended by a case study to be openly discussed (Lahtinen et al., 2015).
7.2.5 Methodological approach

A methodical approach was suggested to be associated with satisfaction with the A-FO (Study II). Methods and activities can be used throughout the A-FO design process: for defining change objectives and vision, conducting an inventory of the existing workplace and problems, ideation and decision making on solutions, conceptualization and visualization, detailed planning and follow up (Study VI). The methods framework (Study VI), structured according to these subgroups, follow standard design project process stages (Hansson et al., 2015), and suggests participatory, professional and communicative methods in all stages of the process. Participatory methods facilitate involvement of employees and interaction within the company (Nielsen, Randall, Brenner, & Albertsen, 2009). For example, workshops on rules may facilitate discussions on office use, which is essential to facilitate shared understanding of how to use the premises and guide individual actions. Workshops on giving feedback could also prevent difficulties to approach colleagues about behaviours, which has been identified as a problem in A-FOs by previous studies (de Been et al., 2015; Gorgievski et al., 2010).

The methods framework aims to inspire work environment professionals and organizations to involve and activate employees and work environment professionals throughout the process. This includes the earlier stages where work environment can be designed and transformed to the lowest costs (Broberg & Hermund, 2004; Eklund & Daniellou, 1991). The selection of participatory methods is of importance to allow a genuine two-way communication (Broberg, Andersen, & Seim, 2011). Examples in the framework are reference site visits, photo safaris, the SOFT model and inventory of occupancy ratio (space utilization study). Reference sites visits and visual images have shown beneficial in a previous cross-case study on A-FO implementations (de Been et al., 2015).

Several methods, such as layout design game, photo safari, and scenario analysis facilitate discussion through boundary objects. Characteristics of the boundary objects include being physical models (Bligård, Berlin, & Österman, 2018), objects-in-the-making, flexible and malleable, and having built-in affordances, guidelines, temporary learning space and materialized outcomes (Broberg, 2011; Broberg & Edwards, 2012; Andersen & Broberg, 2014).

7.2.6 Work analysis

A comprehensive work analysis was also associated with work environment satisfaction in A-FOs (Study II), which is consistent with literature (Brunia et al., 2016; Toivanen, 2015; van Koetsveld & Kamperman, 2011). Rolfö and colleagues (2017) describes a work analysis conducted in the initial phase by C2 and found that the activities conducted during the work analysis supported analysis of the existing work processes, involved employees at the initiation of the design and implementation process (even before office type had been decided) and throughout the process, and facilitated interaction within the company. Another study supports that a work analysis is central to understand the requirements of work and match the layout and office use to the work tasks/activities (cf. Ruohomäki et al., 2015). This is in conjunction with Vink and colleagues (2006) who stress that a good inventory is important for the success of change. The importance of starting the design process from analysis of work activities (what workers really do) are stressed
by Eklund’s (2003) HTO-model where the activity is in focus. Support for work activities are essential since the core function of an organization is to add value through task performance (Karltun et al., 2017).

7.2.7 Information
Open and adequate information was also associated with work environment satisfaction (Study II & V), which is consistent with other studies that have investigated implementations (e.g. Jimmieson, Terry, & Callan, 2004). Information is suggested to focus on ‘what’, ‘how’ and ‘why’ (Brunia et al., 2016; Vos & van der Voordt, 2002). High extent and transparency of information facilitate employee understanding and can predict the degree of employee participation (Nielsen & Randall, 2013; Weick, Sutcliffe, & Obstfeld, 2005). Employee understanding of the nature of change, ability to ask questions, discuss how the change will affect the individual, and receive quick responses to complaints or misunderstandings are highlighted in Brinia and colleagues’ (2016) cross-case study as being important to successful implementations of A-FOs and new ways of working.

7.2.8 Management commitment
Management commitment was suggested to be associated with satisfaction in the A-FO (Study II), and is consistent with previous literature (Brunia et al., 2016; Lahtinen et al., 2015). Cell offices have been associated with managerial and higher status positions (Marquardt et al., 2002; Sundstrom & Sundstrom, 1986). Management can therefore experience environmental deprivation when relocating to A-FOS, and therefore oppose the implementation. That all office occupiers without exceptions adopt free seating, was a factor contributing to work environment satisfaction according to employees in Study II, and is recommended by previous implementation practitioners (Lidström & Bolter, 2016). For a change to be successful the head of the organization must develop a shared commitment of renewal and act as role models (Kotter, 1995). Moreover, management commitment is needed as managers often allocate resources. Management can show commitment by acting as role models, through active involvement in design process activities, and by allocating employees’ time and the company's financial resources for the implementation.

7.2.9 Consultants
Competent consultants was another suggested factor associated with work environment satisfaction in the A-FO (Study II). Experts, either internal employees or external consultants, are essential for successful change management (Blake & Mouton, 1983; Chernes, 1987). In a case study in A-FO literature there is an example of consultants that are perceived by the employees as not understanding the demands of work (Lahtinen et al., 2015). The importance of the credibility, language and the communication skills when consultants engage with employees are exemplified by Lahtinen and colleagues (2015).

7.3 Aim 3: Workspace factors
The third aim of the thesis was to investigate the alignment of workspace factors and perceptions of work conditions, work environment satisfaction and perceived performance. The results indicated that the plan layout and acoustic diversity are
aligned with work conditions, perceived performance, and work environment satisfaction.

7.3.1 Plan layout
The repeated measures ANOVA/T-tests showed that A-FOs can have significantly better acoustic environment than open-plan offices (Studies I & II). However, Kruskal-Wallis pairwise comparisons showed that A-FOs differ significantly in satisfaction and perceived performance between cases (Study III). Document analyses and interview results from Study III & IV indicate that this is likely due to the provision of different acoustic settings and back-up spaces. Employees in offices with diversity in acoustic settings were more satisfied with privacy, mental work conditions, work environment satisfaction and performance than those without (Study III). Hence, the results indicate that noise and lack of auditory privacy, which are key sources to dissatisfaction (Morrison & Macky, 2017) and reduced performance (Banbury & Berry, 1998; Hongisto, 2005; Jahncke et al., 2013), can be prevented by allocating spaces for different acoustic settings. The importance of diversity of workspaces for employee satisfaction is pointed out in a cross-case study (Brunia et al., 2016). Availability of work environments for undisturbed working was shown in a questionnaire study with 562 office workers to be positively related to job attitudes (Wohlers, Hartner-Tiefenthaler, & Hertel, 2017). Also the positive influence of diversity of workspaces on perceived productivity was found in a study using factor analysis (Haynes, Suckley, & Nunnington, 2017).

7.3.2 Space ratios
Further, Kruskal-Wallis pairwise comparisons showed that employees in cases with higher space ratios were more satisfied with perception of support from the work environment for conducting work, and satisfaction with the work environment, than employees in cases with low space ratios. An office with a desk-sharing ratio of 0.9 (number of desks divided by the number of employees) with an average office presence of 81 % received significantly higher satisfaction scores with the plan layout than the office with a desk-sharing ratio of 0.61 with an office presence of 84 % (Study III). The office with a desk-sharing ratio of 0.68 with an office presence of 92 % (Study III) was perceived to hinder performance (Study I); the low number of available workstations increased time of searching, provided insufficient support for side-by-side work and decreased incentive to switch workstation (Study I & V). In previous studies it has been suggested that the desk-sharing ratio is of importance for the A-FO to work (Alker et al., 2015; Wohlers & Hertel, 2016). Too few workplaces are suggested to cause irritation and inhibit autonomy to use locations suitable to work tasks (van der Voordt, 2004). Similar to many other systems with too high capacity utilization, A-FOs with a too low desk-sharing ratio is likely to stop function. Interviewees in Study I reported to leave their belongings to make sure to get a station. However, few specific ratios have previously been provided in research literature. In a study by Kim and colleagues (2016), a desk-sharing ratio of 0.77 received complaints of insufficient supply of workstations.

Moreover, the back-up room ratio of 0.06 in the office of C1 was perceived insufficient by the employees and were often occupied according to observations (Study I). Previous studies have reported on lack of back-up rooms for confidential
conversations and privacy (Gorgievski et al., 2010). A recent study showed that employees with low access to support facilities are the least satisfied with their office (Bodin Danielsson & Theorell, 2018). However, the few studies in this area either fail to report specific desk to occupant ratio, or do not provide this information at all. A reason could be that sufficient number of open-plan spaces, back-up rooms and workstations may vary between cases, due to for example work tasks (Appel-Meulenbroek et al., 2015). The best workspace design depends on the activity (Gibson, 2003). However, the results indicate that there is a lower threshold of the ratios and that office presence, not only prior but also after relocation, needs to be evaluated for optimizing space utilization, work environment satisfaction and perceived performance.

Further, amount of space was reported as a parameter aligning with workspace satisfaction. No correlation has previously been found between satisfaction with amount of space and gross amount of space (Frontczak et al., 2012). Rather, the quality of the layout and interior design is of more importance (Bodin Danielsson, 2010). In Study III it is suggested to measure the net amount of space of areas that are frequently used, excluding for example corridors that are not perceived as work spaces. Employees in offices (e.g. C3) with the largest work area in terms of square meters (7.5m²) were the most satisfied with workspace parameters, which could indicates a correlation between the two variables. However, further research is needed to confirm/reject and specify this relationship.

7.3.3 Ambient factors and interior design
The results indicate that ambient factors and interior design were aligned with work environment satisfaction. The A-FOs scored highly on aesthetics, and freshness (Studies I & II) in comparison to open-plan offices, which is consistent with literature (de Been & Beijer, 2014). Moreover, employees in colorful A-FOs were more satisfied with aesthetics than in those without, which is consistent with the literature (e.g. Bodin Danielsson, 2015). Air quality, outdoor view and daylight, which has been shown to influence satisfaction (Frontczak et al., 2012; Sundstrom & Sundstrom, 1986; Toivanen, 2015), improved significantly after relocation to A-FOs (Studies I & II).

7.4 Aim 4: Rules and policies
The fourth aim of the thesis was to identify rules and policies and explore compliance with rules and their possible influence on perceptions of work conditions. Study IV identified that applying rules and the explicitness of rules to be of great importance for A-FOs to function. Rules, routines and policies are ways to express formal control and prevent things from going wrong (Cherns, 1987). However, they are also said to inhibit adaptation (Cherns, 1987) as they stop employees from independently performing tasks. Moreover, Study I found that applying rules can be opposed due to potential rule breaking. However, the purpose of rules in A-FOs are to preserve the optimal functionality of workspaces (Gerdenitsch et al., 2017) to support the work processes (Study III). Rules are mechanisms in work systems that coordinate and control other sub-systems (Hendrick & Kleiner, 2016). To remove belongings by the end of the workday is a common rule across A-FOs to make sure there are available workstations for employees for next working day, which ensures the
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flexibility of the whole system. Unambiguous rules can facilitate cultivation of behavioural issues among colleagues (de Been et al., 2015).

The results highlighted that there is no standard specified by the A-FO concept on repeated use of workstations and scarce zones on consecutive days, thus this needs to be discussed and decided by each organization. The results of Study IV indicated that nesting (repeated use of the same workstation) occurs when (i) rules are implicit and ambiguous, (ii) the switching of workstations is perceived as too time- or resource-demanding, (iii) the perceived usefulness is insufficient, or (iv) no negative individual or group consequences are perceived. When nesting occurs in the scarce zones (for example back-up rooms or quiet rooms for 1-2 persons) or by the majority of the employees in the open-plan areas, it likely leads to implicit assignment of workstations. The employees that still apply clean-desk policies will avoid workstations that other people usually occupy (cf. Appel-Meulenbroek et al., 2011; Hirst, 2011). Consequently, the number of unoccupied workstations and desk-sharing ratio is more likely to be perceived to decrease, which leads to collective consequences such as limiting other employees’ autonomy or a team’s opportunity to find available or appropriate workstations. In order to decrease nesting tendencies clearly defined rules are recommended, specified through employee involvement (Studies II & V). In the cross-case study on rules (Study V) the cases that had discussed rules in the design and implementation processes were unified in how to use the A-FO, were more accepting towards the A-FO concept and reported fewer negative work condition consequences. In short, the employees experienced that explicit and unambiguous rules were important to feel more secure in their choice of actions, improved work conditions, and increased efficiency and work environment satisfaction.

7.5 Aim 5: Organizational preconditions

The final aim of the thesis was to investigate organizational preconditions that correlate with preference for A-FOs.

7.5.1 Culture, organizational structure and power conditions

The case that had the highest satisfaction and performance ratings (C2) had a culture which showed consideration for colleagues (Rolfö et al., 2017). A strong culture, defining values and norms, binds the organization together and motivates engagement (Jacobsen, 2013). Relocations to A-FOs can be used as a change management tool (Lahtinen et al., 2015) by organizations with the ambition to change culture, increase company pride, and unify employees across the organization (van Koetsveld & Kamperman, 2011). It has been suggested that an insufficient change in organizational culture can be of more importance than office design to why A-FO implementations fail (Haynes, 2008). Interestingly a strong culture can support, but also hinder change, as the change may threaten the culture and sense of coherence (Jacobsen, 2013).

Organizational structure and power conditions were also suggested to be associated with the outcomes (Studies II & IV). Unclear division of responsibilities for maintaining rules, and organizations’ size and hierarchical structure, may be reasons behind less defined speech and desk-sharing rules (Study V). The structure (e.g. degree of centralization) and power conditions are stressed in research literature to
influence the outcomes of an organizational change (Jacobsen, 2013) and highly relevant for implementing new ways of working (Kleijn, Appel-Meulenbroek, Kemperman, & Els, 2012).

### 7.5.2 Office type prior relocation

Spearman coefficient of rank correlation in Study V indicated that relocation from cell-offices can be more challenging for reaching employee satisfaction than relocations from open-plan offices. The model proposed by Riratanaphong & van der Voordt (2012) suggests the office type prior relocation to influence satisfaction and performance post relocation. A possible reason could be that the A-FO is normally based on open-plan spaces. Employees relocating from open-plan offices may be accustomed to the open-plan spaces to a higher degree than employee relocating from cell offices and shared offices (cf. Wohlers & Hertel, 2016).

### 7.5.3 Tasks and internal processes

Spearman coefficient of rank correlation indicated that work tasks are associated with satisfaction in A-FOs which is consistent with previous A-FO research (Gorgievski et al., 2010) and organizational change (Jacobsen, 2013). The case that had the highest satisfaction and performance ratings (C2) utilized digital processes rather than paperwork and was flexible in terms of work environment.

The aim of the A-FO concept is to support all kinds of tasks; communicative as well as concentrative work tasks (Appel-Meulenbroek et al., 2015). However, the Spearman test results indicate that A-FOs support innovation demanding tasks to a higher extent than concentration demanding tasks. A reason for the lack of support for concentrative tasks could be that the concept is normally based on open-plan areas with additional back-up spaces, not the other way around. In addition to this, speech policies commonly encourage interaction in open-plan areas. The lack of support for concentration demanding tasks could perhaps be improved if a more even distribution between interactive and concentrative open spaces are created. Brill and colleagues (2001) claim in their report that doing quiet work is the most common mode of work amongst office workers across all categories and organizations, even heavily teamwork driven organizations. Exceptions are managers and call centers (Brill et al., 2001). In contrast to other studies, most of the interviewees in C3 in this thesis reported on good opportunities to choose a quiet area, shielding oneself from interruptions and avoiding distractions (Study IV). This case had two open-plan areas, equal in size, with different speech policies (Study III). In this case the workspace and policies supported concentrative tasks, more than in the other cases. Another possible critical factor for support of concentration demanding tasks could be the number of back-up spaces. The results from Study V indicate that the A-FO does not support concentration demanding tasks, however, with a correct analysis of work the layout parameters and speech policies can change the A-FO to also support concentration demanding tasks.

The results from Study V showed that frequency of tasks demanding confidentiality of information did not correlate with preference for the A-FO. In contrast, in a project report, confidentiality of information was found to be a problem in A-FOs (Pettersson-Strömbäck et al., 2018). Type of confidential information, whether the information is confidential also for colleagues, and risks of external clients
overhearing confidential conversations over the telephone, needs further investigation.

7.5.4 External organizational context
All studies were conducted within the Swedish context with Swedish regulations and normative conditions, which may have influenced work environment satisfaction. Due to the external context, organizational change of a company in the United States of America differs from an organizational change in Sweden (Jacobson, 2013). Organizations in Sweden have been shown to have a more flat hierarchy than in many other countries (Hofstede, 1984) and have higher expectations of being able to influence the planning and design of work (Waluyo, Ekberg, & Eklund, 1996). According to Swedish law (1976:580) employees should be invited to participate in decisions regarding work conditions. This is a normative condition in the Swedish context. It is pointed out in van Koetsveld and Kamperman (2011) that implementations of A-FOs does not only include physical change but also includes organizational change in terms flexibility, autonomy and decentralization. As autonomy, decentralization and participation are more common in Swedish contexts, the implementation of A-FOs may be more permissive in Sweden than abroad. Comparative studies are needed.

7.6 A-FO definition
The desk-sharing policies and workspace diversity are interdependent components of the A-FO work system. The workspace diversity, enabled by plan layout and speech policies according to results in this thesis, distinguishes the A-FO from the flexible office/hot desking office concept (Figure 9). When A-FOs have no variation in acoustic settings, there seems to be little incentive to switch workstations or setting in the office, and nesting is more likely. Further, the desk-sharing policies are suggested to distinguish the A-FO from the combi-office or an over-crowded open-plan office. Combi-offices are also activity-based offices with workspace diversity, but have additional assigned individual workstations in either cell offices or open-plan areas (Bodin Danielsson & Bodin, 2008; de Been & Beijer, 2014). When the desk-sharing policies are violated, employees settle for a workstation, commonly in the open-plan area (cf. Hirst, 2011).

If workspace diversity is not provided, or desk-sharing policies not followed, the office will automatically turn into an open-plan office. Hence, if employees nest they do not benefit from the provision of different work settings and will thus not be supported to a higher extent than in an open-plan office (unless they are completely supported by a single office work environment). The same drawbacks found in open plan offices will be found in A-FOs. For example reduced performance have been shown in open-plan offices (Banbury & Berry, 1998). Hence, an A-FO where the ways of working are not changed, will not be conducive to performance and it can be questionable whether the reduced overhead costs actually are conducive to productivity.

As can be seen in Studies III and IV, some of the cases (C1, C4 and C5) perceived more demands than resources, compared to the other cases. Carayon and colleagues (2006 p.53) state that a system should be redesigned so that it is “easy to do things right and hard to do things wrong” to support change of the personnel sub-system
and individual actions. In an A-FO system it can be easy to remain in the same location even though other office settings support the current work task better. Hence, the physical and mental effort taken to relocate to work in another setting in an A-FO, as in transport time, finding and adjusting a new workstation, and getting acclimatized must be perceived as less demanding than the effort to remain within the setting, for example mentally blocking noise distractions if placed in the interaction areas. Another A-FO study illustrates the extra effort in time and energy on hindrances at the workplace, and the perception of heavy workload of switching workstations (Ruohomäki et al. 2009). Therefore the layout (e.g. placement of individual enclosed rooms in relation to the open-plan area), desk-sharing ratio, back-up-room ratio, interior design in terms of furniture and ICT-system, have detrimental effects on the perception of effort taken to relocate. The relative location of workplaces have previously been suggested to impact where activities are conducted (Appel-Meulenbroek et al., 2011). Easy access to meeting places have provided higher group cohesiveness and job satisfaction in A-FOs (Lee & Brand, 2005). Moreover, the A-FO should provide acoustic, visual and informative privacy through alternative workplaces and apply speech rules for employees to perceive added value of switching workstation. Inadequate number of workstations, back-up rooms, and zones with a lack of variety of speech levels can translate to low incentives to change workplaces (nesting), which increase physical and mental demands.

<table>
<thead>
<tr>
<th>Desk-sharing</th>
<th>Flexible office / Hot-desking</th>
<th>Activity-based Flexible Office</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td></td>
<td>Combi-office (or an over-crowded open-plan office)</td>
</tr>
<tr>
<td>Low</td>
<td>Open-plan office</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 10:** The office concepts’ relationship with workspace diversity and desk-sharing and speech policies.

### 7.7 Methodological discussion

#### 7.7.1 Case studies

The longitudinal single case (Studies I & II) and cross-case comparisons of four cases (III-IV) gave comprehensive understanding of design and implementation processes, workspace, rules and their consequences on work conditions in five A-FOs, and overall work environment satisfaction and perceived performance. Case studies are real cases and it is uncommon to find studies that make in-depth reports from more than one or two cases. However, case studies provide little basis for scientific generalization (Yin, 2009). The selection of five cases is too small to draw firm conclusions. For example the cases in this thesis include one floor A-FOs and small/medium sized private organizations, or departments of large private organizations. The transferability to larger multi floor sized A-FOs or public organizations is not studied. Moreover, the cases do not cover design and implementation processes from cell offices or all work tasks and activities that can
be conducted by knowledge workers. Other work tasks not studied in these case studies may prove challenging to conduct in A-FOs.

As commonly used in case study investigations, the interpretation of results in this thesis are based on empirical facts while taking theories (e.g. the model by de Croon et al., 2005) into consideration (cf. Alvesson & Sköldberg, 1994). A specific case can be interpreted with a hypothetical model that, if correct, can explain a situation. Hence, the case study can expand to generalise theories, also known as analytical generalization (Yin, 2009). The interpretation and theories are then corroborated and refined through new case studies (Alvesson & Sköldberg, 1994). The results from the case studies are supported by other research studies investigating interventions, participatory design, architecture, A-FOs, sociotechnical systems theories and organizational change (e.g. Jacobsen, 2013; Nielsen & Randall, 2013; Porras & Robertson, 1992). As stated by Yin (1984) case studies can be used as good examples and particular results can be generalized to broader theory.

Using the case study design no causal relationships can be identified, irrespective data collection and analysis methods. There will always be a degree of uncertainty due to for example bias in interviews and observations or the significance level being set to 0.05. A control group of employees not relocating or relocating to another office type would have been valuable to see whether the work environment satisfaction and performance was due to the relocation to A-FOs or other confounding factors, such as change in leadership. Nevertheless, studying A-FO transformations, where organizational changes are encouraged, it is challenging to distinguish the effects of the new work environment from the interdependent organizational, social and leadership changes. The triangulation of data, including the interviewees’ statements of causal relationships in the different cases, provides strong support that the design and implementation process, workspace, rules, and that it was the change to the A-FO that influenced perceptions of work conditions, work environment satisfaction and perceived performance for these cases.

The thesis stresses a number of factors that are associated, but are not internally or externally exclusive, with employee satisfaction and perceived performance in A-FOs. For example, high work environment satisfaction and perceived performance was in a case aligned with: good design and implementation processes as well as good workspace solution, appropriate organizational preconditions such as work tasks and hierarchy, and applied desk-sharing and speech rules. The snowball effect may be a reason for the covariance. For example, extensive design and implementation processes, which include employee empowerment, increase opportunities for addressing rules and adjusting the workspace to the work and other organizational factors. Correlation tests evaluating which of the factors that contributes the most to the outcomes and that test for confounding factors would have been beneficial.

7.7.2 Mixed methods
A strength of this thesis is the mixed method approach since it includes different types of objective and subjective data. Objective data (from plan layouts, photographs, planning documentation and observations) and subjective data (from questionnaires and 105 interviews) enabled triangulation and internal validation of data results. The objective data provided facts regarding the office design, design and
implementation processes and compliance with rules. As stated in research literature, subjective data provides valuable and informative insights for office design (Gerdenitsch et al., 2017) as it is the employees who are the best source of information on workers’ preferences, and evaluation of a specific place that cause users to consider it satisfactory or unsatisfactory (Vischer, 2008).

Much of the discussion section is based on interview results. The questionnaire data revealed changes and differences of physical comfort and functional comfort (to which degree the environment supported users’ tasks). However, individual needs extends beyond physiological comfort to psychological comfort and self-fulfilment (Gawel, 1997; Vischer, 2007). The interviews provided in-depth understanding of these concepts by discussing motives, feelings and ways of thinking.

One description of quantitative validity is “the scores received from participants are meaningful indicators of the construct being measured” (Creswell & Plano Clark, 2018, p. 217). A description of quantitative reliability is “scores received from participants are consistent and stable over time” (Creswell & Plano Clark, 2018, p. 217). In qualitative research validity has many definitions, whereof two interpretations are trustworthiness and authenticity (Creswell & Plano Clark, 2018, p. 217). The validity and reliability of the data collection methods are further discussed below.

7.7.3 Questionnaires

Being part of a doctoral thesis running over a five year period the baseline measurements did not always include questions in the questionnaire that would have been valuable for comparison over time. When the questionnaire was created the A-FO had been studied sparsely. The first version of the questionnaire was therefore mainly based on questions from validated work environment questionnaires, one thesis studying flexible offices and own face-validated questions. The questionnaire was later updated to achieve comparability with results from other research studies. Despite modifications, 62 within-subjects tests were conducted (Studies I & II), 172 responses were compared on 30 questions in Study III and 780 responses were compared on one question in Study V. A methodological strength of this thesis giving the results robustness, besides the large number of responses, is the high response rate, averaging 86%. The drop-outs in Study I is not known. For post relocation questionnaire in Study 2, of the 32 respondents of the pre-relocation questionnaire, two employees were on leave, and two did not respond.

Using the mean on ordinal data like the Likert scale is controversial (Denscombe, 2014), as ordinal scales are a set of ordered categories where the intervals may not be equal. Within this argument one school of thought claims that numerical operations are invalid (e.g. Jamieson, 2004). These operations are thought justified by another school of thought, which finds the parametric tests valid on Likert scale items if certain conditions apply, such as assumptions of skewness (Lubke & Muthén, 2004). Many studies go even further and state that ANOVAs are highly robust to skewness and non-normality and that many studies show this robustness (Norman, 2010). Further, a number of sources support that numerical operations on Likert scales are valid for sample sizes larger than 10 per group (Glass et al., 1972; Lubke &
DISCUSSION

Muthen, 2004; Boneau, 1960; Pearson, 1931). They have been shown to generate similar results as interval scales (Carifio & Perla, 2008; Traylor, 1983).

The overall aim of the thesis was to explore satisfaction and perceived performance of the A-FO’s physical and psychosocial work environment. In the questionnaire, the question “How satisfied are you with your physical work environment?” was posed. The intention was to measure overall work environment satisfaction. To avoid the perceived risk for employees interpreting the questions as only concerning aesthetics, it was placed at the end of the questionnaire after questions regarding ambient conditions, privacy and communication. Further, the question “Which office type do you prefer?” was posed in order to capture the unique features of the A-FO, referring to non-territoriality and space variety. Preference is an indicator of satisfaction, but also reflects employees’ previous experiences or preconceptions of other office types. Although statistical analyses are needed to confirm the assumption of relation to work environment satisfaction, the combination of these two questions were hoped to get closer to the overall satisfaction aim.

Perceived performance is challenging to measure as respondents may avoid to state they are not performing well or may interpret the question as amount of effort. A number of different parameters was therefore used. Cognitive tests could be valuable to evaluate the results from the questionnaires. Moreover, longer follow-up time could have been beneficial to capture possible changes over longer time-spans. A previous study showed that perceived quantity and quality of performed work increased significantly 15 months after relocation to A-FOs (Meijer 2009).

7.7.4 Interviews
The deepening of reasoning and interpretation of results are based on the interviewer’s skills and knowledge (Kvale & Brinkmann, 2014). In semi-structured interviews the interviewees immerse into what the interviewer finds meaningful, which may have limited the results. However, to explore and probe into work environment satisfaction and perceived performance of the A-FO’s, many similar general questions were asked in the interviews such as satisfaction/dissatisfaction, strengths/weaknesses, and opportunities/concerns. The interviewer also used the opportunity to dig deeper into reasoning when new concepts were encountered.

The short time (two months) after relocation the evaluation was conducted in C3 may question whether employees’ actions had learnt to use the office. Although observations and interview results indicated that the employees had settled to a high extent, later follow-up would have been valuable to confirm the results. Central concepts were, however, brought up by all cases, irrespective of time interval.

Moreover, the interplay between the interviewer and interviewee is shaped by the situation, the context and the relationship between the interviewer and interviewee (Lantz, 2013). The interplay may have been influenced by age and gender of the interviewer. Also the interviewees’ names were noted and the interviews were recorded (with consent), which may have influenced honesty and caused unease amongst the interviewees. Social desirability effect may have existed in some cases, referring to a tendency to give answers that the employer or researcher desire (Hongisto, Haapakangas, Varjo, Helenius, & Koskela, 2016). That one of the cases
tried to win a price for the best place to work, may also have influenced the reliability of the responses (the competition evaluation was not based on the research results presented in this thesis). To decrease risks of bias all questions were neutrally posed.

The design and implementation process factors are, besides the correlation between employee empowerment and work environment satisfaction and perceived performance, solely based on interviews, which may question the reliability of the results as interviews are based on perceptions, prejudices and assumptions. Therefore, when creating the conceptual framework the results from the interviews were compared to existing research literature.

The most comprehensive analysis of interviews was the content analysis jointly conducted by two researchers in Study IV. To increase reliability of the analyses, they could have been conducted separately and compared. However, each categorization and interpretation of interview responses were discussed. Debates between the researchers included for example interpreting interview comments exactly as stated or interpreting underlying meaning using previous knowledge about the cases from visits, observations and questionnaire responses. These debates were perceived to enhance the reliability of the interpretations and reduce risk for bias. In addition the discussions between the researchers uncovered new thoughts and views of the A-FO.

Quantifying interview results are controversial as the aim of interviews normally is to understand people’s viewpoints and subjective reasoning (Alvesson & Sköldberg, 1994). However, when doing qualitative research it can be sensible to perform simple quantifications to be used as contextual information (Alvesson & Sköldberg, 1994).

7.7.5 Observations
As employees’ office presence can fluctuate between weeks and time of the year, it is difficult to know whether the observations of the occupancy ratio were representative for normal working days. For Study I, half a day of observations were excluded when it was realised the afternoon was not representative. Moreover, there was a difficulty in interpreting the claimed but unattended workstations in Study I. After discussions with employees the code for “claimed” was displayed by the workstation’s computer screen being locked.

7.7.6 Documentation
In one of the studies (Study I) reasons for relocating to the A-FO was based on an internal assessment document. There is a risk that this document was used to put the relocation project in good light. The reliability of the document may therefore be questioned. The statements from the document was therefore presented with complementing results from observations of the context and interviews. Another complication was the plan-layouts not being updated with for example additional workstations (Study II). Notes were taken before the observations and the plan-layouts were updated in Photoshop.
'I have to mentally prepare every morning. Where was I? What was most important? Takes a lot longer to get started.'
– Case 3, Interviewee 9
Conclusion

This thesis explored and assessed perceptions of the workspace and work conditions, work environment satisfaction and perceived performance. A comparison of 11 cases showed that preference for the A-FO before other office types varies between 13-92 %. Four of the cases studied in more detail in this thesis were among the top five cases, and showed that the A-FO can be the most preferred office type amongst A-FO occupiers, and satisfaction with the workspace, work conditions and perceived performance can increase after relocation from open-plan offices to A-FOs. Workspace factors such as acoustic privacy, possibility of privacy, outdoor view, visual comfort and aesthetics increased significantly after relocation to A-FOs. The cases with most satisfied employees were positive towards the concept already before the change. The results indicate that reasons for positive outcomes are the combination of having sound design and implementation processes, a workspace diversity with ample desk-sharing and back-up room ratios, and rules that support work and clarify how to act in the A-FO. Internal and external organizational preconditions, such as office type before relocation and work tasks seem to facilitate or hinder the implementation (Figure 8).

The exploration of design and implementation processes showed that employee empowerment in the A-FO design process had a strong positive correlation with work environment satisfaction and perceived performance. Identified factors contributing to overall employee satisfaction were (1) change objectives meaningful to the employees (2) ample financial and time resources, (3) methodological approach, (4) focus on organizational and social change, (5) open and adequate communication, (6) high management commitment, and (7) competent consultants. Various methods can be used in different stages of the design process; participatory and communicative methods as well as professional work environment methods. Methods such as a work analysis and workshops for deciding rules and policies are essential for customizing the A-FO to the internal organizational context. Design and implementation processes methods are recommended in a methods framework.
CONCLUSION

The exploration of workspace design and rules indicated that A-FOs with varying acoustic environments, and generous space ratios (e.g. desk-sharing ratio) were aligned with high satisfaction with office plan layout, ambient conditions and mental work conditions. Moreover, employees in the A-FOs with most back-up spaces and well separated zones, and with workstations well separated from corridors, were most satisfied with privacy parameters. These spatial factors, in combination with the specification and application of desk-sharing and speech rules, were aligned with work conditions such as employee autonomy, privacy, inter- and intra-team communication, interpersonal relations, and physical and mental work conditions, as well as higher work environment satisfaction and perceived performance.

For the internal organizational context frequent performance of concentration demanding tasks correlated negatively, and frequent performance of innovation demanding tasks correlated positively with preference for the A-FO. Tasks demanding high confidentiality were not significantly associated with A-FO preference. Furthermore, employees coming from open-plan offices preferred the A-FO to a higher extent than those coming from cell offices. Internal and external organizational context, such as culture, structure, power conditions and normative conditions need further investigation.

In summary, A-FOs can be perceived as noisy workplaces that create extra work, decrease interaction and create uncertainties in how to act. However, A-FOs can also be perceived with high work environment satisfaction and perceived performance. This thesis has stressed the importance of a holistic sociotechnical viewpoint during A-FO implementations, and the importance of employee involvement and empowerment, workspace diversity and desk-sharing policies.
‘I feel more creative when I can choose where to sit. It’s the best thing with this office.’

– Case 1, Interviewee 20
9

Practical implications and future work

9.1 Practical implications
For A-FO implementations that generate high level of employee satisfaction and performance this thesis encourages a drive towards a combination of having the right internal organizational preconditions, sound design and implementation processes, a physical office solution that supports work and individual preferences, and rules that support work and clarify how to act in the A-FO. Organizational preconditions, such as innovative work tasks, flat hierarchical structures, strong culture and an open-plan office type prior to relocation may facilitate implementations of A-FOs. The organizational and social structures need to be changed in symbiosis with the physical change.

Important design and implementation processes factors include meaningful and comprehensible objectives for employees and allocation of time and financial resources. The organizational and social structures and policies need to be changed in symbiosis of the physical change. Methods and a methods framework can be used to facilitate participation of employees and work environment professionals throughout the design and implementation processes, and facilitate communication. A methodical approach including a comprehensive initial work analysis, and employee participation and empowerment facilitate discussions, communication, analysis of work processes, which in turn can facilitate mental preparation and acceptance of the new work system. The change will likely not generate high employee satisfaction if employees do not believe the A-FO will reach the objectives and solve the potential problem. The methods framework (section 6.2.2) can be used to facilitate the process, and involve employees and work environment professionals.

The physical office is suggested to have ample desk-sharing and back-up room ratios, areas with different acoustic settings, corridors separated from workstations, and a low number of workstations in a row and per area. When calculating and following up on ratios, office presence needs to be considered.
Rules in the A-FO need to be discussed by employees covering, for example, allowance of occupying the same workstations in open-plan and enclosed areas on consecutive days, and the allocation of areas where speaking on the phone, and verbal interaction with colleagues and interruptions, are allowed or forbidden. These rules need to be explicitly stated.

9.2 Future work

A conceptual framework, based on empirical research results and literature, is presented in this thesis that stresses factors that are associated with work conditions, work environment satisfaction, health and perceived performance. Studies are suggested that confirm the framework and specific interconnections. Deeper knowledge is needed on specific contexts; company size, type, age, history and hierarchical structures may influence the match between work activities and A-FO solutions. For example, multiple floor A-FOs are suggested to lower work environment satisfaction due to difficulties for employees to find colleagues and available work spaces (Brunia et al., 2016). More studies are needed that address these aspects of the A-FO.

For some of the methods in the methods framework it had not been specified by reference literature when in the design and implementation process they were recommended to be used, and some methods were suitable for several stages. Although the methods framework, and many of the methods therein, have been used and evaluated by work environment professionals (Study VI), the placement of the methods in the methods framework, and applicability of each method in different A-FO contexts, need further evaluation.

The results of the thesis indicate that A-FOs increase inter- and intra-team communication (Study II) and facilitate innovation (Study V). Redundant structures where employees have overlapping tasks is a characteristic of organizations with a high degree of innovation (Jacobsen sid 107). The impact of internal organizational structures (such as redundant structures), in combination with flexible working in A-FOs, on innovation needs further research. Having a home base (Morrison & Macky, 2017), which is implemented in some A-FOs, and ICT solutions may also influence transitioning and the expected benefits of the A-FO. Further, although Study V investigates work tasks, more knowledge on how work activities, work procedures and professions affect workspace dimensions, satisfaction and performance is needed. For example, managers are predicted to be involved to a high extent in formal and informal meetings (Appel-Meulenbroek et al., 2015). It has been suggested that employees with a low level of task variety do not need different work locations. Looking for an appropriate workstation every day might be a stressor that exceeds the benefits of flexible working in A-FOs (Wohlers & Hertel, 2016). Furthermore, a discussion on the architectural design and specification of space ratios have been initiated in this thesis. Further elaboration and more examples in other A-FOs are needed for more definite specifications as well as more clear descriptions of an A-FOs’ architectural qualities and weaknesses. Additionally, performance and productivity in A-FO work environments need more objective investigation to confirm or disconfirm subjective results such as perceived performance.
Moreover, there is a gap in knowledge concerned with the match and mismatch between specific internal and external organizational preconditions, work activities and A-FO solutions as well as the consequences of the matching between the A-FO solution and the work activities on the psychosocial work environment. A-FOs have been critized for problems with cohesion, psychological illness (Morrison & Macky, 2017) but also the opposite in terms of self-rated health (Bodin Danielsson & Bodin, 2008; Kim et al., 2016). Studies are needed that systematically investigate the relationships between psychological illness and work tasks, and the design and implementation processes of A-FO work environments. An overview of how these aspects influence work engagement, job crafting, well-being, psychosocial work environment and psychosocial health is needed.

The variance of preference for the A-FO ranging from 13-92 % (Study VI) indicate that reasons for preference are based on group and organizational level factors. The individual level perspective that includes personality, impairment and age is, however, an ongoing debate. Apart from agreeableness having a negative interaction with distraction and job satisfaction in A-FOs, no other associations between the A-FO working environment and personality traits have been found (Seddigh, 2015). The lack of individual adjustments in A-FOs for people with, for example, cognitive difficulties have also been stressed (Pettersson-Strömbäck et al., 2018). Moreover, the working population is aging (Shah & Robinson, 2007). Since society needs to take better care of the older working population (Eriksson, Wahlström, Nordin, Hofverberg, & Pettersson-Strömbäck, 2014), and other groups, more studies on how these groups are influenced by flexible working and A-FOs are needed.

Abrahamsson and Johansson (2013) describe normative and rational approaches for good psychosocial work environment implementations. The normative philosophy is applied by organizations that emphasize using participation, corporate culture, values and symbols, and learning is a motivator for change (Abrahamsson & Johansson, 2013; Kampschroer & Heerwagen, 2005). For a normative change project the primary question is not how to perform work more efficiently, but the work actually done and whether employees’ capabilities can be utilized in a way that is consistent with their life (van Koetsveld & Kamperman, 2011). The rational philosophy is applied by organizations with a problem-solving perspective (Kampschroer & Heerwagen, 2005) and is based on the idea that people and organizations are preferably managed by technology, centralization, standardizations and rules (Abrahamsson & Johansson, 2013; Kampschroer & Heerwagen, 2005). The ambition to streamline collaboration, optimize use of ICT and design of space to facilitate completion of work tasks leads to, in the best case, an integral A-FO where people adopt a workstyle that increases trust, increases self-control and creates a unification of goals (van Koetsveld & Kamperman, 2011). Investigating normative and rational approaches and their relationships with A-FO outcomes would be interesting.
Acknowledgements
The 5 years of work behind the construction of this thesis have profoundly changed and shaped me and my life. Leaving my home, family and friends in Gothenburg and starting a new life in Stockholm proved to be very nourishing.

So first of all, I would like to thank AFA Insurance for providing resources that made the PhD position possible. I greatly enjoyed working in the project “projektering och planering av nya arbetsmiljöer” and hope I can be involved in other applied research projects that promote good work environments, performance and health at work. It has brought meaning to my work. A special thank you to the case organizations and the employees who answered numerous and long questionnaires and who set aside time for interviews. Also, I would like to thank Office Ergonomics Research Committee (OERC) for inviting and flying me to the Marconi meeting at the Chautauqua Institution in upstate New York. It was a great learning experience.

Jörgen Eklund, the stripping professor and my supervisor. I am deeply grateful to you for giving me challenges, support and freedom (and of course for approving nice conference travels). Your extensive knowledge, experience and strategic mindset have guided me and expanded my knowledge as a researcher. I have enjoyed our meetings, especially the times you’ve been useful and when preparing role play presentations.

I also wish to thank Dr. Christina Bodin Danielsson, my co-supervisor, for being frank, giving honest feedback and showing the architectural viewpoint in my world of ergonomics viewpoints. Dr. David Hallman, Prof. Mats Ericson, Peter O'Reilly, Anna Williamson and Karin Andersson, thank you for reading and giving feedback on the thesis. David and Peter, the thoroughness and enriching feedback exceeds highest expectations. The time you spent on my work was very generous of you.

A special gratitude to my co-authors, Dr. Helena Jahncke and Lic. Maral Babapour, for teaching me scientific writing. I have had the privilege to work with and learn from you. Thank you Maral for fantastic collaboration, great explanations and good discussions. I hope this is not over.

With a special mention to my colleagues and friends; the unifying Ellen Jaldestad, the reliable Dr. Andrea Eriksson, the skilled Anna Williamson, the energetic Dr. Linda Rose, the helpful technical genious Liyun Yang, the wild Karin Andersson, the dark and handsome Catalanian professor Mikael Forsman, the storytelling professor Mats Ericson, the sharp Dr. Annika Vänje, the forever youthful Lic. Lena Nord Nilson, the wise Malin Håkansson, the diplomatic Dr. Marcus Strömgren, the philosophic Dr. Carl Lind, the prudent Dr. Pernilla Lindskog, and the Petrus cliff Dr. Kjestin Vogel. I am humble towards your fine characteristics, ambitions, knowledge and generosity towards others (read me). You are truly great. It has been a pleasure working with you and getting to know you during fikas, work outs and writing camps.

Thank you Alexandra Nadiya Rudyk Kinannder and Anna Bella Rosell, for nice travels and making life enjoyable and less lonesome after relocation to Stockholm.
Where to travel next? Thanks also to Gunnar och Anne-Marie Åhlander for lending your cabin to the Ergonomics department for writing camp purposes, and numerous lunch boxes, giving me more time and energy to spend on work. A special thanks to my old friends Malin Sundemo, Jeanette Zackariasson and Helen Magnusson for not being too angry about my relocation to Stockholm. Helen, thank you for telling truths I don’t want to hear and cheering me up as only you can.

I want to send a thankful thought to my eternal cheerleader - my mother who believes I can do anything I want better than everybody, and who listens to all my academic issues and stories about my frustrating, and fantastic, colleagues and supervisors. Also, thanks to my sister for being a role model on social skills and showing ideal ways to include people in discussions.

Lastly, I am thankful to you Martin, for driving and getting me home from work, making my life proportional and calming me down. Your all-knowing knowledge and different viewpoints makes life so much more resourceful. Thank you for dancing me through life. Du & Jag!

Tullinge, October 2018
References


REFERENCES


REFERENCES


The table presents the questionnaire used in studies I-V. The questionnaire was used in total 6 times; 2 times at C1, 2 times at C2, and once each in C3-4. The table presents the variables analysed in respective study, as well as scale, scale variables, number of scale points, scale type, and variable origin. The following item origins are included: Babapour: Unpublished questionnaire by Maral Babapour, Chalmers University of Technology; Brennan: Published paper (Brennan et al., 2002); COPSOQ: Copenhagen Psychosocial Questionnaire (Pejtersen et al., 2010); Jahncke: Unpublished questionnaire by Helena Jahncke, University of Gävle, used in 2011. It is based on an “industry standard” Post-Occupancy Evaluation (POE) database from CBE (Center for the Built Environment) at the University of California, Berkeley. CBE’s occupant survey questionnaire is one of the most widely used POE tool at present and is also prescribed within the IEQ section of building rating systems such as LEED (USGBC, 2009) and in Australia, NABERS (2009); LOHP: Leadership/Organization/Health/Production Questionnaire (Fagerlind Ståhl, 2015); Moberg: thesis by Anna Moberg, University of Linköping (Moberg, 1997); Seddigh: Published paper (Seddigh et al., 2014); SWEBO: Scale of Work Engagement and Burnout - SWEBO (Hultell & Gustavsson, 2010).

<table>
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<th>Scale type</th>
<th>Scale</th>
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<td>5</td>
<td>Ordinal</td>
<td>Never - always</td>
<td>COPSOQ</td>
</tr>
<tr>
<td>9</td>
<td>Count</td>
<td>5</td>
<td>Ordinal</td>
<td>Never - always</td>
<td>Jahncke</td>
</tr>
<tr>
<td>10</td>
<td>Overview multiple things</td>
<td>5</td>
<td>Ordinal</td>
<td>Never - always</td>
<td>Jahncke</td>
</tr>
<tr>
<td>11</td>
<td>Make phonecalls</td>
<td>5</td>
<td>Ordinal</td>
<td>Never - always</td>
<td>Jahncke</td>
</tr>
<tr>
<td>12</td>
<td>Secrecy</td>
<td>5</td>
<td>Ordinal</td>
<td>Never - always</td>
<td>Own</td>
</tr>
<tr>
<td>13</td>
<td>Which office type did you occupy before relocation?</td>
<td></td>
<td>Categorical</td>
<td>Cell, shard, small, medium, large OPO, Flex, Combi, Other</td>
<td>Own</td>
</tr>
<tr>
<td>14</td>
<td>To what extent are you pleased with the participation in decision making regarding the design of the new premises?</td>
<td>5</td>
<td>Ordinal</td>
<td>High extent - No extent</td>
<td>Own</td>
</tr>
<tr>
<td></td>
<td>Space configuration</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 11: Questionnaire used in studies I-V
| 15 | o | o | ... distance between you and your colleagues? | 7 | Interval | Very dissatisfied / satisfied | Jahncke |
| 16 | o | o | ... the degree of privacy with walls, separation panels and furnishings around your work place? | 7 | Interval | Very dissatisfied / satisfied | Jahncke |
| 17 | o | o | ... the possibility to retreat to private areas for conversations, phone calls or quiet, concentrated work? | 7 | Interval | Very dissatisfied / satisfied | Jahncke |
| 18 | o | o | ... the size of your work place in the aspect of receiving visitors? | 7 | Interval | Very dissatisfied / satisfied | Jahncke |
| 19 | | | ... aesthetics of the work place? | 7 | Interval | Very dissatisfied / satisfied | Jahncke |
| 20 | | | ... functionality of furniture (chairs, tables, drawers...)? | 7 | Interval | Very dissatisfied / satisfied | Moberg |
| 21 | | | ... storage opportunities? | 7 | Interval | Very dissatisfied / satisfied | Babapour |
| 22 | o | o | ... the speech volume level you can hear from your workstation? | 7 | Interval | Very dissatisfied / satisfied | Jahncke |
| 23 | o | o | ... the amount of background noise (not speech) you can hear from your work station? | 7 | Interval | Very dissatisfied / satisfied | Jahncke |
| 24 | | | ... the conversation volume that you can hear from your workstation? | 7 | Interval | Very dissatisfied / satisfied | Jahncke |
| 25 | | | How often have colleagues phone conversations you can hear? | 5 | Ordinal | Never - always | Own, inspired by Babapour |
| 26 | o | o | ... the amount of light at your work station? | 7 | Interval | Very dissatisfied / satisfied | Jahncke |
| 27 | o | o | ... the visual comfort (glare, reflections, shadows etc.)? | 7 | Interval | Very dissatisfied / satisfied | Jahncke |
| 28 | o | o | ... the possibility to view the outdoors? | 7 | Interval | Very dissatisfied / satisfied | Jahncke |
| 29 | o | o | ... the temperature? | 7 | Interval | Very dissatisfied / satisfied | Jahncke |
| 30 | o | o | ... the airflow? | 7 | Interval | Very dissatisfied / satisfied | Jahncke |
| 31 | | | How easily do you have access to equipment you need to perform your work (printer, projectors)? | 4 | Ordinal | Very easy/difficult | Own |
| 32 | | | Physical work conditions | | | | |
| 33 | o | o | How often do you leave work material or belonging on a desk over night? | 5 | Ordinal | Never - always | Babapour |
| 34 | o | o | How often do you sit at the same workstation on consecutive days? | 5 | Ordinal | Never - always | Babapour |
| 35 | o | o | How often do you change workplace during a day (e.g. quiet room, meeting room)? | 5 | Ordinal | Never - always | Own |
| 36 | o | o | How many minutes do you spend per day on finding a suitable workplace? | 35 | Ratio | Minutes | Jahncke |
### APPENDIX

<table>
<thead>
<tr>
<th>Question</th>
<th>Scale Type</th>
<th>Scale</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>How often are you disturbed so that you cannot fully concentrate on your work task?</td>
<td>Ordinal</td>
<td>Never - always</td>
<td>Seddigh</td>
</tr>
<tr>
<td>To what extent are you distracted by people passing by?</td>
<td>Ordinal</td>
<td>High extent - No extent</td>
<td>Own</td>
</tr>
<tr>
<td>To what extent are you distracted by people sitting closelyby?</td>
<td>Ordinal</td>
<td>High extent - No extent</td>
<td>Own</td>
</tr>
<tr>
<td>Have you at work the latest two weeks felt easily distracted?</td>
<td>Ordinal</td>
<td>Never - always</td>
<td>SWEBO</td>
</tr>
<tr>
<td>Have you at work the latest two weeks felt fully concentrated?</td>
<td>Ordinal</td>
<td>Never - always</td>
<td>SWEBO</td>
</tr>
<tr>
<td>... the possibility to adjust your work station (e.g. with flowers, pictures)?</td>
<td>Interval</td>
<td>Very dissatisfied /satisfied</td>
<td>Jahncke</td>
</tr>
<tr>
<td>...the possibility to adjust the interior to meet your individual needs (chairs, tables, drawers ...)?</td>
<td>Interval</td>
<td>Very dissatisfied /satisfied</td>
<td>Jahncke</td>
</tr>
<tr>
<td>... the acoustic privacy at your work desk (possibility to make conversation without neighbours hearing)?</td>
<td>Interval</td>
<td>Very dissatisfied /satisfied</td>
<td>Jahncke</td>
</tr>
<tr>
<td>... the visual privacy at your work station (to not be observed)?</td>
<td>Interval</td>
<td>Very dissatisfied /satisfied</td>
<td>Jahncke</td>
</tr>
<tr>
<td>When you are at the office, how many times per average day do informal meetings occur (walking over and asking a colleague something, or a colleague asking you something)?</td>
<td>Ratio</td>
<td>No. of times</td>
<td>Own - inspired by Moberg</td>
</tr>
<tr>
<td>When you are at the office, how many times per average day do spontaneous meetings occur (e.g. when collecting print-outs or mail)?</td>
<td>Ratio</td>
<td>No. of times</td>
<td>Own - inspired by Moberg</td>
</tr>
<tr>
<td>How is the productivity within the team?</td>
<td>Ordinal</td>
<td>Very good/bad</td>
<td>LOHP</td>
</tr>
<tr>
<td>How does intra-team cooperation work?</td>
<td>Ordinal</td>
<td>Very good/bad</td>
<td>LOHP</td>
</tr>
<tr>
<td>How well do new ideas spread within the team/unit?</td>
<td>Ordinal</td>
<td>Very good/bad</td>
<td>LOHP</td>
</tr>
<tr>
<td>How well do new ideas spread to other teams/units?</td>
<td>Ordinal</td>
<td>Very good/bad</td>
<td>LOHP</td>
</tr>
<tr>
<td>How well does work-related communication function between the colleagues in your team/unit?</td>
<td>Ordinal</td>
<td>Very good/bad</td>
<td>Moberg</td>
</tr>
<tr>
<td>How do you perceive the spreading of information in units/departments all in all?</td>
<td>Ordinal</td>
<td>Very good/bad</td>
<td>Moberg</td>
</tr>
<tr>
<td>... ease of interaction with colleagues?</td>
<td>Interval</td>
<td>Very dissatisfied /satisfied</td>
<td>Jahncke</td>
</tr>
<tr>
<td>... is it easier or more difficult to quickly get hold of one of your closer colleagues for a shorter errand?</td>
<td>Ordinal</td>
<td>Much more difficult/easy</td>
<td>Moberg</td>
</tr>
<tr>
<td>... is it easier or more difficult to gather together colleagues if needed?</td>
<td>Ordinal</td>
<td>Much more difficult/easy</td>
<td>Moberg</td>
</tr>
<tr>
<td>... does the information exchange with your closest colleagues work better or worse?</td>
<td>Ordinal</td>
<td>Much better/worse</td>
<td>Moberg</td>
</tr>
<tr>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>57</td>
<td>○</td>
<td>… does cooperation (coordination, problem-solving, decision-making etc.) with your closest colleagues work better or worse?</td>
<td>5</td>
</tr>
<tr>
<td>58</td>
<td>○</td>
<td>… does the verbal communication with your closest colleagues work better or worse?</td>
<td>5</td>
</tr>
<tr>
<td>59</td>
<td>○</td>
<td>… does competence exchange with your closest colleagues work better or worse?</td>
<td>5</td>
</tr>
<tr>
<td>60</td>
<td></td>
<td>How often do you get help from your colleagues within the team/unit?</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>61</td>
<td></td>
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<td></td>
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<tr>
<td>62</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>63</td>
<td>○</td>
<td>How satisfied are you with your physical work environment?</td>
<td>4</td>
</tr>
<tr>
<td>64</td>
<td>○</td>
<td>Does working in the new office function good or bad?</td>
<td>5</td>
</tr>
<tr>
<td>65</td>
<td></td>
<td>Which office type do you prefer?</td>
<td>8</td>
</tr>
<tr>
<td>66</td>
<td></td>
<td>The office design matches your work tasks optimally.</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>67</td>
<td>○</td>
<td>How often do you manage to be productive at your work station?</td>
<td>5</td>
</tr>
<tr>
<td>68</td>
<td>○</td>
<td>In comparison to before relocation do you work more or less efficiently?</td>
<td>5</td>
</tr>
<tr>
<td>69</td>
<td>○</td>
<td>In comparison to before relocation do you and your colleagues together work more or less efficiently?</td>
<td>5</td>
</tr>
</tbody>
</table>
Appendix B – Interview guide

- What is your name?
- How many years have you been employed at the company?
- Describe your most common work tasks during a week of work.
- How many hours per week do you spend within the office?
- How much of your work is concentrative respective cooperative work?
- Where do you choose to sit while doing these work tasks?
- Did you take part in the decision-making whether or not to implement an A-FO?
- Were you positive or negative towards the A-FO when you heard you were relocating to an A-FO?
- Were you positive or negative towards the A-FO right before the relocation?
- Did you participate in needs and activity analysis, and in design of the premises?
- How many hours did you spend on this?
- Are you satisfied with the process? Why?
- What could have been done differently?
- What in the process was most rewarding?
- Have you been able to influence the design? Give examples.
- Are you satisfied or dissatisfied with the outcomes (the A-FO after relocation)?
- What do you think contributed to the good/less good outcomes?
- What was the most positive change?
- What was the most negative change?
- Is your office optimally designed for your work tasks? Motivate please.
- Does the office satisfy all your space requirements?
- Are there work tasks you choose not to conduct at the office? Why?
- Are you promoted or hindered to work flexibly/switch workstations according to work activity?
- Is it important to you to have colleagues in your vicinity?
- How has the social interaction changed?
- How has the cohesion changed?
- Biggest sources of irritation?
- What (other) strengths do you notice for your work in the new office work environment?
- What (other) weaknesses do you notice for your work in the new office work environment?
- Do you see new opportunities/concerns for your work in the new office work environment?
- Has the A-FO influenced your ability to perform (your work tasks)?
- Anything else that is influenced by the work environment and the office design that you would like to highlight?
- Please give three pieces of advice for others that are thinking about implementing A-FOs