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Dedicated to Mark Schilling and Franz Kühmayer,

true enablers of the future of work.

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Abstract

The economies of most western countries are changing and with them the world of work. In modern economies, which are increasingly information and service-industry centered, knowledge is the key to sustaining productivity and growth (Blok, Groensteijn, Schelvis & Vink, 2012). This transition puts knowledge worker and their particular needs into the spotlight. Knowledge workers' requirements on an office differ and has let to the developments of so-called flexible offices (Ruostela, 2012).

Flexible offices provide workers with no fixed desk but in turn a number of work scenario designated spaces they can freely choose from (Bodin Danielsson & Bodin, 2008). Typically these spaces are meant for individual concentrated work, meetings, phone calls or collaboration. Although scientists from very different fields of research have taken an interest in the effects this office type has on workers, till this date no synthesis of their studies results existed.

Overall fifteen studies met the criteria for this synthesis. To analyze the effects flexible offices have on workers' well-being as well as on communication and collaboration a meta-analysis was conducted. Following the results of research done so far, it was hypothesized that flexible offices would influence laborers' well-being, communication and collaboration. A literature review was done to evaluate the effects on workers productivity and performance. In this case prior studies let to the hypothesis, that flexible office would have no effect.

The meta-analysis revealed a very low but significant effect of r = 0.04 for workers well-being. Therefore flexible offices appear to not especially boost health, but are not particularly harmful either. The results for communication and collaboration show a low but significant effect of r = 0.16, suggesting that flexible offices do indeed foster the exchange among colleagues as intended by the design (Heerwagen, Kampschroer, Powell, & Loftness, 2004). The results of the literature review are inconsistent, with studies reporting positive, negative and in some cases no effects at all.

Keywords:

flexible office concept, innovative office concept, desk sharing, new work, well-being, health, communication, collaboration, productivity, performance

Abstract (German)

Die Ökonomien der meisten westlichen Länder haben sich wirtschaftlich als auch strukturell stark gewandelt. In modernen Volkswirtschaften, die primär auf wissens- und servicebasierenden Branchen bauen, kommt gerade Wissen eine neue Schlüsselrolle für wirtschaftliches Wachstum zu (Blok et al., 2012). Diese Entwicklung lässt Wissensarbeiter und damit auch ihren Ansprüche an eine Büroumgebung stärker in den Fokus rücken. Daraus entstand ist das Konzept der flexiblen Büroumgebung (Ruostela, 2012).

In flexiblen oder szenarioorientierten Büros wird häufig nicht für alle Mitarbeiter ein persönlicher Schreibtisch bereitgestellt, dafür können Arbeitsplätze frei in unterschiedlichen, an Arbeitsszenarien orientierten Flächen, gewählt werden (Bodin Danielsson & Bodin, 2008). Zu den typischen Flächen gehören Räume für konzentriertes und individuelles Arbeiten, Besprechungen, telefonieren und informelle Abstimmungen. Forscher unterschiedlichster Fachrichtungen haben sich mit den Effekten dieses Bürokonzepts auf Arbeiter beschäftigt, allerdings gab es bis dato keine umfassende wissenschaftliche Zusammenfassung ihrer Forschungsergebnisse.

Insgesamt fünfzehn Primär-Studien flossen in diese Analyse. Um den Einfluss auf das Wohlergehen, als auch auf die Kommunikation und Zusammenarbeit, von Büroarbeiter in flexiblen Büroumgebungen zu analysieren, wurde einen Metaanalyse durchgeführt. Auf der Basis bisher durchgeführter Studien wurde die Hypothese aufgestellt, dass flexible Büroumgebungen einen Einfluss auf diese haben. Eine Literaturanalyse wurde angewandt, um die Effekte auf Produktivität und Leistungen zu evaluieren. Hier wurde zunächst die Hypothese aufgestellt, dass flexible Büros keinen Einfluss haben würden.

Die Metanalyse ergab einen sehr niedrigen aber signifikanten Effekt von r = 0.04 auf das Wohlbefinden von Arbeitern. Das Ergebnis kann als Indikator dafür gewertet werden, dass das Bürokonzept keinen gesondert positiven aber auch keinen schädlichen Effekt auf das Wohlbefinden von Arbeitern hat. Das Resultat für die Kommunikation und Zusammenarbeit zeigt einen ebenfalls niedrigen aber signifikanten Effekt (r = 0.16), welcher indiziert, dass flexible Bürokonzepte tatsächlich einen Einfluss haben auf diese Aspekte haben. Die Ergebnisse der Literaturanalyse waren inkonsistent und ergaben keine klare Antwort auf die Frage nach den Effekten auf Produktivität und Leistung von Arbeitern.

Schlüsselwörter:

flexibles Bürokonzept, innovatives Bürokonzept, Desksharing, Neues Arbeiten, Wohlbefinden, Gesundheit, Kommunikation, Zusammenarbeit, Produktivität, Leistung

Introduction

Nowadays we are facing drastic changes in the way we work (Manoochehri, 2003). Most western economies are transforming from agriculture and industrial manufacturing to a knowledge and service-based economy (Blok et al., 2012). Hence, knowledge became the key to productivity and economic growth. Knowledge intensive tasks are not only increasing in prevalence, but also in complexity and in their dependence on sophisticated technology (Vischer, 2007). At the same time does the introduction of new information and communication technologies, such as smartphones and laptops, allow for greater flexibility in how, when and where workers fulfill their jobs.

The majority of workers in the EU and the USA already works in offices (de Korte, Kuijt- Evers, & Vink, 2007). Today we know that poor working and office conditions can cause stress and malaise, possibly creating substantial costs for the organization (Bodin Danielsson, 2013). Meanwhile it is no longer only workers productivity that guarantees the company's success, but also their creativity and originality. That is why current research is increasingly focusing on how office design could foster well-being, health and satisfaction, as well as the possible influence workers creativity (Bodin Danielsson, 2013).

By its nature knowledge work is strongly cognitive as well as social (Heerwagen et al., 2004). The notion has grown in popularity that modern workplaces should be designed based on people's actual task requirements (Ruostela, 2012). Many national and international companies of diverse size and from various fields have recently changed their office concepts in order to better foster their workers' creativity and collaboration (Heerwagen et al., 2004). Several companies went from providing fixed workplaces for all their employees to a more flexible office concept, subdividing their offices into acoustic zones (Volker & van der Voordt, 2005) while decreasing the number of desks. The different zones commonly have drop in desks and are designed to suit different work styles, for example quiet areas that are being utilized for focused individual work, opposed to collaboration areas, often comfortably furnished, which are being used for group work. To prevent others from being disturbed by their colleagues' calls, some companies install phone booths and even establish social hubs for the relaxation of their staff. Becker and Sims (2001) summarize this shift quite accurately when saying that: ”Rather than thinking of the office as a

place primarily for solidary activity, from which one occasionally breaks out in time and space to settings intended for social activity, the office is designed primarily as a social setting, from which one occasionally seeks out more private place" (p. 52)

The majority of these office alterations are certainly being made with certain benefits in mind. Firms establishing new office concepts often hope to increase employee productivity (Blok, Groenesteijn, van den Berg & Vink, 2011) while reducing costs through making more efficient use of the existing space (Ornstein, Leite & de Andrade, 2001). Another motivation for initiating these particular changes in the office layout is to become more attractive for talented employees, by offering a more enjoyable work environment with a variety of working areas to choose from (Maarleveld, Volker, & van der Voordt, 2009).

Since these changes often require huge investments by the company, a better understanding of the effects of flexible office concepts on employees is essential. The objective of this thesis is to locate, analyze and synthesize existing scientific work on their observed effects of new office concepts on employees. The focus lies primarily on their impact on workers' well-being, communication, collaboration, productivity and performance.

Theoretical Background

Office Concepts

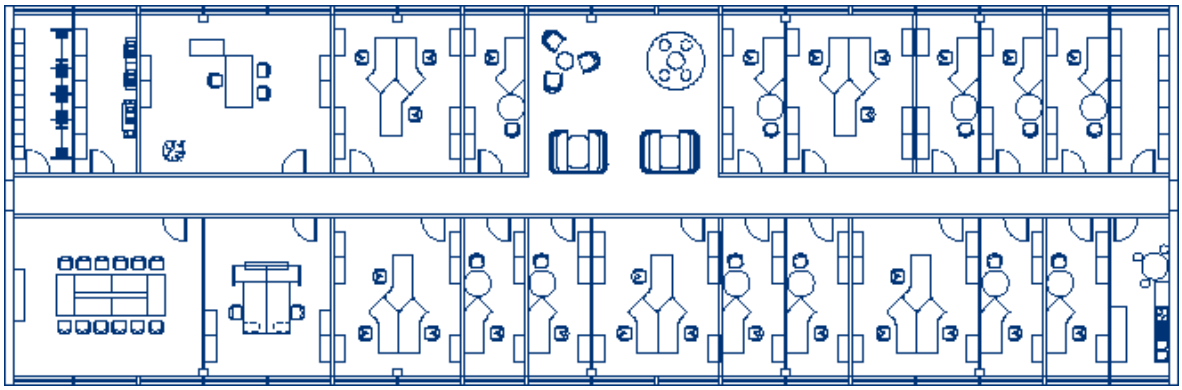
Office rent makes up the second greatest expense factor after human resources for most companies (Davis, Leach, & Clegg, 2011). Although teleworking has become more common during the last decade, the majority of white-collar workers in western countries still works in some kind of office environment (Duffy & Powell, 1997).

An increase in awareness of different workflows, work styles and requirements has led to a formation of diverse office concepts (Harrison, Wheeler, & Whitehead, 2004). Organizational literature offers several office type classifications. Harrison et al. (2004) for once differentiate workplaces on three levels – place, space and use. “Place” refers to the location, which can be an office building, as well as a home office or coffee shop. “Space” stands for the actual layout features of the place, for example open or closed. The applied office space concept (e.g. fixed desk vs. shared space) represents the „Use“ level. Whereas Duffy (1999) offers four categories for office types, each with a unique combination in physical and functional features. He distinguish between “Cell” - a single person room office; “Club” - a multiple task space, which he sees best suited for knowledge laborers working for example in advertising; “Hive” is an office that typically lacks interior walls and can host a great number of workers with individual workstations; and “Den” an office that consists of several team, meeting and work spaces. While Harrison et al. (2004) offer a rather broad definition that allows for many combinations of different model and room types, Duffy’s definition might be too narrow to categorize most modern offices (Danielsson, 2005).

Building on Duffy & Powell’s (1999) and Harrison’s et al. (2004) work Danielsson (2005) further developed the definitions of office classifications. She identified seven office types, categorizing them by their architectural and functional features. The architectural features mainly refer to the spatial organization of the office. The functional features are based on the work that is being done in the office. Five of these different office types follow a traditional outline, these are cell offices, smaller shared room offices (2-3 people sharing one room) as well as small, medium and large open plan offices. Figure 1 pictures an exemplary outline for a cell and smaller shared room office. Here a

maximum of three people are sharing one room, with single cell offices still prevailing. The space for informal exchange is limited, the focus lies on formal meeting rooms.

Figure 1*: Exemplary outline of a cell and shared room office*[1]



In addition Danielsson (2005) classified flex and combi offices. Flex offices are open plan workplaces with so called back up spaces, which are being used for focused work, meetings or phone calls. Employees choose their workstation freely and have no personalized desks (Bodin Danielsson & Bodin, 2008). Bodin Danielsson and Bodin state this to be the most flexible office type.

Figure 2: *Exemplary outline of a flex office*[2]

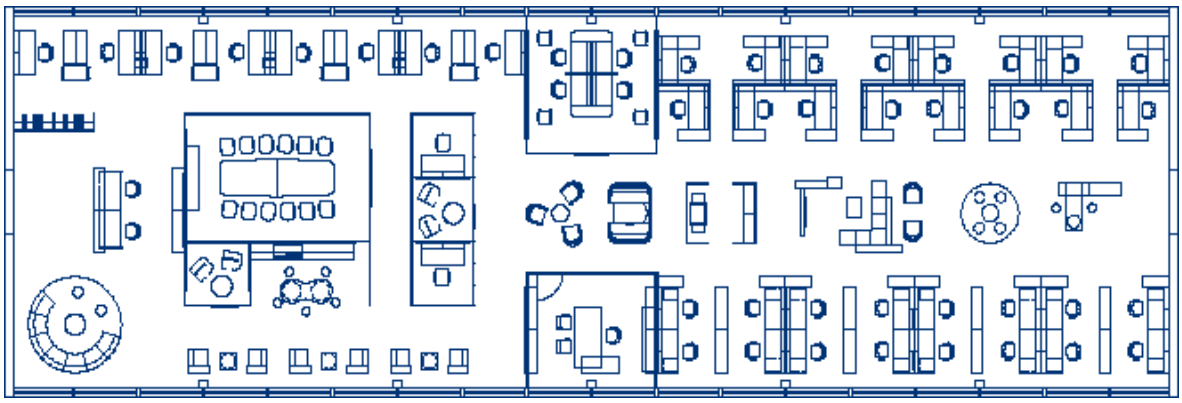


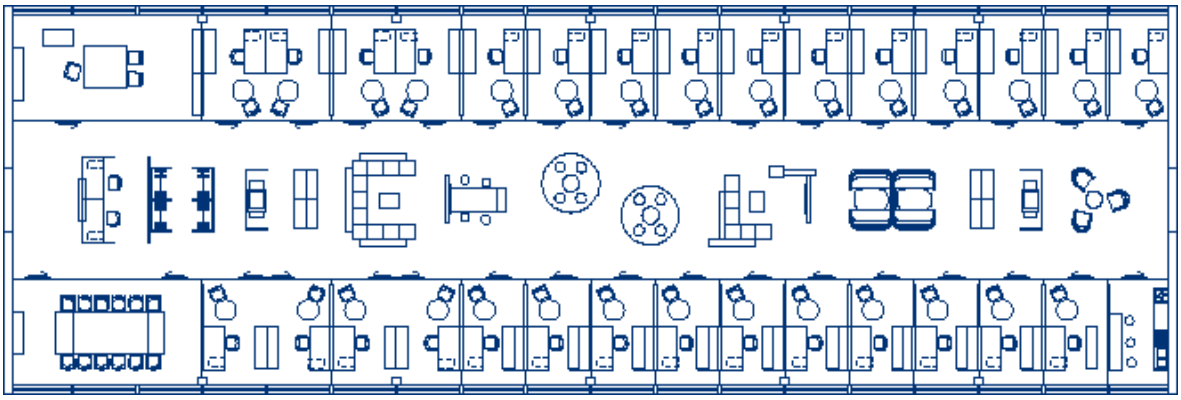
Figure 2 shows an exemplary ground plan of a flex office. Apparently only formal meeting areas and potential offices of superiors are intended to be separated by

[1] [2] Retrieved from: http://bene.com/en/office-furniture-concepts/planning-design/office-types

walls. Moreover plenty of space is designated for informal meetings. Davis et al. (2011) refer to these areas rather appropriately as “social hearts or hubs” (p. 206). They are mostly gathered in the center of the office and vary in size and layout.. All in all a very open office landscape is intended.

The Combi office is depicted by Bodin Danielsson and Bodin (2008) as being similar to the flex office, but with employees spending more time at their individual workstations, only switching to the backup spaces for long-term project work or formal meetings. Figure 3 depicts a possible combi office. Employees work in enclosed single or two person offices. Multi-functional areas are provided in the office center, but with fewer seats and variation in furnishing than in the flex office. Bodin Danielsson and Bodin (2008) concede in their paper that their categories of office types are still rather broad and that plenty of real life variations exist.

Figure 3: *Exemplary outline of a combi office*[3]



A New Way of Work and Flexible Office Concepts

The rapid changes in information and communication technologies, economics, social trends and organizational changes over the past 40 years demand an adaptation of the way we work (Volker & van der Voordt, 2005). „ Work environments are in a state of transition from something familiar and predictable to something not yet defined, multi-locational, virtual and physical “

[3] Retrieved from: http://bene.com/en/office-furniture-concepts/planning-design/office-types

(Gillen, 2006, p. 62) Until now the traditional corporate office makes up the majority in modern businesses (Elsbach & Bechky, 2007). Yet several new ways of working as well as office concepts are accelerating in response to recent dynamic developments (Elsbach & Bechky, 2007; Volker & van der Voordt, 2005).

According to Robertson & Vink (2012) common elements in the new way of work are flexible working hours, teleworking (working from home or while travelling), greater autonomy in the fulfillment of one's job, a objective oriented leadership, desk sharing and an appealing indesign that fosters communication. Overall new ways of work go beyond the mere physical workspace and technology, but deeply effect a company's organization and management as well as company culture (Blok et al., 2012).

Duffy & Powell (1997) argue that modern workplaces should offer employees a variety of work areas with different functionality, for example reading rooms, team rooms or café areas. A combination of this scenario based on working environment and desk sharing, appears to be especially fruitful for companies with workers who are spending a considerable amount of their time traveling or working at client offices, or from other remote locations, such as home office. In these occupations it is unlikely that 100% of the employees are going ever to be present in the office at the same time, which makes desk sharing a more logical option (Markland, 1995). Here different possible approaches exist such as hot-desking or hoteling. With a hot-desking concept workstations are available to every worker whenever required. Hoteling on the other hand implies, that workers have to reserve a desk for themselves before coming to work (Davis et al., 2011). At the same time, with colleagues spending fewer hours at the office, new needs of interactions and socializing emerge (Elsbach & Bechky, 2007). Flexible offices encourage exchange among workers, by eliminating walls and assigned desks, and offering a variety of meeting spaces (Heerwagen et al., 2004). In these new environments social exchange and communication are seen as most important qualities of an office (Harrison et al., 2004). The offices are based on the demands of different work activities or as Blok et al. (2011) put it "New Ways of Working is an outlook of ways of working that corresponds as closely as possible to the needs of the knowledge worker" (p. 5).

The Origins of Flexible Office Concepts

Although first ideas for new office concepts reach back to the 1970s, a broader attention on flexible working and the associated office concepts has just emerged in the past couple of years. (Van Meel, 2010). During that decade a multitude of driving factors impacted office work. Among them is the availability of mobile technology such as Laptop Computers, SmartPhones, which make it less and less necessary to work from a specific place (the office desk) but rather enable workers to fulfill many of their tasks away from their desk and even away from the office. The increase in female employees strengthened the demand for more flexible work environments. All these factors lowered the office occupancy rate, and hence the idea of desk sharing became popular in the 1990s (Appel-Meulenbroek, Groenen, & Jannsen, 2011). One of the first scientifically monitored flexible office concept was implemented in 1972 by IBM with a group of product engineers. Although they were successful in increasing communication within the department, an increase in performance could not be determined (Allen & Gerstberger, 1973).

Van Meel (2010) sees two major reasons, as to why these modern office concepts were rather poorly received until many years later. For once the necessary technologies were not yet established; digital devices lacked the required computing power, speed or portability. Secondly he attributes the management of the 1970 a lack of the proper mind-set. For flexible working to be successful, employees must have a high level of autonomy, trust by their supervisors and an objective-oriented leadership (Blok et al., 2011).

Risks and Benefits associated with Flexible Office Concepts

Several studies have shown, that the workspace itself can have a great impact on workers' job satisfaction (Veitch, Farley, & Newsham, 2007), motivation (Oldham & Brass, 1979) and communication (Sundstrom, 1986) and can potentially increase their productivity by 20% (Leaman & Bordass, 2005). Therefore it does not seem farfetched to expect that flexible office concepts should have a specific impact on their users as well.

While open plan offices are known to be noisy, to lack privacy and to visually distract (Harrison et al., 2004), cell offices tend to hinder communication and exchange among colleagues (Boutellier, Ullman, Schreiber, & Naef, 2008).

Bearing this in mind, an office concept that offers a variety of activity related workspaces appears to be the perfect compromise. In flexible office concepts employees are free to choose the workspace that best suits their current task and as a consequence – in theory – should make work more enjoyable and effective (Maarleveld et al., 2009). On top of that the organizational effectives is increased (Lee & Sawyer, 2010) and office space can be saved. At the same time a autonomy over one's work is assumed to be positively related to job satisfaction, performance and even well-being (Lee & Brand, 2005). Flexible workspaces also increase the exchange among team members, supporting a variety of daily work tasks (Berndt, 2000). However the cognitive research done by Seddigh, Berntson & Westerlund (2014) indicates, that the proximity to others might only be beneficial for tasks that are unfamiliar. Whereas once the tasks have been learned and have become routine, the proximity of co-workers might interfere with much needed focus.

Combined with attractive architecture, state of the art IT equipment and ergonomic furniture an increase in creativity, job satisfaction (Ruostela, 2012) and group cohesiveness (Lee & Brand, 2005) is supposed. The external effects should not be underestimated either, including the positive image on customers and partners, as well as a contribution to sustainability (Ruostela, 2012). In addition these concepts provide an opportunity to sharpen a companies image as modern and innovative and to increase employer attractiveness (Heerwagen et al., 2004).

A reduction in space, and consequently in rent, stands opposed to the high investments in advanced communication and information technologies, facilities and fees for various kinds of consultants and reconstruction supervisors (Davenport & Bruce, 2002). In addition major investments into modern and high-end furniture are frequently being made, in an attempt to compensate for the loss of personalization of one's own workplace (van der Voordt, 2001). How much space can be saved by the implementation of a flexible office highly depends on the number of part-time workers and the mobility of the employees in general (Davis et al., 2011; van der Voordt, 2001). At the same time deliberate fundamental management decisions have to be made, for example: Should the office offer a designated desk for every employee? Or should employees be required to book a desk for the days they are planning to spend in the office? Should all employees be asked to give up their personal desk or only those who

are working outside the office most of the time anyway? Eventually the office scale, amount of rent and the expected depreciation period will determine the if and when of the break-even point(van der Voordt, 2001).

In contrast to Ruostela (2012) Maarleveld et al. (2009) put forth the argument that desired positive effects of flexible offices, such as cost reduction and increased workforce productivity, come at the price of declining job satisfaction. Sure enough a commonly assumed drawback that is immanent to the concept of flexible offices is the lack of personal workspace. Volker & van der Voordt (2005) found in their study that only 20 % of employees are genuinely dissatisfied with not having their own desk. While the workplace might be designed according to task requirements, it can barely be adapted according to workers own personal needs (Maarleveld et al., 2009). Elsbach and Becky (2007) argue that the inability to possess and personalize one's workspace hinders employees in expressing their identity and in maintaining relationships with their colleagues, forcing workers to find substitutes or "proxies" in conduct, communication and symbolism to properly express their identities at work (Brunia & Hartjes-Gosselink, 2009). Also most flexible office concepts take away the staff's opportunity to express status (Volker & van der Voordt, 2005). This can mean great adjustments for some involved in the change process. Another inconvenience that comes along with the lack of a designated desk and a clean-desk policy, is the need to store one's work every night (Heerwagen et al., 2004). Due to their general openness, flexible offices often show a below average security rating (Gorgievski, Voordt van der, Herpen van, & Akkeren, 2010).

Privacy is an often discussed issue when it comes to flexible offices. In theory the perceived privacy should be even higher in flexible offices, since privacy is defined as being able to regulate the level of interaction with others (Nobuyuki, 2013), which is much easily achieved in a flexible office, compared to a fixed desk with limited opportunity to regulate interactions. Nevertheless in Volker and van der Voordt's (2005) study the lack of visual and acoustic privacy, for example for confidential staff appraisal, is perceived more gravely, causing 40% of the workforce dissatisfaction. Great distractions and excessive stimulation at the workplace can lead to fatigue and a forfeit in productivity (Volker & van der Voordt, 2005). Greater sense of privacy in a flexible office can be facilitated through effective lighting techniques and informal break areas, which help to create a more at home feeling (Pitt & Bennett, 2008).

Theoretically another disadvantage could arise from employees changing workplaces frequently, namely colleagues constantly searching for one another. On the contrary Gorgievski et al. (2010) found in their study, that the number of times workers actually changed workspaces during a regular day remained relatively modest, while an increase of home office time was registered. This impact can be compensated with investments into the company IT infrastructure, allowing for virtual meetings, shared presence information, exchange and document storage. Consequently, this thesis focuses on these three areas of impact.

Research questions and hypothesis

While there are studies on noise (Bodin Danielsson, 2008), organizational identification (Millward, Haslam, & Postmes, 2007), personalization (Brunia & Hartjes-Gosselink, 2008) and office satisfaction (Gorgievski et al., 2010), they are scarce and only followed up by few scientists. Enough research to justify a research synthesis has merely been published on the issues of workers well-being, communication and collaboration, performance and productivity.

During the past two decades the issue of well-being at the workplace has immensely increased in the general corporate focus (Kunter, 2009). Nonetheless knowledge and research especially on the effects of flexible office concepts on workers general health and well-being is still relatively thin. Only a handful of studies have been conducted investigating this particular relation. Bodin Danielsson & Bodin (2008) found that workers in flex offices report better health conditions compared to employees in open-plan offices. The research done by Meijer, Frings-Dresen, & Sluiter (2009) supports these findings. They recorded that employee's general health improved after the company relocated from an office with cell structure to a flex office. However Seddigh et al. (2014) were unable to find a significant difference in self-rated health between employees of different office types. In a later study Bodin Danielsson, Chungkham, Wulff & Westerlund (2014) even found that employees in flex offices went on sick leave more frequently, while workers in combi offices seemed to have a tendency for less sickness related absences.

There are several theories as to why flexible office concepts might have an impact on employee's well-being and health. We know that the personal control over one's surrounding environment plays a fundamental role in the well-

being of humans (Ward, 2012; Lee & Brand, 2005). Flexible work environments allow for just that, by enabling a person to freely choose the environment that best fits their current needs. On the other hand Sparks, Faragher & Cooper (2001) argue, that perceived autonomy is known to affect health and well-being. But people might differ in their desire for control in the workplace. Great autonomy at work might be empowering for some but stressful for other employees, causing divergent results. Bodin Danielsson et al., (2014) put forth the argument of flexible offices bearing a lower risk for infections, compared to for example open offices, since they tend to host a smaller number of people in one room and the peer control is greater in manageably sized offices. Yet another reason for the reported decrease in the discomfort of the overall body might be due to the improvement through the extra effort often put into the ergonomics of the workstations in new office (Meijer et al., 2009). Brunia and Hartjes-Gosselink (2008) theorize flexible offices might have a negative effect on well-being, since they ignore the universal need of personalization. As to why some studies might find no effect of flexible work environments on health at all, Seddigh et al. (2014) offer the following explanation: “It is also possible that such effect can be seen only after a prolonged exposure and follow-up time” (p. 173). All studies considered for the analysis of workers well-being can be found in Table 1. Altogether the discussed findings lead to the following prediction:

Hypothesis 1: Flexible office concepts affect office workers’ well-being

Table 1: *Overview of studies included in the hypothesis on well-being*

General health	*Meijjer et al. (2009)* *Bodin Danielsson & Bondin (2008)*
Change in health	*Meijer et al. (2009)*
Sick leave	*Bodin Danielsson & Bodin (2008)* *Bodin Danielsson et al. (2014)*

Physical problems	*Bodin Danielsson & Bodin (2008)* *Meijer et al. (2009)* *Robertson et al. (2008)*
Psychological problems	*Bodin Danielsson & Bodin (2008)* *Seddigh et al. (2014)* *Meijer et al. (2009)* *Bodin Danielsson & Bodin (2010)* *Gerdenitsch (2015)*

Especially in knowledge heavy industries collaboration is seen as the key to organizational success (Heerwagen et al. 2004). Collaboration describes two or more people working together, producing a joint output (Kraut, Egido, & Galegher, 1988). Their interaction can be of short or long duration. Short collaboration, happening in a matter of minutes, often occurs spontaneously, a quick exchange of ideas in the coffee kitchen for example, while focus lounges might be used for more extensive collaboration (Heerwagen et al. 2004). With an increase of public spaces and colleagues constantly changing the workspace, flexible offices are likely to have an influence on workers communication and collaboration (Blok, De Korte, Groenesteijn, Formanoy, & Vink, 2009). Workers changing the workspace several times a day speeds up the internal information flow and simplifies spontaneous team exchanges (van der Voordt, 2003). In their 2009 study Blok et al. found an increase of communication not only among colleagues but also with visitors. The research results of Bouttelier et al. (2008) reinforce the theory that people in flex offices have increased collaboration among one another. However the duration of the exchange seems to decrease in these particular office types. While de Been et al. (2014) also found an increase of communication and social interaction among the participants of their study, for them working in a flexible office did not lead to a higher satisfaction regarding the communication. The collection of studies that went into the meta-analysis is listed on Table 2. The arguments brought forth by the authors lead to the proposition of the following:

Hypothesis 2: Flexible office concepts do effect office workers

communication and collaboration.

Table 2: *Overview of studies included in the hypothesis on communication and collaboration*

Events of communication	*Boutellier et al. (2008)*
Duration of communication	*Boutellier et al. (2008)*
Communication with colleagues / visitors	*Blok et al. (2009)* *Allen & Gerstberger (1973)* *Blok et al. (2010)* *Gerdenitsch (2015)*
Satisfaction with communication	*Beijer & de Been (2014)* *Robertson et al. (2008)*
Collaboration	*Gerdenitsch (2015)* *Robertson et al. (2008)* *Gerdenitsch (2015)*

There are several hopes and wishes involved in the implementation of flexible office concepts. One is certainly an increase in employee productivity and general performance by creating a workspace that fosters collaboration and communication among colleagues (van der Voordt & van der Kloster, 2008).

Performance refers to a company's overall achievements, and is thus a complex, multidimensional phenomenon, that can be evaluated from several different perspectives (Ruostela, 2012). Among other factors, like efficiency and effectiveness, it is the workers' productivity that determines a company's performance (Hannula, 1999). In turn, their productivity is again influenced by a great number of factors, for example by leadership, company culture, technology, working conditions and the physical work space (Ruostela et al., 2014). Since there are so many factors influencing productivity alone, it is hard to isolate the factor workplace in research projects (De Paoli, Arge, & Blakstad, 2013). To further complicate the assessment of productivity, knowledge workers output can

barely be measured by quantitative factors and is seldom comparable (Appel-Meulenbroek et al., 2011).

So far research results on the influence of innovative office concepts on productivity differ. Van der Voordt (2004) studied two cases in which a new flexible office concept was introduced and found a positive influence on productivity in one and a negative influence in the other. He assumed that the different effects with more or less the same concept could partly be explained by a differing starting situation, e.g. open plan office versus cell office, as well as different strategies of implementation. Blok et al., (2009) showed no significant difference in performance between a traditional office and a flexible office, concerning the quality, quantity, creativity and perceived efficiency of work. These findings find support in the research done by Meijer at al. (2009) who, after a significant decrease in the self-described productivity immediately following the implementation of a new office concept, showed in the long term no difference compared to baseline. De Been & Beijer (2014) even discovered that employees in individual and shared room offices rated their work environment significantly more supportive for their productivity than employees in combi or flex offices. Table 3 displays all studies that qualified. Hence the third hypothesis of this thesis has been formulated as follows:

Hypothesis 3: Flexible office concepts do not influence office workers' productivity.

Table 3: *Overview of studies included in the hypothesis on productivity and performance*

Productivity eupport of the office	*Beijer & de Been (2014)*
Quantity of work	*Meijer et al. (2009)* *Blok et al. (2010)*
Quality of work	*Meijer et al. (2009)* *Blok et al. (2010)*

Perceived productivity	*van der Voordt (2004)* *Blok et al. (2009)*
Performance	*Allen & Gerstberger (1973)* *Seddigh et al. (2014)*

Method

> "*A methodological principle overlooked by writers of … reviews is that research results are probabilistic. What this principle suggests is that, in and of themselves, the findings of any single research are meaningless – they may have occurred simply by chance. It also follows that if a large enough number of researches has been done on a particular topic, chance alone dictates that studies will exist that report inconsistent and contradictory findings! Thus, what appears to be contradictory may simply be the positive and negative details of a distribution of findings.*" *Taveggia, (1974, 397- 398)*

Literature Search and Selection

Since scientists across several disciplines have taken an interest in flexible office concepts, a search was conducted in a number of electronic databases, including ProQuest, PsycINFO, PsycARTICLES, EBSCO, Scopus, EconLit and Web of Science. The search was carried out using the following keywords: *non-territorial office, activity based management, workplace/office design, new ways of working, flexible working/office environment, activity related/based work/office, multi locational* and *innovative offices.* The same terms were used to search the Internet and Google Scholar to locate on-going or unpublished research.

For studies to come into a closer consideration, they had to be written in either German or English. Secondly, the individual studies had to investigate the effects of a flexible office concept or a comparable concept, on workers' communication and collaboration, well-being or productivity and performance. Third, in order to be suitable for a meta-analysis, the effect sizes, or sufficient results to compute one, had to have been reported. This excluded for the meta-analysis studies without quantitative data such as literature reviews, theoretical or qualitative work. If data was used in more than one publication, all data was coded in the study first published.

Final Sample

The final sample consists of 15 studies, each researching effects of a flexible office type on workers' well-being, productivity, performance and/or

communication and collaboration. Approximately 15,000 workers participated in these studies. This includes small sized studies with up to 9 people (Allen & Gerstberger, 1973) to major nation wide studies researching several office concepts with over 11,000 participants (De Been & Beijer, 2014).

All studies were published between 1973 and 2014, but with a higher concentration of publications at the beginning of the new millennium. Most of the research has been conducted in Europe, especially in the Netherlands and Sweden. The remaining studies were conducted in the USA and in Australia.

The studies differ in their exact definition and implementation of the flexible office concept, describing it for example as a “multi-space concept” (Boutellier, et al., 2008) or an “activity-related concept” (Volker & van der Voordt, 2005). But they all have in common that at least a part, if not all, of the participants had no designated desk to themselves and chose their workspace from a variety of task facilitating spaces.

A detailed list of the operationalizations applied by the different studies, as far as the authors provided them, can be found the appendix.

Seven studies collected data on well-being, among them the concept was operationalized very dissimilarly. Some authors focused primarily on health in general (Bodin Danielsson, 2008; Meijer et al., 2009; Seddigh et al., 2014), in which workers were asked to self-rate their current health status. Others chose to evaluate sick leave rates (Bodin Danielsson, 2008; Bodin Danielsson et al., 2014), the change in health after the implementation of a new office concept (Meijer et al., 2009), or rated physical as well as psychological problems (Bodin Danielsson, 2008; Seddigh et al., 2014; Bodin Danielsson & Bodin, 2010; Brummelhuis, Bakker, Hetland, & Keulemans, 2012; Robertson et al., 2008). Psychological problems were for example measured with items such as: „I feel emotionally drained because of my work“ or „I feel used up at the end of my workday“ (Brummelhuis et al., 2012).

The influence of flexible office concepts on communication and collaboration was researched by seven different studies. While some studies preferred to evaluate the overall number and duration of communication events (Boutellier et al., 2008; Blok et al., 2009) others focused specifically on the communication with colleagues and visitors (Robertson & Vink, 2012; de Been & Beijer, 2014; Blok et al., 2009; Allen & Gerstberger, 1973). Data on the

perceived quality and satisfaction of the communication was collected by Brummelhuis et al. (2012) as well as by de Been & Beijer (2014).

Seven studies took an interest in workers' productivity and performance in flexible office concepts and found several ways of measuring it. Meijer et al. (2009) and Blok, Groenesteijn, Formanoy, de Korte, and Vink (2010) collected data on the changes in the quality and quantity of work. For example workers were asked how much work they had performed during regular hours compared to a normal working day (Meijer at al., 2009). Van der Voordt et al. (2004) chose a more direct approach, asking the participants with several questions to directly rate their perceived productivity. A sample item would be: „What percentage of time is spent working productively?". A similar approach was chosen in an earlier study done by Blok et al. in 2009. They requested workers to self rate their productivity before and after moving into a flexible office environment. Work performance was evaluated by Allen & Gerberger (1973) and Seedbigh et al. (2014). Beijer & de Been (2014) asked workers how they perceived the impact of the new office environment on their productivity.

Purpose of the Meta-Analysis

The development of new information and communication technologies has not only changed the way we work, but also let to an increase in research and its availability in general, raising the need for a better research synthesis (Eisend, 2014). Before the techniques of meta-analysis were developed, empirical research concerning similar topics was merely summarized, one study after another explained, interpreted and concluded (Cooper, 2010). A meta-analysis offers a more systematic technique to synthesize scientific research. The effect sizes of the different studies are collected, summarized and integrated, explaining one phenomenon as a whole, leading to a higher precision, reliability, validity and power of the findings opposed to the primary research (Rustenbach & Pawlik, 2003). Synthesizing the existing scientific results also allows the testing of hypothesis at a qualitatively different level and the refining of existing theories (Humphrey, Nahrgang, & Morgeson, 2007).

Conducting a meta-analysis on the effects of flexible office concepts appears to be appropriate for a number of reasons. Despite the increasing popularity and spreading practice of flexible office concepts, the existing research on the effects of the concept is often contradictory. At the same time,

the research on the topic spreads over a great field of research areas with scientists from multiple disciplines inquiring (e.g. Psychology, Economics, Ergonomics, Medicine or Architecture) and publishing their findings in dispersed literatures. This meta-analysis was conducted following the steps and methodology recommended by Harris Cooper (2010).

Data Synthesis

The data for the meta-analysis was collected from the published studies. In case the given data or information would not suffice to calculate the effect sizes, the authors were contacted with the request to fill in the blanks. Where results of different publications based on the same data set, a mean effect size was calculated to estimate the actual overall result.

Homogeneity

Before the different study results could be properly combined, they had to be tested on their observed variance opposed to the expected one. Essentially the analysis of homogeneity evaluates how likely it is that the variance expressed by the effect sizes can be fully explained by sampling error alone (Cooper, 2010).

A common measure for the consistency of study results is Cochran's Q, which is computed with the weighted sum of squared differences between the different study effects as well as the pooled effects across studies. Q is calculated as a chi-square statistic, with k-1 degrees of freedom, one less than the number of included studies. Another measure of heterogeneity that is less dependent on the number of studies considered is I^2. This statistic measures which percentage of variation across studies can be explained by heterogeneity rather than chance (Higgins, Thompson, Deeks, & Altman, 2003). It must be taken into consideration, that I^2 has lower power with studies of smaller sample size. So even if the result is significant and may indicate a problem with homogeneity, a non-significant result is not consequently evidence that the opposite is true (Higgins et al., 2003).

Different Models of Error

The variability of effect sizes can be calculated assuming a fixed-effect or random-effect model of error. The fixed-effect model ignores variations that

might arise from the variation in study methods, while the random-effect model presumes a study-level variance that adds to the source of random influences (Cooper, 2010). The decision on which module to use should be based on the outcome of the analysis of homogeneity. If the hypothesis of homogeneity is rejected, based on the results of Cochran's Q and I^2, then a switch to the random-effect model is advised (Cooper, 2010). Secondly, Cooper (2010) suggests to consider which model will better represent the real world circumstances of the original studies.

In this meta-analysis the random-effect model of error was applied. The decision for this particular model was based on the consideration that a great amount of variance results from the variation on the study level, for example different implementations of flexible office concepts.

Confidence Interval

The confidence interval evaluates the variability of the estimated effect sizes and indicates, with a 95% probability, the range within which the true effect is to be located. The spread of the confidence interval for the individual study highly depends on the size of the sample. Large studies tend to have a more precise effect estimate and thus a smaller confidence interval. The range of the confidence interval for the meta-analysis as a whole depends on the number of studies included as well as on the exactness of the individual study results. Under the random-effects model the confidence interval will narrow with increasing homogeneity of the combined studies (Green & Higgins, 2008). A poor overlap generally indicates a high statistical heterogeneity. Should the confidence interval enclose zero, the existence of an effect should be questioned.

Subgroup Analysis

In a subgroup analysis the existing data is subdivided into groups, often to allow for a comparisons between them. This may be done to compare different sets of participants (such as male and female) or other subsets, as in this case different types of flexible offices. A subgroup analysis can also help to evaluate the origins of a high heterogeneity, by partly explaining the observed variance (Bock, 2013).

Sensitivity Analysis

Different studies can have different influences on the final combined effect. Sensitivity analysis aims at assessing which studies have an especially high or low effect and determines how the analysis might differ without them (Borenstein et al., 2009). The analysis is performed by removing each study one after another from the meta-analysis, while computing the effect size with the remaining studies, assessing the contribution of the single study to the pooled effect. However according to Green and Higgins (2008) there is no standard rule as to whether the removal of a study has a significant influence in the pooled effect.

An analysis of sensitivity differs from a subgroup analysis as they do not aim to evaluate the effect of the group of studies removed from the analysis, while in a subgroup analysis an effect is estimated for every subgroup.

Results

Workers' Well-Being

Overall 7 studies went into the meta-analysis to ascertain the effect of flexible office concepts on workers' well-being. The analysis revealed a low but significant effect (r = 0.04; CI = 0.02 - 0.07; p = 0.002). The test for heterogeneity between studies was not significant (Table 4). An analysis of sensitivity across all studies revealed that no study had a particular strong or weak influence on the overall effect. The effect varied between r = 0.04 and r = 0.05.

Table 4: *Test for heterogeneity between studies*

	N	I^2	p	Q	df
Well-being	9	10.62	0.30	34.68	8

Explanatory note: I^2 = percentage of variation across studies; p = level of significance; Q = weighted sum of squared differences; df = degrees of freedom

Furthermore a subgroup analysis comparing the results of combi and flex offices was conducted. This revealed a low and significant effect for flex offices with r = 0.04 (CI = 0.02 - 0.07; p = 0.001) as well as a low non-significant effect for combi offices with r = 0.04 (CI = -0.01 - 0.1; p = 0.12). The test for heterogeneity between these two subgroups was not significant (Table 5).

Table 5: *Test for heterogeneity between the subgroups flex and combi office*

	N	p	Q	df
Flex & combi offices	2	0.99	0	1

Explanatory note: p = level of significance; Q = weighted sum of squared differences; df = degrees of freedom

In a second subgroup analysis the effects on general health, change in health, physical and psychological problems as well as sick leave were analyzed. Apparently, only the effects on general health, physical and psychological problems are significant (Table 6), with physical problems showing the highest effect at $r = 0.15$. The test for heterogeneity between the groups was significant (Table 7).

Table 6: *Effects according to the subgroup analysis*

	N	r	CI	p
Change in health	1	0.04	-0.04 - 0.13	0.31
General health	1	0.10	0.03 - 0.16	0.00
Physical problems	3	0.15	0.07 - 0.22	0.00
Psychological problems	5	0.04	0.00 - 0.07	0.04
Sick leave	2	-0.01	-0.07 - 0.05	0.68

Table 7: *Test for heterogeneity between the subgroups of well-being*

	N	p	Q	df
Subgroups well-being	5	0.01	12.45	4

Explanatory note: p = level of significance; Q = weighted sum of squared differences; df = degrees of freedom

Workers' Communication and Collaboration

Seven studies qualified for a meta-analysis regarding workers' communication and collaboration, resulting in a low but significant effect of r = 0.16 (CI = 0.09 - 0.24; p = 0.000). The test for heterogeneity between studies was significant (Table 8). According to the analysis of sensitivity especially the study done by Boutellier et al. (2008) had a strong influence on the cumulated effect. Without their results the effect would drop to r = 0.10.

Table 8: *Test for heterogeneity between studies*

	N	I²	p	Q	df
Communication and collaboration	12	86.30	0.000	80.31	11

Explanatory note: I² = percentage of variation across studies; p= level of significance; Q = weighted sum of squared differences; df = degrees of freedom

Table 9: *Effects according the subgroup analysis*

	N	r	CI	p
Collaboration	4	0.11	0.07 – 0.16	0.000
Communication with others	4	0.12	0.02 - 0.22	0.002

Duration of communication	1	0.02	-0.15 - 0.19	0.827
Events of communication	1	0.72	0.62 – 0.80	0.000
Satisfaction with communication	2	0.08	0.03 – 0.12	0.001

A further subgroup analysis revealed that the effects of flexible office concepts on collaboration, duration and events of communication, satisfaction with communication and communication with others differ greatly (Table 9). Ranging from the low effect on satisfaction with communication (r = 0.08) to the relatively strong effect on events of communication (r = 0.72). The test of heterogeneity between the subgroups is significant (Table 10).

Table 10: *Test for heterogeneity between the subgroups of communication and collaboration*

	N	p	Q	df
Subgroups communication and collaboration	5	0.00	74.99	4

Explanatory note: p = level of significance; Q = weighted sum of squared differences; df = degrees of freedom

Workers' Productivity and Performance

In the process of synthesizing the collected studies, it became apparent that conducting a meta-analysis with the research results found on productivity and performance was not feasible. For once, the studies grouped for the third hypothesis showed a greater heterogeneity in operationalization than those in hypothesis one and two. The different measurements of

productivity ranged from self-rated perceived productivity (van der Voordt, 2004; Blok et al., 2009), the general appraisal of staff performance by superiors and key personnel (Allen & Gerstberger, 1973) to the individual assessment of productivity support by the office (De Been & Beijer, 2014). This obvious diversity might render a meta-analysis meaningless and might even obscure genuine differences in effects. This consideration is complemented by the fact that, although the authors of the studies in question were contacted, not all necessary data for calculating an effect size could be recovered. These arguments led to the decision to conduct a qualitative literature synthesis on the effects of flexible office concepts on productivity and performance rather than a meta-analysis.

The perceived productivity support of the office environment was evaluated by one study (De Been & Beijer, 2014). They had workers evaluate the personnel, team and organization as well as the overall productivity support of their offices. Their research revealed people working in combi or flex offices to be significantly less satisfied with their offices productivity support, than people working in other office concepts.

Two studies concentrated on the impact of flexible offices on the quantity and quality of employees work. Blok et al. (2010) conducted their research in departments moving from a traditional office to a flexible office, issuing their questionnaire six weeks before and after the movement. The results showed no significant difference in the quality or quantity of the work being done. Meijer et al. (2009) followed a similar case but with three evaluations. Measurements were done at baseline, short-term (6 months) and long-term (15 months) post movement. The first measurement of self-rated quantity of performed work right after the implementation showed a significant decrease. The numbers recovered till the evaluation 15 months later showed no significant difference to baseline in the end. The perceived performed quality of work showed only a small non-significant drop after the 6 months, but in the long term no measurable change was identifiable. The synthesis of these two studies suggests that there is no measurable effect of flexible office concepts on workers' quality or quantity of work.

The effect of innovative flexible offices on workers' general productivity was evaluated by two studies. In the first van der Voordt (2004) investigates two companies relocating from a traditional office to a combi office. Firm number 1

perceived a drop in productivity in the short-term and a slight recovery at a second follow-up. However, at firm number 2 an increase in productivity was reported. In the study conducted by Blok et al. (2009) measurements were carried out first with workers in a traditional office and two months after settling in the new flexible work environment. There the self-rated productivity increased. With both studies reporting different results, there is insufficient evidence to come to a conclusive decision on the effects on general productivity and hence has to be assessed as inconsistent.

Two studies evaluated the effect of a flexible office concept on workers performance. Allen & Gerstenberg (1973), the oldest study in this synthesis, measured the impact on performance of a group of engineers using several semi-structured interviews. They conducted the interviews before and after the office remodeling, primarily with members of other departments, asking them to rate their colleagues' performance. Their interviews revealed that the introduction of the new office concept had resulted in no noticeable change of the team's performance. Seddigh et al. (2014) came to a similar conclusion. In their study they distributed their questionnaire to workers of several different office types, including flex offices, but found no main effect on performance.

Discussion

The following chapter presents a brief overview of the results obtained by this thesis's analysis. Subsequently, the results of the synthesis and implications for workers in flexible offices are discussed. Thereafter, the limitations of this analysis are disputed. The chapter concludes with a prospect and recommendations for future research on the effects of flexible office concepts.

Summary and Conclusion

In modern economies that have outgrown their dependence on farming and industrial production, knowledge is the key to organizational success and innovation (Blok et al., 2012). Employment rates in sectors with knowledge intensive tasks have risen sharply (Blok et al., 2012). This development has let to a reorientation of organizational goals and workplace requirements (Beijjer & De Been, 2014). At the same time does technological advancement allow greater local and temporal flexibility for the workforce. These trends resulted in the development of new, more flexible office concepts. The individual design of a flexible office is based on the patterns of work of its residents (Davis et al., 2011). These type of offices are most commonly characterized by offering employees a variety of work locations within the office. The different settings are based on different work tasks, for example formal meetings, phone calls, focused work, as well as informal collaboration and exchange with colleagues (van Meel, 2010). Secondly, assigned desks are eliminated (Heerwagen et al., 2004). Among the organizational goals when implementing such office concepts are the increase of communication and exchange among employees (Beijjer & De Been, 2014), the reduction of rent (Maarleveld et al. 2009), the improvement of the external reputation as well as the retention of high-quality workers (van der Voordt, 2004). Nevertheless the most important goal remains the increase of organizational productivity (Meijer et al. 2009). But while there are many hopes and whishes involved, conclusive scientific evidence on the actual effects of a flexible office on workers is still scare.

In order to achieve a better insight into effects of these modern offices and to synthesize the research that has been done up to this date, a meta-analysis and literature review were conducted. The synthesis focused on the well-being, communication and collaboration as well as productivity and performance of

workers. A meta-analysis was conducted in order to analyze the first two variables. However since not enough quantitative data could be found on productivity and performance, a qualitative review of the literature was done.

This synthesis was able to corroborate some of the assumptions associated with flexible office concepts. Only a very small positive effect of the office concept on workers' well-being could be determined, thus no empirical evidence could be found to support Hypotheses 1. Meanwhile a subgroup analysis revealed that the effect appears to be slightly stronger for general health and physical problems. Although the results suggest that flexible offices do not have a strong positive impact on workers' well-being, they do not appear to be particularly harmful either. This is a positive note on its own, considering that skeptics feared laborers in innovative offices might be overwhelmed by their new autonomy (Sparks et al., 2001). This might still be the case for some individuals, but does not seem to affect the broad majority. The same might be true for the apprehension that the deficit in workplace personalization presents a risk for workers' well-being (Brunia & Hartjes-Gosselink, 2009). The slightly stronger positive effects that can be registered for physical problems might be related to the installment of more ergonomic office furniture mentioned in some studies (Robertson & Vink, 2012). While the acquisition of better furnishings is a common occurrence when installing a flexible office, it is not directly related to the concept.

The proposed Hypothesis 2 was reinforced by the data. Overall a moderate positive effect on workers communication and collaboration was found. A subsequent subgroup analysis showed that the effect was more prominent for events of communication and communication with others. As intended by the design (Heerwagen et al., 2004), flexible office concepts appear to have a positive effect especially on workers' communication and collaboration, increasing both frequency and duration. The segmentation of the office into different acoustic zones, together with the waiver of a personal desk seems to lead to the desired result. Yet the satisfaction with communication did not increase particularly. This could be due to the fact that the quality of and satisfaction with communication is not only dependent on the opportunity to interact, but on aspects like modern communication technology, training in its use as well as rules of engagement. A well functioning electronic communication system can prevent workers from feeling isolated from their teams, when they

now longer share a designated team room together. At the same time jointly agreed upon rules of engagement, for example about the allowed noise volume in the different areas, can prevent conflicts among colleagues.

The literature review failed to provide conclusive evidence on Hypothesis 3. The results on workers' productivity and performance in flexible office concepts differ, with studies reporting positive, negative and often no effects at all. This is a dissatisfying result, considering that an increase of productivity has to be the ultimate goal for companies. It is at all possible that a rise in communication does not lead to greater productivity or more likely that the relation between the two variables is much more complex. Brummelhuis et al. (2012) theorized, that working in a flexible office would make colleagues more accessible to each other and foster an "enhanced availability" resulting in a "high-pace work process" (p.118). Nevertheless the positive impact created by the increase in communication might be undone by the lack of privacy and personalization (van der Voordt, 2004) or the increase visual and acoustic distraction, which is known to negatively influence productivity (Lee & Brand, 2005). Further possible explanations for the considerable differences with more or less the same office concept could be the different starting situations and also the different strategies of implementation (van der Voordt, 2004). According to Blok et al. (2012), an increase of productivity can only be achieved, if all the aspects of New Way of Work are successfully implemented, including information technology, management style and the work environment.

Overall, the results of this synthesis point to a tempered view on flexible office. While modern office concepts have several benefits in theory (Maarleveld et al. 2009; Becker, 2002), when adapted to the real world for the majority these benefits appear to be modest. Therefor, when introducing a flexible office concept, companies should be aware of the fact that working in an innovative office will be a novelty for most employees and will require mediation and instruction to deliver its full potential (Davenport & Bruce, 2002). Blok et al. (2009) argue that only proper training in the use of the new office spaces will lead to an increase in productivity. To design an office that actually fits the company's needs, the workers "work activities" and "communication structures" (p. 26) should first be analyzed (Harrison et al., 2004), ensuring the development of an office that best supports their particular needs. Important questions about the need for communication and concentration, telephone

activity and home office customs should also first be answered when developing the concept. For example it appears plausible that flexible working might support the work of members of Sales or Support, but is not practical for back or front office workers. The implementation of a thusly tailored office, together with the other components of New Way of Work, represents a major change process that should not be underestimated. Employees will be required to work more autonomously and at the same time more team oriented. Hierarchy will ease and the work environment will become more dynamic. The introduction of home-office and flextime policies will signify a shift away from the classic 9-to-5 workday (Volker & van der Voordt, 2005). Khamkanya and Sloan (2009) regard the familiarization with a flexible, non-territorial work environment and the staff's resistance to the associated cultural changes among the greatest challenges. Nevertheless long-term preparation together with expert moderation can most certainly ease some of the discussed challenges.

Limitations and Implications for Further Research

This thesis can be considered a starting point on the broader research on the effects of flexible office concepts on workers. While this synthesis offers a valuable collection of studies, it would have profited immensely from a greater selection of data. So far the number of primary studies published appears to be yet too limited to draw final conclusions on the effects. This goes especially for the findings on productivity and performance, where the number of studies with formally evaluated cases is distressingly low. A greater number of studies would also have allowed for a finer subgroup analysis, providing a more in-depth understanding of the dependent variables. In addition the meta-analysis was also limited by incomplete information given in studies about ascertained moderators. More detailed information would have allowed for a stricter grouping of studies by the exact flexible office concept characteristics described. At the same time results of a synthesis are always constrained by the methodology of the original studies, especially if the approaches deviate strongly. To do the individual characteristics of each office justice is certainly a challenge for the research on flexible office concepts. While most flexible offices share certain common features, they also differ strongly, mainly because, as mentioned already, each office design is adapted to the organizational requirements. At the same time was every studied office a busy and engaged

workplace, not allowing for highly randomized and controlled experiments.

Since the majority of studies included were conducted in the Netherlands and Sweden, the results allow no generalization to all western cultures. Another aspect to consider is the age of the studies. While the office described by Allen & Gerstberger (1973) qualifies as a flexible office concept, the general working conditions must have been tremendously different back then than they are today, raising the question of comparability.

Subsequent research should focus on gaining comprehensive insight into the potential influences of moderators like for example sex, age or work experience. In addition studies should focus on evaluating the effects of flexible office concepts on an individual level. While most of the collected studies focused highly on the effects on the workforce as a whole, it might be of importance to understand how the effects differ from person to person. Moreover this thesis's findings, that flexible offices really do increase office workers' communication and collaboration, while the effects on performance and productivity vary, should be corroborated and it should be determined how the link between these two variables can be explained and strengthened. Finally, since organizations are increasingly introducing flexible offices (Boutellier et al., 2008), more formal evaluations should be done, so that future studies can more accurately assess the global risks and benefits involved.

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Appendix

Operationalizations of Well-Being

Study	Variable	Operationalization
Meijer, E.; Frings-Dresen, M.; Sluiter, Judith (2009)	General health	One question about the perceived health of the worker on a scale from 1 (excellent) to 5 (poor)
	Change in health	Was measured on a response scale ranging from 1 (much worse than 1 year ago) to 5 (much better than 1 year ago)
	Participants with UE complaints	Participants who reported pain in the neck, shoulder, arm, elbow, wrist or hand for more than 4 days within a 1-week period
Bodin Danielsson, C.; Bodin, L.; (2008)	Sick leave short	"How many days have you been absent from work because of personal illness over the last 12 months?"response options: "0 days," "1 to 7 days," "8 to 24 days," "25 to 99 days" and "100 to 365 days." (p. 661)
	Sick leave long	Over 8 days indicated a long sick leave
	General health	Was measured by asking participants to delineate their general health using the following response alternatives, "excellent", "very good", "good" "fairly good" or "poor" (p. 661)

	Physical/ psychological problems	Was defined as physical and emotional problems affecting social activities over previous 4 weeks, the response alternatives were given: “all the time,” “most of the time,” “a large part of the time,” “some of the time,” “a small part of the time,” and “at no time at all/never.”
Bodin Danielsson, C.; Chungkham, H.; Wulff, C.; Westerlund, H. (2014)	Number of short sick leave spells	Was measured with the question ““How many times have you taken sick leave for a week or less during the past 12 months?” The answer was dichotomised into one or no short absences (‘not at all or 1 spell’) vs. more than 2 spells.” (p. 142)
	Number of long (medically certified) sick leave spells	Was measured with the question: ““How many times you taken sick leave for longer than a week during the past 12 months?” The answer was dichotomised into no long absences (‘On no occasion’) vs. all other categories.” (p. 142)
	Total number of sick leave days	Was measured with the question ““Approximately how many days have you in total been on sick leave during the last 12 months?” The response was dichotomised into 7 days or less (‘not at all’ or ‘1–7 days’) vs. more than 7 days (‘8–30 days’, ‘31–90 days’ and ‘91 days or more’).“ (p. 142)
Bodin Danielsson, C.; Bodin, L. (2010)	Stress	A 20 items questionnaire divided in four categories ranging from “Never/Rarely”, “Sometimes”, “Rather often” to “Very often” scored as 1 to 4.

Robertson, M.; Huang, Y.; O'Neill, M.; Schleifer, L. (2008)	Overall body discomfort	Was measured with the question "How many days have you been absent from work because of personal illness over the last 12 months?" (p. 485) and the response alternatives: "0 days," "1 to 7 days," "8 to 24 days," "25 to 99 days," and "100 to 365 days."
Seddigh, A.; Bernston, E.; Bodin Danielson; c.; Wersterlund, H. (2014)	Cognitive stress	Was measured by the cognitive stress scale from the Copenhagen Psychosocial Questionnaire. A sample question is: „How much of the time during the past 4 weeks have you found it difficult to think clearly?" (p. 170) All items are scored on a 5-point rating scale (1 = never, 5 = always)
	Burnout	The Maslach Burnout Inventory General Survey was used to assess. All items were scored on a 7- point rating scale (ranging from 1 = never, 7 = daily)
	General health	"How would you judge the state of your general health?" (p. 170) The participants responded on a 5-point Likert scale from 1 = poor to 5 = very good
C. Gerdenitsch (2015)	Cognitive irritation	*not given*

Operationalizations of Communication and Collaboration

Study	Variable	Operationalization
Boutellier, R.; Ullman, F.; Schreiber, Naef, R. (2008)	Frequency of communication	The frequency in number of events per person per hour was measured
	Participants per communication	The number of participants per event was measured
	Duration of communication	The duration per event in minutes was measured
Blok, M; Korte, E.; Groensteijn, L.; Formanoy, M.; Vink, P.; (2009)	Duration of communication in total	Extent of communication in person minutes per hour
	Time without communication	Was measured on a scale from scale 1 to 7, 1= extremely bad, 7 = extremely good
	Communication with colleagues	Was measured on a scale from scale 1 to 7, 1= extremely bad, 7 = extremely good
	Communication with visitors	Was measured on a scale from scale 1 to 7, 1= extremely bad, 7 = extremely good
Blok, M; Groensteijn, L.; Formanoy, M.; Korte, E.; Vink, P (2010)	Communication with colleagues	Was measured on a scale from 1 to 7, 1= extremely bad, 7 = extremely good
	Communication with clients/visitors	Was Measured on a scale from 1 to 7, 1= extremely bad, 7 = extremely good
C. Gerdenitsch (2015)	Collaboration with and between teams	*not given*

	Informal Communication with colleagues / managers	*not given*
	Informal communication with colleagues/ managers about work	*not given*
	Informal communication with colleagues/ managers about clients	*not given*
Beijer, M.; De Been, I. (2014)	Satisfaction with communication	One Item on a ten-point scale ranging from a very negative evaluation (1) to a very positive evaluation (10) negative
Allen, T.; Gerstberger, P. (1973)	Communication within the department	Number of communications with a colleague on the sampling day
	Communication between departments	Number of communications with a colleague on the sampling day
	Communication outside of the plant	Number of communications with a colleague on the sampling day
Robertson, L.; Huang, Y.; O'Neil, M.; Schleifer, L. (2008)	Communication	A 5 items questionnaire by Caplan et al. (1975). Alll scaled in five categories ranging from „strongly disagree" to „strongly agree. Sample: „I am satisfied with the overall quality of face-to-face communication I have with coworker in this office" (p. 485)

Operationalizations of Productivity and Performance

Study	Variable	Operationalization
Beijer, M.; De Been, I. (2014)	Perceived support of the own productivity by the office	Was measured on a one item, ten-point scale ranging from a very negative evaluation (1) to a very positive evaluation (10)
	Perceived support of the team productivity by the office	Was measured on a one item, ten-point scale ranging from a very negative evaluation (1) to a very positive evaluation (10)
	Perceived support of the organizational productivity by the office	Was measured with one item on a ten-point scale ranging, 1 representing a very negative evaluation to 10 a very positive evaluation
Meijer, E.; Frings-Dresen, M.; Sluiter, Judith (2009)	Quality of work	"Was measured on a 11–point scale, with 0 representing 'no quality' and 10 representing 'normal quality" (p. 1031)
	Quantity of work	„Workers were asked how much work they actually performed during regular hours on the most recent working day compared to a normal working day, with a 11-point numerical scale, ranging from 0 representing 'nothing' and 10 representing 'normal quantity'." (p. 1031)

van der Voordt, T. (2003)	Perceived productivity	Was measured with the following questions: “What percentage of time is spent working productively? What percentage of time is spent working unproductively because of distraction? What percentage of time is spent searching for a suitable workplace?“ (p.136)
Seddigh, A.;Bernston, E.; Bodin Danielson; c.; Wersterlund, H. (2014)	Need concentration	Was measured with the questions: “To what extent do you have individual tasks that require concentration?” The 5-point scaleranged from “low extent” (1) to “high extent” (5). (p.170)
	Performance Distraction	Was measured on a five-point scale using a five-point rating scale (1 = never, 5 = very often), the questions were “How often are you for some reason disturbed so that you do not get the opportunity to fully immerse yourself in the task you have in front of you?”; “How often are you interrupted when you have little time to complete an important task?”; “To what extent are you disturbed by colleagues’ conversations and phone calls?”; and “To what extent are you disturbed by the instantaneous sound from other colleagues’ ringtones, text message alerts, people walking, computers, etc.?” (p.170).
Blok, M; Groensteijn, L.; Formanoy, M.; Korte, E.; Vink, P	Quantity of work	Was measured on a 7 point scale, 1 being extremely low and 7 being extremely high

(2010)	Quality of work	Was measured on a 7 point scale, 1 being extremely low and 7 being extremely high
	Efficiency of work	Was measured on a 7 point scale, 1 being extremely low and 7 being extremely high
	Creativity of work	Was measured on a 7 point scale,1 being extremely low and 7 being extremely high
Allen, T.; Gerstberger, P. (1973)	Performance general appraisal	Was measured on a 5 point scale, 1 being extremely low and 5 being extremely high

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