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Green outdoor places, stress and productivity: an exploratory study at Kista ICT Hub, Stockholm, Sweden

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Abstract

In modern world a workplace can be defined as a location where someone works for his or her employer, a place of employment. In technology industry such locations got a name - tech hub. A tech hub is a specific area or a part of a city with a specific building or set of buildings where companies can rent space alongside each other to share facilities and ideas. Kista ICT Hub is one of the most important places for jobs in Stockholm and in the region. ICT related professionals are at a constant pressure to deliver services efficiently and have to be cost effective. Hence, stress is high in ICT professions because of their nature of work. The aim of this study is to explore how physical and/or visual access to green outdoor environments at a tech hub, might relate to employees' stress level and productivity loss. Data about the perceived physical and/or visual access to greenery, perceived stress level and loss of productivity of employees were collected by means of questionnaire, qualitative interviews and observation. The principle of triangulation has been the main approach. Obtained quantitative data indicate that reported perceived level of stress might increase with the presence of green outdoor environments. Whereas productivity loss (fewer missing days due to personal illnesses) seems to improve when physical access/or view of greenery is perceived in the environment. Qualitative data and observation suggest that the lack of greenery at workplace and location of green outdoor places might be compensated by efficient office planning, comfortable interior design, presence of indoor plants and dedicated place for rest and relaxation. Lastly, a discrepancy has been identified between the perception of physical access to greenery and reality.

1. Introduction

In modern life, rapid growing process of urbanization has been a new cause for stress and stress-related illnesses. Because of the urbanization, urban dwellers are leading to have, also intensive, busy and unhealthy lives. Although people's access to restorative nature is decreasing with urbanisation, it is difficult and not necessarily desirable to prevent people from moving to cities. Planners and designers have thus sought to create urban green places that provide opportunities for restoration as part of everyday life (Nordh et al., 2009).

However, in today's city planning, the importance of green outdoor places in workplaces is less known. It is mostly neglected and within whatever small parts they can take place on the maps, there are no values presented referring to people's preferences, needs or health. For most employees, the office workplace is where they spend at least one-third of their time; ≥ 8 h of the 24-h day and the office workplace is often a stressful, tension-filled, and fatiguing environment with few elements of nature other than the presence of indoor plants and some window view (Chang, & Chen, 2005).

For industrialized societies, the workplace is one of the most important social spaces other than the home, constituting a central concept for several entities: the worker and his/her family, the employing organization, the customers of the organization, and the society as a whole. That is why importance of good worker health contributes to high loss of productivity and success of the enterprise, which leads to economic prosperity in the country, and individual social well-being.

Recent WHO-led study estimates that depression and anxiety disorders cost the global economy one trillion USD each year in lost productivity (Burton, WHO, 2010). A negative working environment may lead to physical and mental health problems, absenteeism and lost productivity. Workplaces that promote mental health and relieve work-related stress are more likely to reduce absenteeism, increase productivity loss and benefit from associated economic gains (Figure 1.1), (ibid). The model below reinforces the business case for healthy workplaces. Creating a healthy workplace is not just a matter of caring for the well-being of employees. As indicated below, the health and well-being of workers impacts on the ability of the enterprise to perform its functions, and to meet its vision and mission (ibid).

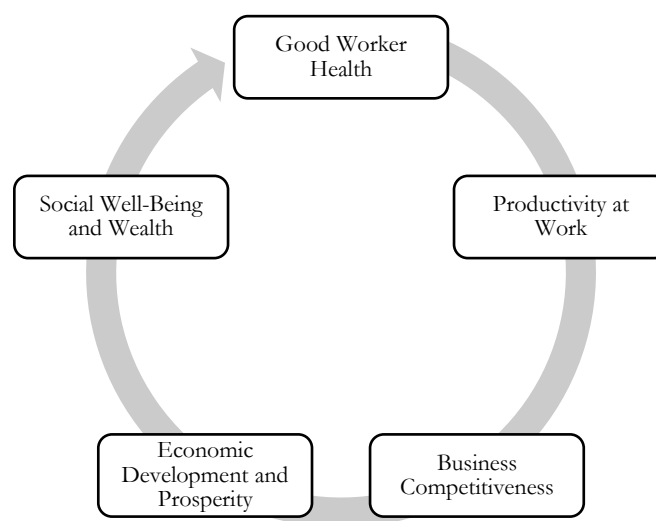


Figure 1.1. Relationship between health and wealth.

Source: WHO, 2010.

2. Background

Stress at work is associated with significant economic and human costs to individuals, businesses, communities and, arguably, society at large: including, increased absenteeism, increased worker turnover, decreased job satisfaction and associated decreases in worker's health (Leka & Jain, 2010). Work-related stress is commonly defined as a perceived imbalance between the demands made on people and their resources or ability to cope with those demands (WHO, 2005).

“As health is not merely the absence of disease or infirmity but a positive state of complete physical, mental and social well-being, a healthy working environment is one in which there is not only an absence of harmful conditions but an abundance of health promoting ones”, (WHO, 1986).

From an environmental psychology perspective, “Stress” can be defined as the condition that results when person-environment transactions lead the individual to perceive a discrepancy (whether real or not) between the demands of a situation and the biological, psychological or social resources of the individual (Evans & Cohen, 1987).

Moreover, as suggested by the human environment interaction model, stress can be caused by the need of the individual to develop adaptive strategies in order to balance the environment demand (i.e. different environmental factors/stressors) with the tasks of engagement and their personal characteristics (Küller, 1991). At the workplace, the environmental factors include both; physical and social aspects (i.e. built and natural environment and social support and interaction with people) (Bjornstad, Patil, & Raanaas, 2016).

The vast majority of studies examining work-related stress have tended to focus, almost exclusively, on psychosocial factors of work organisation and the social context of the work environment (for instance, job demand, work motivation, organization culture and climate, control at work etc.) (Cooper & Cartwright, 1997) with, in comparison, limited attention examining the association between characteristics of the physical work environment and work-related stress (Vicher, 2005).

There is, however, a growing body of research suggests that natural settings in the physical working environment and physical and/or visual access to the green outdoor environments at workplace are significantly related to employees' stress level, wellbeing, job satisfaction and performance (Lottrup, Grahn & Stigsdotter, 2010; Stigsdotter et al., 2010; Nielsen & Hansen, 2007; Kaplan, 1993; Kaplan et al., 1996; Pati, Harvey, & Barach, 2008).

Previous studies indicate that different types of nature contact, either physical or visual, at work are related to less stress and fewer health complains, even more it shows an increased positive attitude towards workplace (Lottrup et al., 2010). Outdoor nature contact, for example taking breaks from work and go to green outdoor environments has significant impact on employees' stress level and well-being (ibid). For instance, Hernandez (2007) concluded that a garden provided freedom for the employees and became a ‘coping mechanism’ to seek diversion during the working day. This relationship also is in line with other existing studies which have addressed the connection between job satisfaction and workplace outdoor environments and general improvements employees' overall well-being (Kaplan et al., 1996; Kaplan, 1993; Leather et al., 1998; Shin, 2007).

Findings from a study by Kaplan (1993) indicates that employees with an office window providing views of natural elements such as vegetation (trees, flowers), water, felt less frustrated and reported better overall health. Moreover, Leather et al. (1998) in his study found that a view of a green outdoor environment from the workplace window was related to the employees' feeling less

uptight than if they had a view of an urban scene such as buildings and roads, even with no obstruction of natural light.

In some studies, presence of indoor plants was also found to have positive impact on employees' psychological and physiological health and well-being (Chen-Yen Chang & Ping-Kun Chen, 2005). Raanaas et al., (2011) studied benefits of plants in a windowed environment and found that participants who had plants present at the workstation showed an improvement in their performance of a directed attention task over time, while participants who sat in a lean control environment did not.

Despite all these known positive impacts of greenery at workplace, the physical environment of office buildings appears to be less important than features of the psychosocial work environment (Marmot et al., 2006). The trend in European city planning is densification (Beatley, 1999). This means that access to green spaces is under threat within urban areas, due to demand for space to construct housing, office buildings, roadways, and other structures. Therefore, small green alternatives such as pocket parks, roof gardens, and tree-lined streets are likely to become more important as settings for restoration (Nordh et al., 2009). Moreover, even if there is presence of greenery nearby, studies show that the majority of office workers do not go outdoors during the working day, mainly due to a perception of being too busy and a working culture that does not include outdoor behaviour (Hitchings, 2010; Lottrup, Stigsdotter, Meilby, & Corazon, 2012).

2.1. Tech Hub concept

In modern world a workplace can be defined as a location where someone works for his or her employer, a place of employment. Such a place can range from a home office to a large office building or factory. In technology industry such locations got a name - tech hub. A tech hub is a specific area or a part of a city with a specific building or set of buildings where companies can rent space alongside each other to share facilities and ideas. It is a place where ideas germinate and companies prosper, meeting investors is easier. A tech hub is a general name and there are derivatives of it such as Information Technology (IT) hub, Information and Communications Technology (ICT) hub, Health hub etc.

The best-known tech hub is probably Silicon Valley, US, California with estimate amount of tech start-up companies 14,000 to 19,000 with 1,7-2,2 million of employees. Silicon Valley is home to the world's biggest technology companies, including Facebook, Apple, Alphabet (Google's parent company), Netflix, Tesla, and Intel.

So, what it takes in this day for a city to make it as a tech hub. There are features which identify a tech hub:

- a. Immenseness. To be able for tech companies to prosper in the right environment both culturally and geographically and to be constantly innovating and creating it need an immense territory (Tritsch, 2016).
- b. STEM. A city needs a reputation for innovation, which is fed by a ready supply of suitably skilled graduates holding degrees in STEM subjects – these are science, technology, engineering and mathematics. Cities with universities that are particularly strong in these areas are more inclined to be home to a tech hub. As well as being able to attract these kinds of graduates to relocate there, cities need to encourage its own residents to study these kinds of subjects. Without the right kind of labour skills, a tech hub will struggle to get off the ground (Svetlik, 2018).

- c. Prosperity. A tech hub needs to promote opportunities for like-minded techies to meet-up and discuss issues and opportunities in the industry, to share ideas and knowledge on a particular subject. Real, live interaction promotes a healthy ecosystem by encouraging collaboration, coordination and cross-pollination of ideas. This ecosystem is essential to sustain a healthy pipeline of talent and to promote skills-development as part of the job (Fritsch, 2016).
- d. Connectivity. Any tech hub worth its salt will need cutting-edge digital connectivity. Fast broadband speeds, city-wide wi-fi, and widespread 4G coverage, as well as early uptake of 5G, when that launches.
- e. Infrastructure. Location and transport infrastructure are also key. While technology has rendered a lot of travel unnecessary, it's still useful to be able to travel into and out of the city quickly and easily for client meetings (Svetlik, 2018).

For the purpose of further study, here it is needed to be defined and explained the differences between Tech, IT and ICT. Technology is tool that is designed based on scientific knowledge. Information Technology, or IT, is a product, service or tool that derives its value from data. ICT is sometimes used synonymously with IT; however, ICT is generally used to represent a broader, more comprehensive list of all components related to computer and digital technologies than IT (Figure 1.1.1).

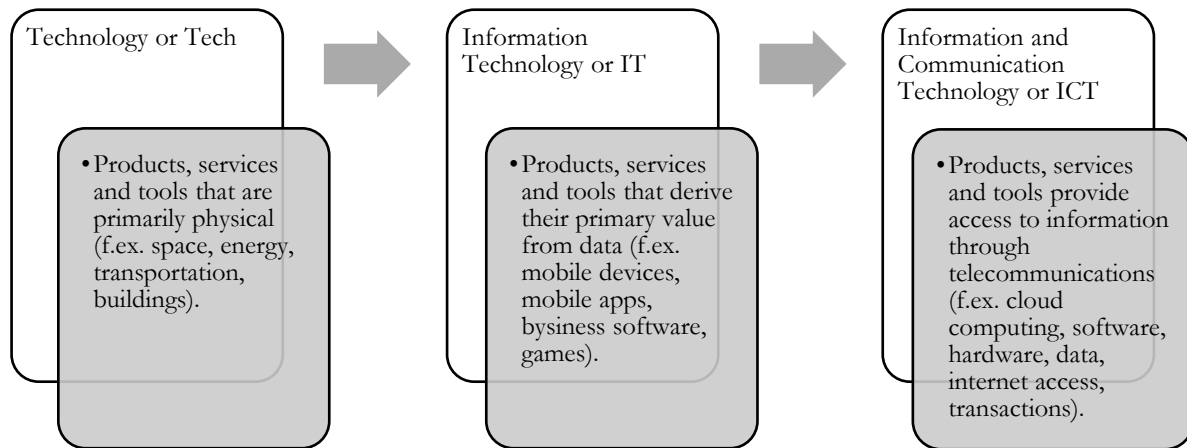


Figure 1.1.1. Definition of Tech, ICT and IT concepts.

To summarise, three of these concepts have one same root which is technology. The definitions are presented for better understanding of the setting in this paper.

2.2. Employee of Tech Hub

After defining what a tech hub is and what it takes today to make a tech hub. It was also clarified the differences and similarities between Tech, IT and ICT concepts with the purpose to define our user group of this study. One of the hub features is STEM subject (sciences, technology, engineering and mathematics). Thus, education on these subjects are required to work in tech industry with computers all the time.

Defining an IT worker is complicated, not only because information technology itself is not clearly defined. A wide range of occupations might be considered IT work. They vary enormously in the technical and other skills required to do the job. These jobs are not located solely in the IT industry (the industry whose primary business is to make and sell IT devices, software, services, and systems), and they do not always involve the design and creation of information technology

artifacts. Instead, they are distributed throughout virtually every sector of society, including government, all sectors of industry, and most nonprofit organizations; and they may involve many people who propose, implement, enhance, and maintain systems that rely upon information technology. Not every job in an IT company is necessarily IT work. For instance, the janitors at IBM IT cannot be considered as an IT worker (CRA, 2012).

ICT refers to technologies that provide access to information through telecommunications. It is like IT but focuses primarily on communication technologies. This includes the Internet, data, wireless networks, cell phones, and other communication mediums. Based on the previous description of sectors, we can surely assume that ICT includes IT as a sub group because the set of skills and education background to work in each industry is the same. Therefore, in this paper ICT and IT will be used as synonymes from here onwards.

ICT related professionals are at a constant pressure to deliver services efficiently and have to be cost effective, it requires huge focus on the work task and any mistake can lead to inevitable consequences and material losses for the companies. The results of a detailed questionnaire of around 1000 Employees in ICT sector in India, Chennai shows that around 56% of participants had musculoskeletal symptoms, 22% had newly diagnosed hypertension, 10% - diabetes, 36% - dyslipidaemia, 54% - depression, anxiety and insomnia, 40% - obesity. The stress score was higher in employees who developed diabetes, hypertension and depression (Padma, Anand, Gurukul, Javid, Prasad and Arun, 2015). Hence, stress is high in ICT professions because of their nature of work, target, achievements, night shift, over workload, troubleshooting, optimizing network performance, ensure network security etc.

3. Research aim and objectives

The aim of this study is to explore how physical and/or visual access to green outdoor environments at a tech hub, might relate to employees' stress level and productivity loss.

The objectives of this study are:

- To explore how physical and/or visual access to green outdoor environments at workplace might relate to stress levels of employees in tech hub;
- To explore how physical and/or visual access to green outdoor environments at workplace might relate to productivity loss of employees in tech hub.

The main motivation for this paper is to capture the contribution of physical and/or visual access to green outdoor environments at workplace for potential reduction of stress level and improvements in productivity loss of employees in tech hub.

The reminder of this paper is organized as follows. Section 3 describes the relevant theories to the topic of this paper. Section 4 focuses on the research approaches adopted in this study: site study, sampling, method of data collection, analysis and interpretation, ethics and limitations. Section 5 describes the results and conclusions. This paper ends, in Section 6, with the discussion of findings and possible improvements, and some final thoughts about future study.

4. Theoretical framework

Daily tool of IT employees is his/her computer and working on a computer can be mentally fatiguing and leave employees with a need for psychological restoration (Evensen et al, 2013). The quantity of empirical evidence supports the benefits of natural environment on psychological and

physiological states of health and well-being (Nielsen & Hansen, 2007; Kaplan, 1993; Pati, Harvey, & Barach, 2008).

Based on research and theories on relationships between people and the natural and built environments (Kaplan & Kaplan, 1989; Ulrich, 1984), a restorative environmental design aims to create psychologically supportive environments for people (Kellert, 2008). Ensuring access to window views of nature and keeping potted plants indoors are two common ways of bringing elements of nature into the office environment (Pearson-Mims & Lohr, 2000).

Restoration is a process of renewing psychological resources that have been depleted and the experience of restoration can help the person to perform more effectively, feel better, get along better with others (Hartig, 2004; Hartig, van den Berg et al, 2014). It has been suggested that the natural environment has inherent restorative qualities and this seems to be due to those fractals pattern that are present in nature, which are easier to perceive for the human eye and receptor system (i.e. Perceptual fluency account theory) (von den Bosch, 2018).

The Theoretical framework of this paper focuses on two theories - Attention Restoration Theory (ART) and Stress Recovery Theory (SRT) – which are relevant to the topic and research problem because these theories discuss both, emotional and cognitive aspects (i.e. stress and productivity).

4.1. Restoration and recovery

There are two predominant theories explaining restorative responses to nature which are the Attention Restoration Theory (ART) (Kaplan and Kaplan, 1989) and The Stress Recovery Theory (Ulrich, 1983; Ulrich et al., 1991; Ulrich et al., 1999). They are both build on the notion that people have an inherent ability to attend to vegetation, water and other physical features of the environment that have been beneficial to survival and well-being during human evolution.

The Attention Restoration Theory (Kaplan, 1995; Kaplan & Kaplan, 1989) uses a cognitive approach to explain the benefits of viewing nature i.e. people-environment interaction. Direct attention to a work task depends on inhibition that is our ability to keep out other competing stimuli. Such attention can be resource-demanding and can lead to ‘mental fatigue’ or the depletion of cognitive resources after intensive periods of directing attention to a work task (Kaplan & Kaplan, 1989). According to ART, restorative environments have four components: being away, extent, compatibility, and fascination. The last of these is essential for cognitive recovery; a setting having fascinating qualities attracts involuntary attention, which demands less mental effort. Nature attracts one’s attention because of its “soft fascination,” providing the opportunity for recovery from mental fatigue (Kaplan, 1995).

Ulrich (1983; 1991) suggests The Stress Recovery to explain emotional and physiological reactions to natural environments. Being in a safe natural environment or viewing natural elements (such as vegetation or water) activates a positive affective response in people. According to the theory, positive emotions can block negative affect, and hence have a restorative effect in stressful situations. Adding nature elements to office workplaces can thus have a positive impact on the stress level, health and well-being of the employees (Grinde et al., 2009).

According to Ulrich et al. (1999), views of nature can produce substantial restoration from psychological and physiological stress within a few minutes. The restorative benefits are manifested as a constellation of emotional, psychological and physiological improvements. The negative effects of psycho-physiological stress can also manifest with significant decreases of cognitive performance. However, people can recover cognitive efficiency simply taking advantage of the

beneficial effect deriving from exposure to nature (Berto, 2014). At workplace, a view of natural elements was found to buffer the negative impact of job stress, intention to quit and it had a positive effect on general wellbeing and cognitive functioning (Leather et al., 1998).

5. Methods

The purpose of this exploratory study is to understand how physical or visual access to green outdoor environments in tech hub might relate to employees' stress level and productivity loss. To address the research questions and the theoretical perspective at different levels of the study a mixed method approach was applied in this paper.

For this study, physical and visual access to green outdoor environments, stress level and productivity loss were operationalized in terms of:

- perceived physical and visual access to greenery; perceived visual access means having window view on greenery.
- perceived stress level;
- productivity loss indicated by missing days due to personal illnesses and vacation days.

The principle of triangulation has been the main approach in this paper. It implies that to gain reliable knowledge about a problem, one must illuminate that problem from different angles (Grahn, Stigsdotter & Berggren-Bähring, 2005). To achieve this goal, quantitative and qualitative research methods have been applied. Thus, data about the perceived physical and/or visual access to greenery, perceived stress level and productivity loss of employees were collected by means of questionnaire, qualitative interviews and observation.

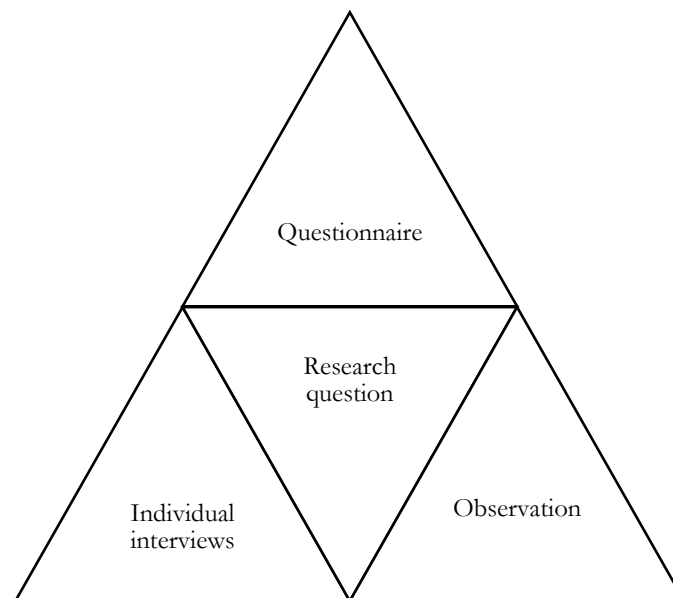


Figure 4.1. Triangulation approach in collecting data.

The method section of this study is designed in such way. First subsection describes settings and sampling. Second subsection presents the structure of the questionnaire, where the content of the three variables object of investigation is presented. Third and fourth, sections about the qualitative interviews and the observations. The fifth section focuses on data collection and data analysis

approaches. The end of the method section provides information about the study ethical considerations.

5.1. Setting and sampling

Setting

This study took place at Kista ICT Hub, Stockholm during February – March months of 2019. Kista ICT Hub is the largest Information and Communication Technology cluster in Europe and the third largest ICT cluster in the world. As a significant cluster, Kista ICT Hub is one of the most important places for jobs in Sweden and in the region (Kista Science City, 2011).

Kista ICT Hub is located just north of Stockholm (Figure 5.1.1). It is home to about 1,400 companies with 31,000 employees, two-thirds of whom work in one of the cluster's 520 ICT companies including well-known names such as Ericsson (with its head office and much of its R&D facilities located at Kista), Microsoft, Nokia, Tele2 and IBM. Kista is clearly specialized in ICT, with shares of about 10% of the firms and more than 30% of employment in this sector. Kista hosts a total of 7000 students attending classes at three institutions: the famous KTH Royal Institute of Technology, the smaller but growing Stockholm University and the recently created European Institute for Technology (EIT-ICT) (Kista Science City, 2011).



Figure 5.1.1. The bird view map of Kista ICT Hub, Stockholm, Sweden.

Source: kartor.eniro.se

Sampling

In this exploratory study, 59 employees at Kista ICT Hub, Stockholm, Sweden responded to the questionnaire. 24% of participants responded by means of online self-administrated questionnaire. 76% of participants responded to the same questionnaire by means of performing the survey on site. Table 5.1.1. shows that there were significantly more male respondents than female. Respondents' ages were varying between 25 and 64 which represents working-age population. The employment status of most of the participants were full time employment i.e. 40 or more hours per week. More than a half of participants reported of having more than nine years of work experience. The other remaining reported work experience less than nine years.

Gender		Age		Employment status		Work experience	
female	17	25-44 years old	37	full time	56	less than 9 years	22
male	42	45-64 years old	22	part time	3	more than 9 years	37
Total	59		59		59		59

Table 5.1.1. Descriptive statistics of sample size in Kista ICT Hub, Stockholm, n=59.

In addition, Table 5.1.2 shows that more than a half of the participants responded as having physical access to green outdoor places at Kista ICT Hub. Same number of participants reported having visual access to greenery and presence of indoor plants within the area of work desk.

Physical access to greenery at workplace		Visual access to greenery at work desk		Presence of indoor plants within the area of vision at work desk	
yes	35	yes	38	yes	38
no	24	no	21	no	21
Total	59		59		59

Table 5.1.2. Descriptive statistics of perceived physical and visual access to green outdoor environments with presence of indoor plants, Kista ICT Hub, Stockholm, n=59.

5.2. The structure of the questionnaire

In order to obtain a representative picture of the perception of employees' physical and visual access to green outdoor places, perceived level of stress and productivity loss in Kista ICT Hub, a questionnaire was conducted in form of pre-coded questions often with categorical multiple-choice options and with close-ended questions. The questionnaire consisted of three parts which addressed the respondent's:

1. Perceived physical and/or visual access to greenery at workplace and habit of visiting green places (Kirtland et al., 2003).
2. Questions which are directly related to productivity loss indicators (missing days due to personal illnesses and vacation days).
3. Self-perceived stress scale (Lottrup et al., 2012).

Perceived physical and visual access to greenery

Perceive physical and visual access were operationalized respectively in terms of, viewing and actual access to greenery, as reported by the participants. In order to grasp the perception of physical and visual access to greenery the questions were designed based upon the scale proposed by Lottrup, Grahn and Stigsdotter in article "Workplace greenery and perceived level of stress: Benefits of access to green outdoor environments at the workplace" (2012).

According to the study above, to use access to workplace greenery as one single variable, the respondents' answers to the questions about physical and visual (window view) access to greenery at workplace were classified into a Workplace Greenery Index which were applied in much more complicated calculations by using ANOVA SAS GLM Type III analyses.

This exploratory study had an intent to discover possible impact of different combination of physical and/or visual access to greenery at ICT Hub on stress level and productivity loss of ICT employees. That is why, similar approach was used as it has been done in Lottrup, Grahn and Stigsdotter study (2012) to create single variables according participants responses to the questionnaire.

The combinations with different access to Workplace greenery in this study are consisting of four levels: no view and no physical access to a green outdoor environment; view of a green outdoor environment but no physical access; no view of a green outdoor environment but physical access; view and physical access to a green outdoor environment. Each level was named as Workplace Greenery Access with numeric identification accordingly where each number represents the respective group only and not used in any further calculation. The variables were used only to describe a possible impact of different combinations of physical and/or visual access to green outdoor places on stress level and loss of productivity and will be presented in the results part of this paper. For a more detailed description of the Workplace Greenery Accesses, see Table 5.2.1. There is also a mediator variable which is the presence of indoor plants in the workplace.

As we see, among 59 responses there are 9 participants who do not have physical access to greenery at workplace as well as no window view on greenery. 15 participants reported as no physical access to workplace greenery but having window view on greenery. 12 participants responded as having no window view on greenery but have physical access to green outdoor environments and last index shows that 23 participants have both physical access and window view to greenery at workplace. These indexes will be used to see how perceived level of stress and productivity loss might varies depending on the perception of physical and/or visual access to green outdoor places.

Table 5.2.1. Description of the construction of “Workplace Greenery Access”, n=59, n_{miss} =0.

Workplace greenery access	Description of the access to workplace greenery covered by the indexes	N	Presence of Indoor plants, n
WG-Access 1	No view and no physical access to a green outdoor environment	9	4
WG-Access 2	View of a green outdoor environment No physical access to a green outdoor environment	15	9
WG-Access 3	No view of a green outdoor environment Physical access to a green outdoor environment	12	10
WG-Access 4	View of a green outdoor environment Physical access to a green outdoor environment	23	15
Total		59	38

In our definition of the concept of green outdoor environments, all types of open green spaces in the town or city were included. In these environments, there are varying amounts of vegetation; they may have been designed by landscape architects or by others. The environment may also appear in the form of relatively wild nature.

Perceived Level of Stress

In the present work the most prominent and clearest questions from the stress and crisis inventory scale - SCI-93 (Nyström & Nyström, 1995), were chosen to achieve a simplified, but relevant, subset of questions to examine perceived stress (the questions were chosen based on Grahn and Stigsdotter (2003; 2011) own interpretation). They chose seven prominent symptoms such as

fatigue, headache, pain in the nape of the neck, backache, irritation, stress and common cold (Grahm & Stigsdotter, 2003).

It was observed that nearly all participants reported Irritation, Stress and Fatigue. However, headache, pain in the nape, backache and common cold had nearly no answers. Even if several respondents reported such symptoms, the grading of responses were among bottom of the measurement scale. Therefore, Irritation, Stress and Fatigue has been chosen as dominant symptoms to represent Level of Stress in this paper. In this study, responses of perceived level of stress were pre coded (Table 5.2.2). Quantity of days refers to the yearly occurrence numbers of each answer. For instance, once every month corresponds to 12 occurrences per year. Therefore, corresponding quantity of days is 12.

Table 5.2.2. Description of pre coded answers of Level of Stress evaluation.

Variants of answers in evaluation of perceived stress level	Quantity of Days
No	0
A few times	2
Maximum once every quarter	4
Maximum once every month	12
Maximum once every 14 days	26
Maximum once every week	52
More than once a week	182
Almost every day	365

Measure of productivity loss

Stress at work has direct impact on physiological and psychological health and well-being of employees (Evans & Cohen, 1987). That is why, in this study, the primary interest was to estimate the productivity loss due to personal illness. An ideal measure of absenteeism would reflect illness-related absences only (Zhang et al., 2017). To measure the productivity loss related to absenteeism in the questionnaire the question: “In the past 12 months, how many days of work have you missed due to personal illness?” was used. The responses were grouped into six categories: “0 days”, “1-7 days”, “8-14 days”, “15-30 days”, “31-90 days” and “91-365 days”.

Another focus was the days of vacations which might have positive impact on boosting the productivity loss. Recent studies show that employees who take regular and long vacations are more efficient and productive (Schulze, 2017). The Project: Time Off survey which took place in USA in 2018 indicated that participants who reported a year or more without a vacation, might have missed an opportunity to relax and reduce stress. To measure the days of vacation in the questionnaire the question: “In the past 12 months, how many vacation days have you used?” was used. The responses were grouped into six categories: “0 days”, “1-7 days”, “8-14 days”, “15-30 days”, “31-45 days” and “46 and more days”.

These two variables were chosen to measure the loss of productivity because they are well defined, easily observed and easily measured. Also, since they were used in the questionnaire, the main target was to have questions short and clear. Needless to say, the results of these questions do not have any documental evidences, that is why it has been completely relied on participants’ responses.

5.3. Data collection and data analysis

Data collection procedure

For the quantitative data, two approaches were used. First, participants received an e-mail with the self-administrated questionnaire link. The questionnaire was conducted by utilizing Google Form platform in Google Drive. The purpose of the questionnaire was clearly described, and participants were informed of their voluntary participation, anonymity and confidentiality. One reminder was sent after two weeks. Recruiting participants relied on companies being willing to distribute the questionnaire via their employees' e-mail list and to allow their employees to complete the survey in their free time.

The companies were chosen based on their access and no access to green outdoor environments with intend to find out if it has impact on stress level and productivity loss of employees in Kista ICT Hub, Stockholm. The results of this approach brought 14 responses, which was not satisfying for the study.

That is why second approach to collect quantitative data was performed by the researcher visiting the site study. The survey in place brought additional 45 responses. The survey to perform around pedestrian places and common areas where employees spend their free time. This approach allowed to reach larger population base. Before responding, the participants were asked if they were currently working in the Kista ICT Hub. Then they were informed about the purpose of the research, anonymity and confidentiality. Before proceeding to the questions, a participant had to mark the location of their workplace on the map. Recruiting participants during street survey were based on participants' willingness to participate in the survey.

As it is mentioned above, the location of participants who responded to self-administrated questionnaire were identified in advance. However, for street survey a different approach was needed where participants could easy identify their location in Kista ICT Hub without revealing the name of their companies. The approach which will allow to keep participants' confidentiality and anonymity. That is why it was decided to divide Kista ICT Hub on sections which have or do not have physical accesses to green outdoor environments. By following the hub's grid architecture 14 sections were defined (Figure 5.3.1).



Figure 5.3.1. Defined 14 sections for Kista ICT Hub.

Source: kartor.eniro.se

For the qualitative data, four employees in Kista ICT Hub were contacted where two of them agreed to participate in the study. The participants were interviewed separately and before proceeding the interview, they were informed about voluntary participation, anonymity and confidentiality. After this step, a consent form from each participant were obtained (Appendix 1). The first interview was recorded on a mobile device (iPhone 6) and the second interview was recorded by note-taking due to the participant's preferences.

The basic ambition in the interviews was for the interviewer to understand the participants' perception of physical environments at their workplace, work-related stress and loss of productivity. Another ambition was to create a comfortable situation for the interviewees to be able to talk freely (Brinkman & Kvale, 2015). Semi-structured interviews were conducted to obtain qualitative data through open-ended questions. This technique was used to collect data about employees' perception of Kista ICT Hub as a workplace and also, to have better understanding of their physical environment and perception of work-related stress, and how it might have impact on loss of productivity.

Investigation of the study site was performed by the author of this work with the purpose of observation and the four zones of contact with the outdoors proposed by Bengtsson (2015) was employed to spot the possible contacts with green outdoor environments in Kista ICT Hub. This approach allowed to have visual description of how outdoor environments are in contact with workplaces in the ICT hub. The results of observation were supported by photographs taken during site visits. Observation of physical access to green outdoor environments in Kista ICT Hub, bird views in Eniro Maps, Google Maps were used. Also, site visits were conducted to investigate the zones of contact with outdoors.

Data analysis

Quantitative data were analysed by using Statistical Package for the Social Sciences (SPSS) and descriptive statistics. Such descriptive statistic is used to describe the frequencies the respondents perceived physical and/or visual access to green outdoor environments, perceived level of stress and productivity loss (missing days due to personal illnesses, days of vacation).

The obtained qualitative data of this explorative study was analysed by applying Thematic analysis with the purpose to find out possible patterns across the data sets that are important to the description of participants' perception of their physical environment at workplace, work-related stress and productivity loss with association to the research questions.

To analyse the obtained qualitative data six steps were followed (Bryman, 2016):

- **Familiarization with the data.** The audio recordings and the taken written notes were verbatim transcribed. The transcribed interviews were read and re-read multiple times, to become immersed and familiar with its content. During this step the notes were taken to start defining the preliminary ideas for codes that can describe the content of the data (Bryman, 2016).
- **Generating initial codes.** This step involved generation of initial codes that identify important features of the data that might be relevant for answering the research question. After that, all the codes were gathered together for next step of analysis (Bryman, 2016).
- **Searching for themes and subthemes.** At this stage of the analysis the main target was to reduce the number of codes and to search for common elements in the codes so they

could be raised to the subthemes or main themes (in this stage they are potential themes and subthemes) (Bryman, 2016). Also, the codes which formed a theme, or a subtheme had a written short summary. This allows to have better understanding why the codes were formed under a defined theme or subtheme.

- **Reviewing the themes and the subthemes.** This phase involved reviewing the preliminary defined subthemes and themes, to determine that they were in line with the obtained data and also answered the research question. Moreover, the preliminary names were defined to capture large portions of the data and provide genuine insights into the data (Bryman, 2016).
- **Defining and naming the themes.** At this stage, the identified themes in the previous step were named and described. Theme names were developed to describe the findings and also, to identify the relation between the themes as well as to overall research question (Bryman, 2016).
- **Writing up.** This was the final stage of the thematic analysis. The prepared basis in previous steps allowed to present the findings.

Four zones of contact with outdoors were applied to investigate Kista ICT Hub regarding possible interactions with green outdoor environments. Site visits were performed to spot and observe green outdoor places on premises and their access. Four zones of contact model was utilized to asses if workplaces in Kista ICT Hub actually have access to greenery. The purpose to utilize a scientific model for such judgement was to avoid subjective decisions by the observer whether a workplace has access or not. Moreover, it was also intended to have a holistic approach which can be applied to the entire area in focus. It was considered that a workplace has access to greenery if Zone 2 or Zone 3 are present. Utilizing four zones of contact is not having direct impact on the results of the quantitative data. However, it was used to support the obtained results and explorative view of entire area.

The principle model of the four zones of contact with the outdoors proposed by Bengtsson (2015) could be used as a mean to elucidate in what way differences in site planning and content in relation to the different zones would result in different experiences of contact with the outdoors (Figure 5.3.2).

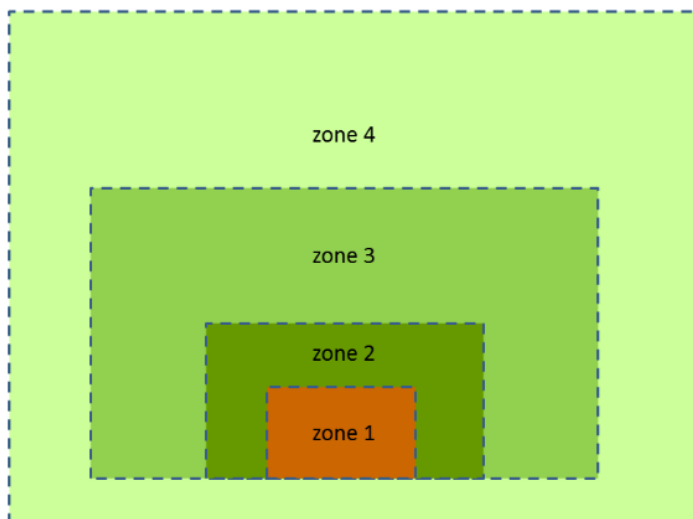


Figure 5.3.2. A principle model of four zones of contact with the outdoors: zone 1, form inside a building; zone 2, transition zone; zone 3, immediate surroundings; and zone 4, the wider neighbourhood.

Zone one corresponds to the possibility of having contact with the outdoors from inside a building (viewing through a window). Zone two corresponds to transition zones between indoors and outdoors, for instance, balconies, patios, conservatories and entrance areas. Zone three

corresponds to the immediate surroundings, that is, ideally an associated garden or park. Zone four corresponds to the wider neighbourhood and whatever opportunities for outdoor experience and use it might encompass (Bengtsson, 2015).

A summary of the methodological progression is reported in Figure 5.3.3.

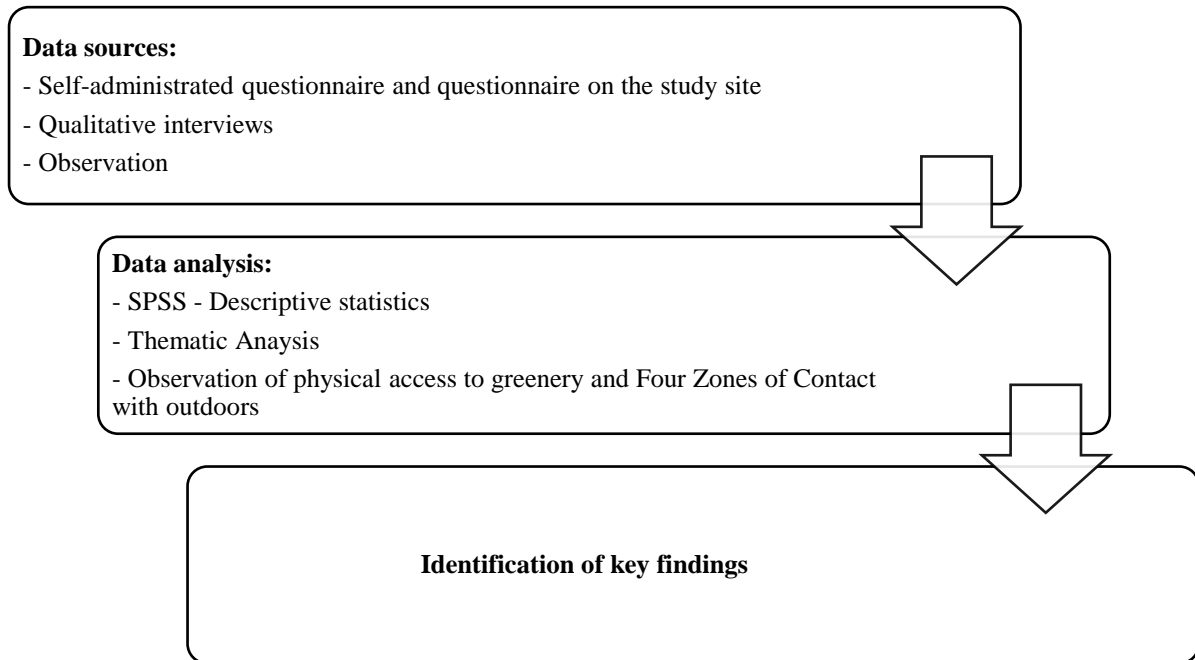


Figure 5.3.3. Design of the methodological approach.

After collecting and analysing each type of data, triangulation method was utilized to have holistic view of employees' perception of physical access to green outdoor environments, perception of stress level and loss of productivity.

5.4. Ethical considerations

In this study, three basic ethical considerations for involving persons in research were applied during the entire research process which are full disclosure, confidentiality and voluntary participation. To achieve these basic principles a consent cover letter was used to provide participants with full information about the aim of the study, the procedure of the study, their confidentiality, their right of voluntary participation and contact information about investigator (Appendix 1).

The first principle is full disclosure. This principle allows any person who participates in a study to have full disclosure of the purpose and procedures of the study (DePoy & Gitlin, 2016).

The second principle is confidentiality. It considers that all information shared by a respondent in the study is kept confidential. Only specified members of the research team can have access to the respondent's information (DePoy & Gitlin, 2016). The paper confidentiality was ensured in several ways. Firstly, the names of the respondents were changed in qualitative interviews. This procedure ensures that the identity of the respondents in this study is protected and that the information they provided will not be linked to their names in the future (DePoy & Gitlin, 2016). The questionnaire was designed in a way that respondents did not need to answer their personal information such as own name, address, name of a workplace etc.

The third and the last principle is voluntary participation. Individuals have the right to choose to participate or not. Also, during the participation in the study, participants had right to refuse to answer any questions in the interviews and the questionnaire (DePoy & Gitlin, 2016). For qualitative part of the study Informal Consent Form was conducted. The conversation about participation in the interview was done by emails.

6. Results

6.1. Perceived stress results and users' responses to the questionnaire

The results of the quantitative data suggest that perceived access to green outdoor environments seems to have less of an impact on level of stress (LS) of employees in Kista ICT Hub. On the contrary, the results might indicate that the perceived LS might be increasing among those who have reported physical and/or visual access to green outdoor environments (Table 6.1.1).

Table 6.1.1. Descriptive statistics of perceived Level of Stress per WG-Access*, n=59.

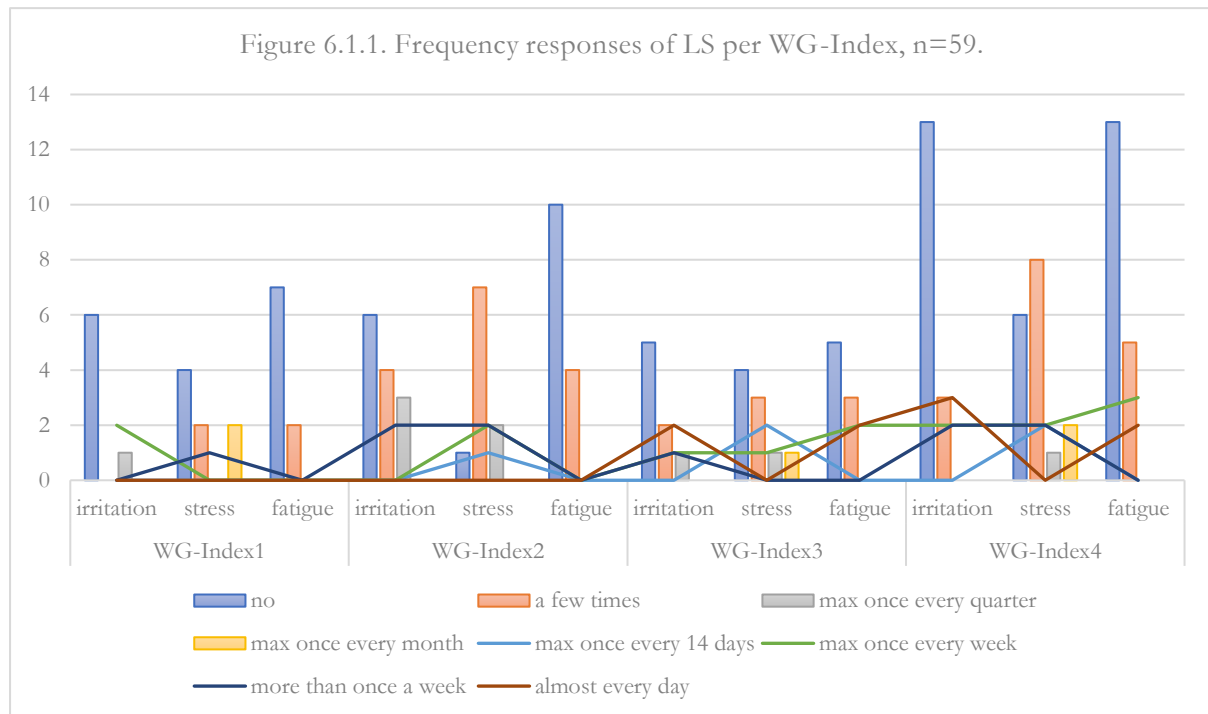
		no	a few times	max once every quarter	max once every month	max once every 14 days	max once every week	more than once a week	almost every day
WG-Access1 N=9	irritation	6	-	1	-	-	2	-	-
	stress	4	2	-	2	-	-	1	-
	fatigue	7	2	-	-	-	-	-	-
WG-Access2 N=15	irritation	6	4	3	-	-	-	2	-
	stress	1	7	2	-	1	2	2	-
	fatigue	10	4	-	-	-	-	-	-
WG-Access3 N=12	irritation	5	2	1	-	-	1	1	2
	stress	4	3	1	1	2	1	-	-
	fatigue	5	3	-	-	-	2	-	2
WG-Access4 N=23	irritation	13	3	-	-	-	2	2	3
	stress	6	8	1	2	2	2	2	-
	fatigue	13	5	-	-	-	3	-	2

* *WG-Access1* stands for no visual and physical access to a green outdoor place. *WG-Access2* indicates having view but no physical access to a green outdoor place. *WG-Access3* represents no view but physical access to a green outdoor place. *WG-Access4* stands for having both physical and visual access to a green outdoor place.

Figure 5.1.1 below visualizes the received responses. Vertical lines represent the highest quantity responses. Horizontal lines are used for responses with lesser quantity for the sake of better understanding. WG-Access1 represents the responses of participants which reported having no access and no view of green outdoor environments. On the other end of the scale, WG-Access4 represents the participants which reported having both physical access and view of green outdoor environments. From left to right, there is a visible tendency of having more “no” responses. This can be understood as the LS is increasing when there is access and/or view of outdoor green spaces.

The presence of indoor plants within the area of participants' work desk (Table 5.2.1) shows that particularly those who are in category of WG-Access1 might compensate the absence of physical

access and window view on greenery at workplace with presence of indoor plants – 4 out of 9. In total, 38 participants reported of having indoor plants within the area of their work desk.



If respondents in WG-Access3 reported higher quantity of “no” responses, results might have indicated a linear increase in “no” responses. Out of 12 respondents in WG-Access3 reported having indoor plants around their working spots (Table 5.2.1). This can further support that greenery around working places might increase perceived LS. Thus, it might as well be a probable cause in the increased LS among WG-Access3 among the scale of responses compared to the general tendency from WG-Access1 to WG-Access4.

The participants who responded in the questionnaire of having physical access to green outdoor places in their workplace (n=35) were asked an additional question; “How often do they visit green outdoor places during office hours?” (Table 6.1.2).

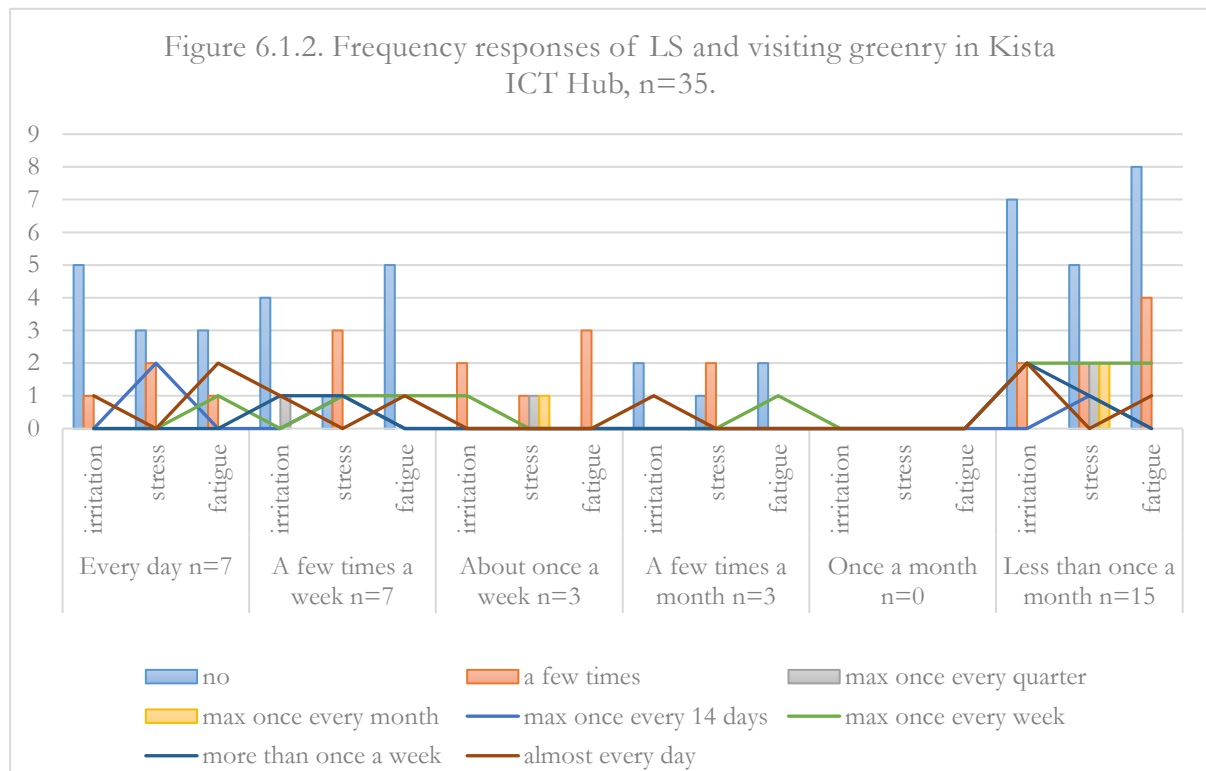
The results might indicate that the respondents who visit outdoor spaces frequently have already high levels of stress and would like to relieve it by taking refuge in green environments and the respondents who reported the least quantity of visits might have highest stress levels due to lack of stress relieving properties of green spaces in their daily work life.

Table 6.1.2. Descriptive statistics of visiting green outdoor places during office hours and LS, n=35.

		no	a few times	max once every quarter	max once every month	max once every 14 days	max once every week	more than once a week	almost every day
Everyday n=7	irritation	5	1	-	-	-	-	-	1
	stress	3	2	-	-	2	-	-	-
	fatigue	3	1	-	-	-	1	-	2
A few times a week n=7	irritation	4	-	1	-	-	-	1	1
	stress	1	3	-	-	1	1	1	-
	fatigue	5	-	-	-	-	1	-	1

About once a week n=3	irritation	-	2	-	-	-	1	-	-
	stress	-	1	1	1	-	-	-	-
	fatigue	-	3	-	-	-	-	-	-
A few times a month n=3	irritation	2	-	-	-	-	-	-	1
	stress	1	2	-	-	-	-	-	-
	fatigue	2	-	-	-	-	1	-	-
Once a month n=0	irritation	-	-	-	-	-	-	-	-
	stress	-	-	-	-	-	-	-	-
	fatigue	-	-	-	-	-	-	-	-
Less than once a month n=15	irritation	7	2	-	-	-	2	2	2
	stress	5	2	2	2	1	2	1	-
	fatigue	8	4	-	-	-	2	-	1

Figure 6.1.2 is visualising the results of LS and frequency of visiting greenery in Kista ICT Hub. Horizontal lines are used for responses with lesser quantity and vertical lines represents the highest quantity of responses for the sake of better understanding. The graph is divided into sections



which represent frequency of visiting where each sector also includes LS. There is a visible tendency of “no” and “a few times” responses for LS which increases in the beginning of the graph, decreases in the middle and again increases in the end. LS response “max once every week” is increasing when frequency of visiting greenery is “less than once a month”.

6.2. Productivity loss results and users’ responses to the questionnaire

As per the obtained results, productivity loss of employees seems to improve (missing days due to personal illness seems to decrease) when window view, perceived physical access or both are introduced in a workplace in Kista ICT hub. However, another criterion of productivity loss,

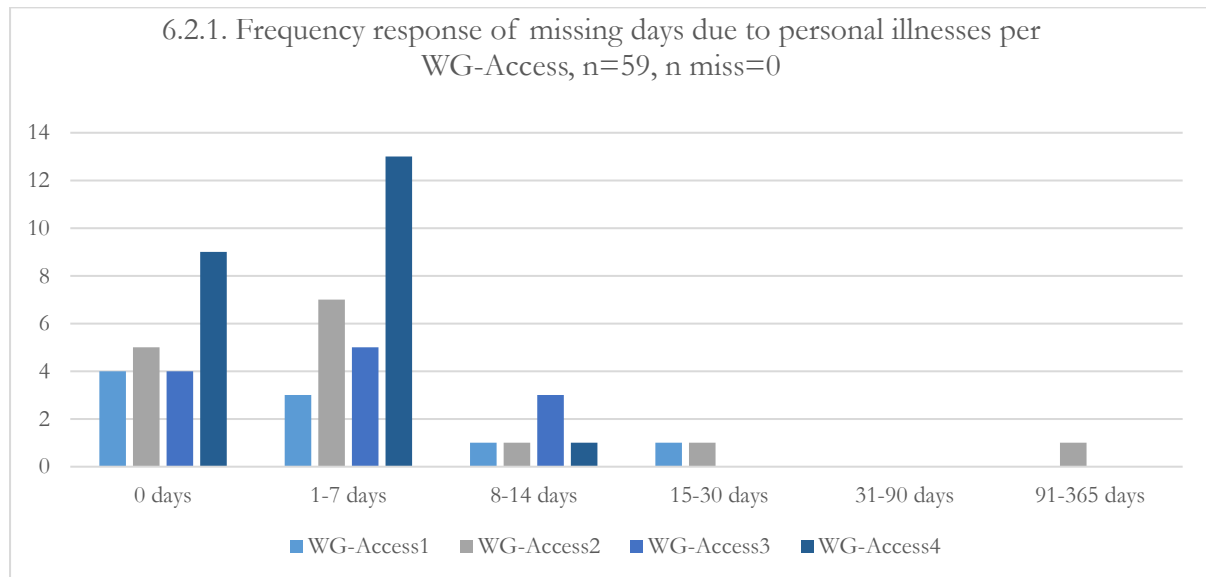
vacation days, has not shown clear indications. Because there is a tendency to have longer vacations in certain periods in Sweden due to established culture which might be the main reason to use vacation days rather than feeling of exhaustion.

Table 6.2.1 shows reported missing days per Workplace Greenery Access. In WG-Access2 -where participants reported having no physical access to outdoor green environments but having window view – there is a single participant who reported days of absence between 91-365. If we can consider this as an anomaly in the collected data due to limited amount of participants, remaining values show a tendency of no missing days or 1-7 missing days while moving from WG-Access1 where participants reported no physical access or view towards WG-Access4 where participants reported both physical access or view.

Table 6.2.1. Descriptive statistics of missing days due to personal illnesses per WG-Access, n=59.

Workplace Greenery Access	n	0 days	1-7 days	8-14 days	15-30 days	31-90 days	91-365 days
WG-Access1	9	4	3	1	1	-	-
WG-Access2	15	5	7	1	1	-	1
WG-Access3	12	4	5	3	-	-	-
WG-Access4	23	9	13	1	-	-	-
Total	59	22	28	6	2	-	1

Figure 6.2.1 visualizes the received responses regarding missing days due to personal illnesses. WG-Access4 – where respondents reported both access and view to green outdoor environments – includes the most responses within 0 days or 1-7 days range. WG-Access3 – where participants reported having access to green environments but no view- received the most amount of responses within 8-14 days range. This shows a clear increase compared to WG-Access4 which might indicate that having both view and access to green outdoor environments decreasing the number of missing days due to illnesses.



WG-Access2 – where participants reported having view but no access to green outdoor environments- reported missing days in all ranges but 31-90. This is also a clear increase compared to WG-Access3 and WG-Access4. WG-Access1 – where participants have no view and no access to green outdoor environments- also received responses in 8-14 days and 15-30 days ranges. Overall, a tendency of increasing missing days ranges have been observed from the scale of

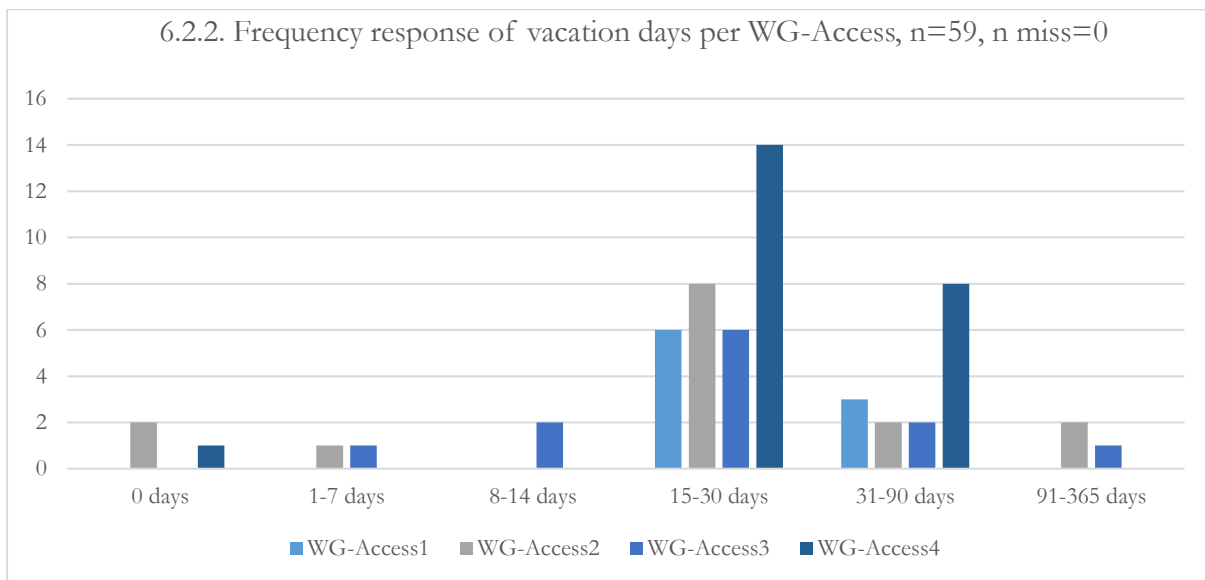
responses where both access and view to green outdoor spaces is present towards the responses where none is present. This might indicate that presence of access and view to green outdoor spaces decreases the missing days due to personal illnesses. Thus, it might be an indication of increase in loss of productivity.

Table 6.2.2 shows the vacation days used by participants. It is observed that majority of reported vacation days in all WG-Accesses are either in 15-30 days or 31-45 days range. In Sweden -where Kista ICT hub is located – there is a historical culture to use vacation days in December, July or August. It is enforced on employers by law to provide minimum 20 vacation days per year and employees are supported to use their vacation days. Use of vacation days are even incentivised by additional payment per used vacation days. Therefore, it is very common to have vacations spanning between 25 to 40 days per year which are usually used during Christmas or Summer months.

Table 6.2.2. Descriptive statistics of vacation days per WG-Access, n=59.

Workplace Greenery Access	n	0 days	1-7 days	8-14 days	15-30 days	31-45 days	46 – more days
WG-Access1	9	-	-	-	6	3	-
WG-Access2	12	2	1	-	8	2	2
WG-Access3	15	-	1	2	6	2	1
WG-Access4	23	1	-	-	14	8	-
Total	59	3	2	2	34	15	3

Looking at the detailed data in Figure 6.2.2, it is hard to draw conclusions or observe a tendency for the reported days within 15-30 and 31-45 ranges due to Sweden’s vacation culture among employees. The only observation which stands out is that WG-Access1 – where participants reported no access and no greenery – didn’t report any vacation days in lesser ranges.



This might indicate that there might be a relationship between exhaustion and access and/or view of green outdoor environments in workplace. When there is no access or no view, exhaustion of employees might increase, resulting in using more or entire vacation allowances.

In conclusion, quantitative data might indicate that reported perceived level of stress might increase with the presence of green outdoor environments. Whereas loss of productivity (fewer

missing days due to personal illnesses) seems to improve when physical access/or view of greenery is perceived in the environment. It is harder to observe a tendency in vacation days due to explained vacation culture in Sweden. However, more vacation allowances seem to be used when access and/or view greenery is not present. It might also be important to note that using more vacation days might indicate a positive impact on productivity loss.

6.3. Results of qualitative interviews

This study investigated the view of employees on how they perceived Kista ICT hub as a workplace via qualitative interviews. A semi-structured interview technique (Kvale & Brinkmann, 2015) was used to investigate individual experience and perception of physical environment and work-related stress in Kista ICT Hub. Therefore, questions were asked to motivate participants to describe their own experiences and their descriptions are mainly originated from each individual's perception.

In quantitative data, participants responded with the perception of physical and or visual access to greenery at Kista ICT Hub, perceived level of stress and productivity. To support findings, in this part of the paper, participants described their own experience and perception of physical environment in Kista ICT Hub and work-related stress. In this way, the interviews complement the data gathered through responses of the questionnaire.

Three main themes and eleven subthemes were identified. The main themes are *perception of physical environment at Kista ICT Hub*, *cooperative and individual perception of work-related stress* and *access and use of green places in Kista ICT Hub* (Figure 6.3.1). One theme *Workplace Attachment* was identified but will not be considered in this paper and it might have future possible opportunity for deeper investigation (Appendix 2).

The defined main themes of qualitative interviews complement and expand the understanding of how employees in Kista ICT Hub perceive their workplace in term of as entire environment of the hub and as an environment of office workplace.

The first main theme is perception of physical environment at Kista ICT Hub. It described how physical environmental parameters such as architecture (modern buildings), urban planning (dense environment), landscape design (concrete environment), interior design and planning of the offices have impact on employees' daily work life. The design of physical environment at Kista ICT Hub has direct impact on perceived physical and visual access to green outdoor places. Lastly, concrete environments show the lack of greenery at the hub.

The second main theme is access and use of green outdoor places in Kista ICT Hub. The theme was defined with two subthemes: design and location of green places and weather conditions. Design and location support the results of observation of access to green outdoor places at Kista ICT Hub (further in the paper). In the hub only one park is present, and its design and location have impact on visiting the green outdoor places. The subtheme -weather conditions- describe that the use of greenery depends on time of the seasons and weather.

The third main theme is cooperation and individual perception of work-related stress. It shows that organization of work and personal relationships have impact on stress at work. The subtheme - balancing R&R time - might show that it has impact on visiting workplace greenery at Kista ICT Hub and as a result impact on reducing stress level and improve employees' productivity.

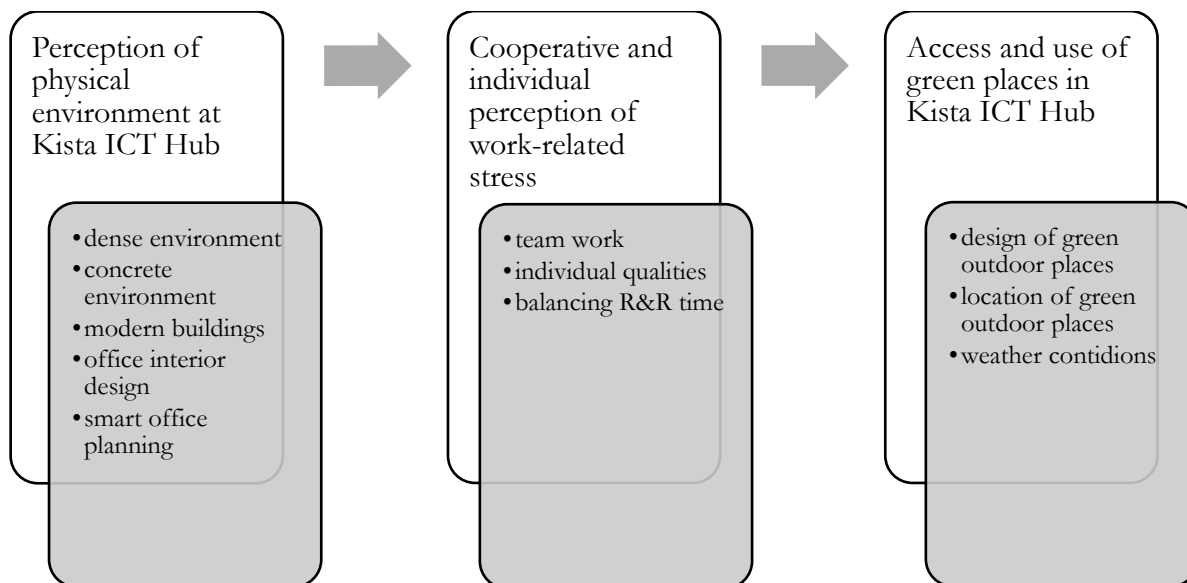


Figure 6.3.1. Description of the defined main themes and subthemes of the qualitative interviews.

An example of how a workplace of an ICT company at Kista ICT Hb looks like is presented on the Figure 6.3.2. The photos were provided by a participant of the qualitative interview.

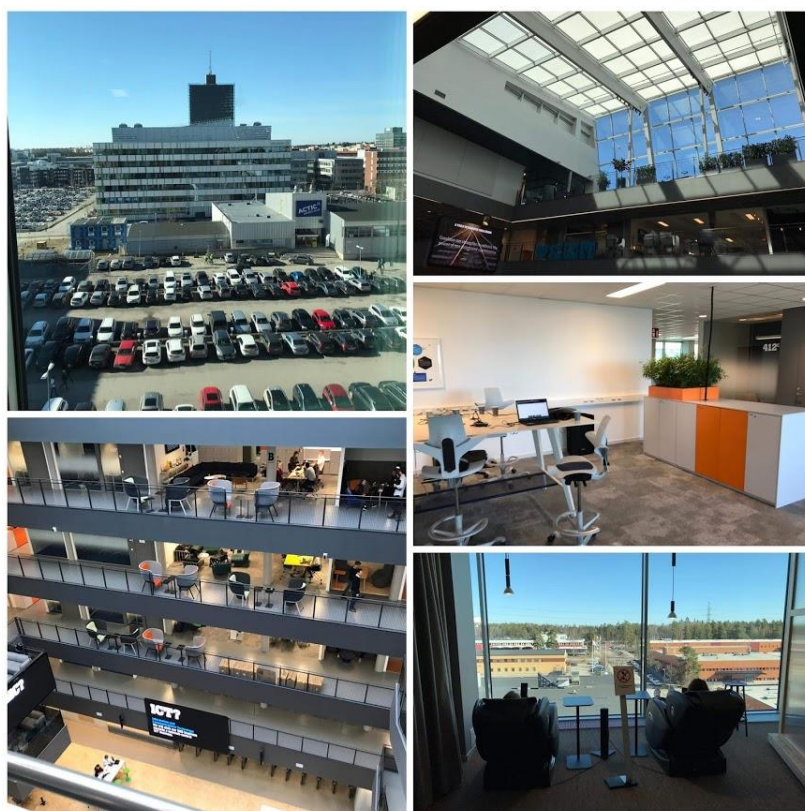


Figure 6.3.2. Interior design, office planning and window views of one company in Kista ICT Hub.

Source: Tetiana Kasaba

Among the photos, one of the window views is facing parking lot and far standing buildings. Another picture of window view with massage chairs has partly view of next standing buildings and far view of the forest. The idea of having massage chairs with such a view might have restorative purposes for employees in this company.

Another positive attribute of this workplace is the glass roof. Such roof allows to get more day light which is very important for health of employees. Glass roofs were observed also in other building at Kista ICT Hub.

In conclusion, the lack of greenery at workplace and location of green outdoor places might be compensated by efficient office planning, comfortable interior design, presence of indoor plants and dedicated place for rest and relaxation. Moreover, perception of work-related stress focuses mostly on performance in the teamwork, individual qualities and lastly balancing time between work and rest. However, the improvement of environmental qualities might have positive impact on visiting green outdoor places (further in discussions).

6.4. Four zones of contact with outdoors at Kista ICT Hub: results of the observation

To have a holistic view of possible contacts with outdoors in Kista ICT Hub, Four Zones of contact was applied. The overview of each Zone in Kista ICT Hub is presented in the Figure 6.4.1 below. Supporting pictures are attached in the following text.

Kista ICT Hub has clear grid architecture with main urban corridors such as Hanstavägen, Torshamnsgatan, Kistagången and Kistavägen. According to Stockholm City Plan (2009), access to parks in central Kista - which is Kista ICT Hub - needs to be improved, e.g. by developing Grönlandsgången into a green corridor and creating parks within the block structure. Grönlandsparken is the only park present in Kista ICT Hub and located at the corner between Kistagången and Grönlandsgången.



Figure 6.4.1. Overview map of Kista ICT Hub with four zones of contact with outdoors.

Source: Coor Service Management.

Detailed description of each zones of contact with the outdoors at Kista ICT Hub is presented in Figure 6.4.2.

Zone 1	Zone 2	Zone 3	Zone 4
<ul style="list-style-type: none"> •Zone 1 is from inside a building (window view). In this paper we do not evaluate the window views of the buildings in Kista ICT Hub due to lack of access to the buildings and also lack of time to evaluate buildings in each sector. 	<ul style="list-style-type: none"> •Zone 2 or transition zone is represented by patios, balconies, conservatory or any transitional places between Zone 1 and 3. In Kista ICT Hub two places which have visible Zone 2 were identified. (Photo collage 5.1.1). 	<ul style="list-style-type: none"> •Grönlandsparken, Grönlandsgången- the green corridor and some inner court yards are representing Zone 3 (Photo collage 5.1.2). 	<ul style="list-style-type: none"> •Kista ICT Hub is a very dense area and Zone 4 here is represented by companies buildings, shopping center, parking lots, residential area, tower blocks and forest on south east side of the hub.

Figure 6.4.2. Description of Four Zones of Contact with outdoors in Kista ICT Hub.

Photo collage below shows the transition zones in Kista ICT Hub which were identified during observation (Figure 6.4.3).



Figure 6.4.3. Transition zones in Kista ICT Hub, Stockholm.

Source: Tetiana Kasaba.

Zone 2 is represented by balconies which are attached along the buildings. They are designed like solid concrete structures with opportunity to plant trees, bushes and other green plants. Such

design allows employees to be outside without actually leaving the buildings. Also, there are tables with seats which probably are used by employees to have lunch or to just spend time outside. Unfortunately, such activity was not observed during site visit. It might be explained by cold weather during that time of observation. On the left side of the collage two pictures show Zone 2 of Kista Science Tower (Figure 6.4.3). On the map its buildings have triangle shape and form a cluster. The buildings are connected by inner corridors. However, one of those corridors is built outside with additional space. The space looks like a balcony. The balcony has couple of exits which are either connected with other parts of the hub or lead to parking lots, which is comfortable. Two pictures on the right side are other samples of identified Zone 2 (Picture 5.4.1). There are two balconies which are attached to second and third floors. It has planted trees and some tables with benches.

Zone 3 in Kista ICT Hub is presented by Grönalandsgången green corridor, Grönlandsparken and some inner court yards. Grönalandsgången is the street which crosses Kista ICT Hub from east to west connecting its two sides. The street is very busy during lunch time and consequently a lot of employees are using it. There seems to be room for improvement in design. However, the density of green plants (trees, bushes etc.) and size allows us to consider it as a green place (Figure 6.4.4).

Grönlandsparken is the only park in the heart of Kista ICT Hub. It is located between two most busy streets (Kistagången and Grönalandsgången). However, visitors were not observed during site visit (Figure 6.4.5). Cold weather can also be the reason for lack of visitors during observation, but the park does not look inviting as well. It is a very open area between the buildings. In the qualitative data, one participant reported a sense of being observed by others during their time in this park. Another participant mentioned the distance from workplace as an obstacle to use the park.



Figure 6.4.4. Zone 3 - Green corridor of Grönalandsgången, Kista ICT Hub, Stockholm.

Source: Tetiana Kasaba



Figure 6.4.5.
Grönlandsparken – Zone 3,
Kista ICT Hub, Stockholm.
Source: Tetiana Kasaba



Figure 6.4.6. Inner court yards
– Zone 3, Kista ICT Hub,
Stockholm.
Source: Tetiana Kasaba.

According to the result of the observation, there are four inner courtyards in Kista ICT Hub (Figure 6.4.6). Three of them are designed like yard with passages passing through and one is

closed for external visitors. The court yards are well designed: benches to sit, walking paths, vegetations, cultural symbols.



Figure 6.4.7. Parking lots in Kista ICT Hub, Stockholm.
Source: Tetiana Kasaba

Parking lots in Kista ICT Hub can be observed everywhere because of the quantity of employees (Figure 6.4.7). Although the hub is well connected with public transportation means, commuting with personal car is still one of the preferred methods in Sweden. This might be the reason why planners of the Hub preferred to allocate more parking spaces than green outdoor environments.

In conclusion, the presence of greenery is lacking and physical access to them is limited due to several factors. The most important one is the location of green outdoor places in Kista ICT Hub. The entire area of the hub is very big and to just visiting the park or green corridor requires substantial amount of time.

6.5. Perceived vs actual access to greenery in Kista ICT Hub: new findings

It was decided to use the 14 sectors in methods part of this paper (Figure 6.5.1) - which were defined in Kista ICT Hub and presented in the questionnaire to help participants to quickly and easily identify the location of their workplace - for evaluation of actual physical access to greenery in each sector.

Having evaluated each sector with actual physical access in Kista ICT Hub, six sectors were identified with access to green outdoor environments which are Sectors A, C, H, I, J and L. Three sectors, Sectors D, E and K are considered as having partial access to green outdoor places. The definition of partial access can be described as a part of a section that has access to the greenery of a neighbouring section, but itself does not have any. Five sectors, Sectors B, F, G, M and N, do

not have access. Detailed description of each sector and their access to greenery at Kista ICT Hub can be found in Appendix 3.

Participants who responded as having physical access to green outdoor places in this paper were considered as having perceived physical access because perceived value is what a participant believes regarding the presence of access although it might be different in reality. That is why it was expedient to compare what participants perceived versus reality.

For this reason, after identifying actual physical access to greenery, sectors were grouped into three groups accordingly: group 1 with access, group 2 without access and group 3 with partial access. Afterwards, participants' perception of physical access to greenery in their workplace have been compared with the actual access to greenery according to the on-site evaluation. The outcome of this investigation presented in Table 6.5.1. Among first group where 18 participants have actual physical access to greenery at their workplace according to the evaluation, 12 participants perceive physical access and 6 do not. In second group with 17 participants with no physical access, 9 participants reported having physical access and 6 did not. The last group with partial access received 24 responses. 11 of them reported not having physical access to greenery and 13 reported having access.

Table 6.5.1. Description statistics of actual physical access versus perceived physical access to greenery in Kista ICT Hub, Stockholm, n=59.

Sectors with actual access to greenery	Participants	Perceived physical access to greenery
With access	18	6 no and 12 yes
Without access	17	6 no and 9 yes
Partial access	24	11 no and 13 yes
Total	59	59

These discrepancies show that perception of physical access to greenery do not match with reality. Perceptions of environmental attributes can influence satisfaction with where people work, and stress level (Leslie & Cerin, 2008). Therefore, this phenomenon has room for further discussion.

7. Conclusions

In conclusion, the results of perceived level of stress of employees in Kista ICT Hub have tendency to increase with having both physical and visual access to greenery. It can be explained due to poor design and inefficient locations. However, loss of productivity of employees in Kista ICT Hub through missing days due to personal illnesses might decrease by having physical or visual access to greenery at the Hub.

Also, in the study, a discrepancy was found between perceived physical access and actual. It might have impact on the results of perceived level of stress and loss of productivity (missing days due to personal illnesses).

Lastly, the results of qualitative interviews and observation suggest that the lack of greenery at workplace and locations of green outdoor places might have negative impact on employees' health and well-being. Moreover, the study seems to find out that at Kista ICT Hub, access to greenery does not reduce stress but it does improve cognition, so the results are confirming the Attention Restoration Theory but not the Stress Recovery Theory.

8. Discussions

The purpose of this exploratory study was to understand how perceived physical and/or visual access to green outdoor environments at workplace might relate to employees' stress level and their productivity loss. Based upon previous theories and study, stress is known to reduce in presence and/or opportunity to access or view greenery (Lottrup et al., 2010; Kaplan, 1993; Ulrich, 1983). However, the results from study suggests that the perceived physical and/or visual access to green outdoor environments in a workplace might increase the perceived level of perceived stress. On the contrary, loss of productivity of employees seems to increase with the visual or physical access to green outdoor environments. This has been observed through investigating missing days due to personal illnesses. As part of the study, vacation days have also been investigated but it is hard to find possible connections to perceived stress levels or loss of productivity due to the culture of having long vacations in Sweden.

The findings of the study also suggest that there is a discrepancy between perceived physical access to green environments and actual access. There have been several other studies about perception of outdoor environments or neighborhoods mismatching with reality. Their conclusion also suggest that several psychological, cultural and behavioral factors may explain the overall low-level agreement between perceptions and objective measures. People perceive their environments based on various types of lifestyle behaviors, including individual transportation routes, personal beliefs and cultural values (Kirtland et al, 2003). Some studies also indicate that, objective neighborhood data and perception of neighborhood do not match because people judge the neighborhood according to their own desires and expectations (ibid). This phenomenon could have had an impact on responses of the participants in this study which might have resulted in different perception of surrounding outdoor green environments.

The qualities of the green outdoor spaces have not been taken into account as a factor in this study. Further studies might be interested to look into it. For instance, a study by Nordh et al, (2009) suggests that the design and the components of a green place such as amount of hardscape, grass, lower ground vegetation, flowering plants, bushes, water might have an impact on the perceived size or even subjective measures of being away, fascination, restoration likelihood and preference. Therefore, it might also impact on the restorative or stress relieving properties as well as perception of physical access. The qualitative data obtained by this study also provides supportive findings as the design and location of green outdoor places were reported as obstacles to access and use of those places. On the other hand, respondents of the qualitative interviews provided information regarding indoor design of the workplaces such as modern and spacious architecture, glass roofs and big windows allowing daylight or comfortable furniture. In addition, dedicated areas for rest and other supportive facilities such as massage chairs were also reported to be present in workplaces. Therefore, findings suggest that perception of greenery seems to affect productivity loss positively, but level of stress might be supported by other indoor design features.

According to Stockholm City Plan (2009) access to parks in central Kista - Kista ICT Hub - needs to be improved, e.g. by developing Grönlandsgången into a green corridor and creating parks within the block structure. In densifying city areas, small green spaces such as pocket parks are likely to become more important as settings for restoration. Well-designed small parks may serve restoration well (Nordh et al., 2009). Therefore, small, accessible parks with restorative properties can be utilized in multiple locations in the further development of Kista ICT hub.

Moreover, the type of ICT work, time shift, or company workplace culture of the employees weren't considered in this study. A study by Johnson et al, (1994) suggests that different

occupations reported different levels of physical health, psychological well-being and job satisfaction. Another study where data from a large national representative sample of working adults in the US supported the hypothesized relationships between the availability of time flexible work policies, health symptoms of stress, employee commitment to their employer, and measures that reflect direct costs to the employer (Halpern, 2005). According to Cooper (1981), the cause of stress is the dynamic between an individual and his or her organization. Adopting an explicit strategy of culture change is an important response to an established culture of stress (Thompson et al, 1996). An ICT hub and companies operating in an ICT hub is a very complex establishment consisting of many job types and work responsibilities carried out in different time-shifts. This might suggest that different roles in an ICT hub might have different levels of perceived stress. Also, stress levels which might be decreased due to the access or view of green environments might be marginal compared to other stress triggering factors mentioned above.

Therefore, the relationship between perceived level of stress and green outdoor environments in an ICT hub can be studied further by adding more parameters to the quantitative methodology such as experienced qualities of green places, actual distance, time of work, type of work and workplace culture. Also, this exploratory study just evaluated the perception of the users. Perhaps different results about stress could have been found if physiological measures were included rather than perceptual. Further investigations might want to look into it.

In case of measuring productivity loss, different approaches might be applied in further studies. For instance, using self-efficacy scale. Self-efficacy has received increased attention in management; in particular, task and domain specific self-efficacy perceptions have been found to impact organizational commitment, job satisfaction, stress, and performance (Mosley, Boyar, Carson and Pearson, 2008).

In the triangulation of data, the evidence produced by different techniques or procedures is compared in order to reveal similarities and incongruencies. Typically, strong similarities could be viewed as a validation of the data or conclusions, while incongruencies would be indicative of either one or more faulty procedures or data sets. In the latter case, triangulation provides scope for the further analysis of the data or additional exploration and research (Weyers, Strydom, & Huisamen, 2008). In this work mixed methods were applied, and thematic analysis was used to analyse qualitative data to support findings in quantitative data. According to many authors, thematic analysis is a process used by many qualitative methods, it is not a separate method, rather something to be used to assist researchers in analysis (Nowell, Norris, White, & Moules, 2017). Others have claimed thematic analysis should be considered a method in its own right (Braun & Clarke, 2006; *ibid*). Thus, a dilemma has occurred, how it should be used in triangulation approach either an assisting analysis or individually standing method. From the researcher perspective it is an ambivalent feeling to make a right decision of choosing the most suitable tools to analyze data where either they should support each other, or they should be independent in purpose to discover new findings.

8.1. Limitations of the study

Limitations related to the research problem were addressed by series of obstacles. The first and main limitation was the access to the population and organizations of the site study. The problem of contacting the right people in organizations or companies were limited because of difficulties to find relevant contacts. Even after having contacts, they were not responsive to the emails or responded as not being in charge.

Second limitation was collecting the data. After sharing the self-administrated questionnaires via emails to contact persons in the companies, it was not possible to have any kind of impact or control on participants' responses. For instance, there were no access to personal emails of participants to send direct reminders. The reminders were sent through representatives of the companies who decided to distribute the survey. That is why it was decided to change the approach and collect the data via street survey.

Another limitation was small sample size. Thus, it was difficult to find relationships from the data, as statistical analyses require a larger sample size to ensure a representative distribution of the population and to be considered representative of groups of people of the study. Moreover, time was limited. Receiving responses from the contacted participants took longer than anticipated which made the data collection phase longer and resulted in postponing the analysis part in the original project plan.

Lastly, access to the buildings in Kista ICT Hub was limited. It was not possible to access each respondent's building and asses the factors like window view or presence of green plants.

Another aspect to mention is that the study is intended to be just exploratory and a first step for possible further investigation. That is why, the study was a first exploratory attempt to gain better understanding of the relation between perceived physical and visual access to greenery, stress and productivity loss among employees who works at Kista ICT Hub.

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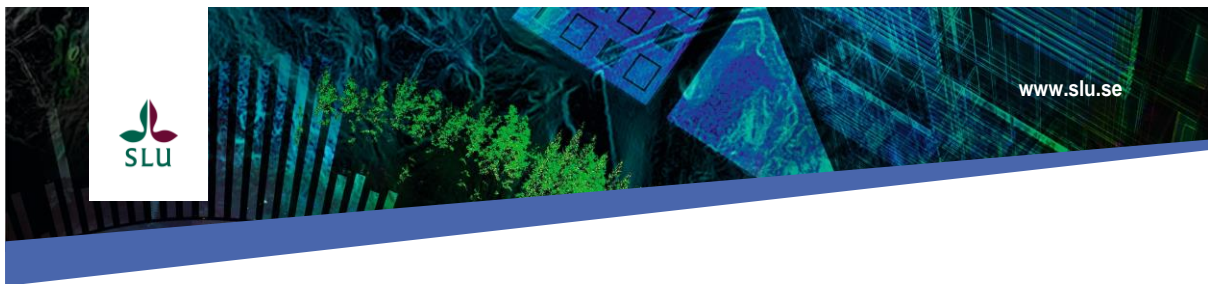
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Summary: Poster



Green open places, stress and productivity: an exploratory study at Kista ICT Hub, Stockholm, Sweden

Kista Information and Communications Technology (ICT) Hub is one of the most important places for jobs in Stockholm, Sweden and in the region.

BACKGROUND

For industrialized societies, the workplace is one of the most important social spaces other than the home. Therefore, the importance of good worker health contributes to high productivity and success of the enterprise, which leads to economic prosperity in the country, and individual social well-being (Burton, WHO, 2010). (Figure 1). ICT related professionals are at a constant pressure to deliver services efficiently and have to be cost effective.



Figure 1. Relationship between health and wealth. Source: WHO, 2010.

AIM

The aim of this exploratory study is to understand how physical and/or visual access to green outdoor places at Kista ICT Hub might relate to employees' perceived level of stress and their productivity loss.

METHODS

The principle of triangulation has been the main approach in this paper.

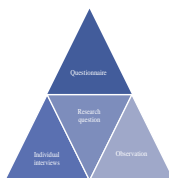


Figure 2. Triangulation approach in collecting data.

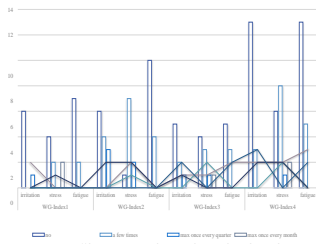
Setting and Sampling

- The exploratory study took place at Kista ICT Hub, Stockholm - the largest Information and Communication Technology cluster in Europe and the third largest ICT cluster in the world.
- 59 employees at Kista ICT Hub, Stockholm, Sweden responded to the questionnaire.

RESULTS

The results of the quantitative data suggest that perceived access to greenery seems to have less of an impact on level of stress (LS) of employees in Kista ICT Hub. On the contrary, the results might indicate that the perceived LS might be increasing among those who have reported physical and/or visual access to greenery (Figure 3).

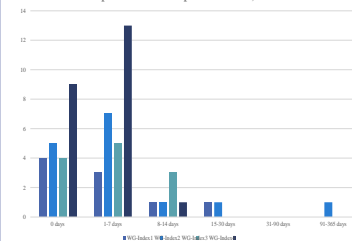
Figure 3. Frequency responses of LS per Workplace Greenery Access (WG-Access), n=59.



*WG-Access1 stands for no visual and physical access to a green outdoor place. WG-Access2 indicates having view but no physical access to a green outdoor place. WG-Access3 represents no view but physical access to a green outdoor place. WG-Access4 stands for having both physical and visual access to a green outdoor place.

Whereas productivity loss (missing days due to personal illnesses) seems to improve when physical access/or view of greenery is perceived in the environment (Figure 4). Qualitative data and observation suggest that the lack of greenery at workplace and

Figure 4. Frequency response of missing days due to personal illnesses per WG-Index, n=59.



location of green outdoor places might be compensated by efficient office planning, comfortable interior design, presence of indoor plants and dedicated place for rest and relaxation. A discrepancy has been identified between the perception of physical access to greenery and reality. The study seems to find out that at work access to greenery does not reduce stress but it does improve cognition so the results are confirming the Attention Restoration theory but not the Stress Recovery theory.

DISCUSSIONS

- Perceived physical access to greenery and actual access might have impact on perceived LS and productivity loss.
- The qualities of the green outdoor places might have impact on the restorative or stress relieving properties as well as perception of physical access.
- The type of ICT work, time shift, or company workplace culture of the employees might have different levels of perceived stress.
- Small, accessible parks with restorative properties can be utilized in multiple locations in the further development of Kista ICT Hub.



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SCIENCE AND EDUCATION FOR SUSTAINABLE LIFE

Appendix 1

CONSENT COVER LETTER

TITLE OF STUDY

Green outdoor places, stress and productivity: an exploratory study at Kista ICT Hub, Stockholm, Sweden.

PRINCIPAL INVESTIGATOR

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PURPOSE OF STUDY

You are being asked to take part in a research study. Before you decide to participate in this study, it is important that you understand why the research is being done and what it will involve. Please read the following information carefully. Please ask the researcher if there is anything that is not clear or if you need more information.

The purpose of this study is to understand how physical and/or visual access to green outdoor places at Kista ICT Hub might have impact on employees' stress level and loss of productivity.

STUDY PROCEDURES

The procedure of the interview will primarily focusing on your own perception of physical environment of your workplace and how it might have impact on your stress level and loss of productivity. First of all, the interview will be conducted in form of conversation. The interviewer will have a list of questions and it will be used to guide the conversation. Follow-up questions can be applied during the interview.

Secondly, the time and place of the interview will be set by the participant. Nevertheless, just for your information, the anticipated time for the interview is estimated to be close to 25 minutes or less.

Lastly, the interview can be recorded as using audio taping (a mobile device) or recorded by note-taking. You have right to choose which one you would prefer better.

BENEFITS

There will be no direct benefit to you for your participation in this study. However, we hope that the information obtained from this study may have contribute for better understanding of how physical or visual access to greenery at workplace might have impact on stress level and loss of productivity.

CONFIDENTIALITY

Your responses to this interview will be anonymous. Every effort will be made by the researcher to preserve your confidentiality including the following:

- Any identifying information about you or your workplace.
- Keeping notes, interview transcriptions, and any other identifying participant information in the personal possession of the researcher.

CONTACT INFORMATION

If you have questions at any time about this study, or you experience adverse effects as the result of participating in this study, you may contact the researcher whose contact information is provided on the first page.

VOLUNTARY PARTICIPATION

Your participation in this study is voluntary. It is up to you to decide whether or not to take part in this study. If you decide to take part in this study, you will be asked to sign a consent form. After you sign the consent form, you are still free to withdraw at any time and without giving a reason. Withdrawing from this study will not affect the relationship you have, if any, with the researcher. If you withdraw from the study before data collection is completed, your data will be destroyed.

CONSENT

I have read, and I understand the provided information and have had the opportunity to ask questions. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason and without cost. I understand that I will be given a copy of this consent form. I voluntarily agree to take part in this study.

Participant's signature _____ Date _____

Investigator's signature _____ Date _____




Appendix 2




Thematic analysis		
Codes	Subthemes	Themes
<ul style="list-style-type: none"> • a lot of tech companies • buildings are close to each other 	dense environment	Perception of physical environment at Kista ICT Hub
<ul style="list-style-type: none"> • concrete environment (boring, depressive) • lack of greenery • a lot of parking lots • car road next to the office 	concrete environment	
<ul style="list-style-type: none"> • big windows • latest technology • modern offices • good illumination • glass roof (on the top floors) • cutting edge environment 	modern buildings	
<ul style="list-style-type: none"> • white walls • colourful furniture • wooden floor • feeling of mechanical design • spacious • comfortable furniture • lack if indoor plants • advertising screens 	office interior design	
<ul style="list-style-type: none"> • collaboration areas • dedicated places for rest on each floor • free sits concept office 	smart office planning	
<ul style="list-style-type: none"> • deadlines • work depends on others • performance does not depend on you • put pressure on others • unclear tasks 	teamwork	
<ul style="list-style-type: none"> • lack of experience • mental maturity • separating from personal life • age 	individual qualities	
<ul style="list-style-type: none"> • hard to balance time to have rest and work • no time to go outside • no time to use dedicated places for resting 	R&R (rest & relax) time	




<ul style="list-style-type: none"> • team trainings 		
<ul style="list-style-type: none"> • in the middle of the hub • the only park in the hub 	location of green outdoor places	Access and Use of Greenery at Kista ICT Hub
<ul style="list-style-type: none"> • not inviting • between buildings feeling of being observed • very open • close to the road • people passing by 	design of green outdoor places	
<ul style="list-style-type: none"> • weather • season 	usability	
<ul style="list-style-type: none"> • lose sense of assessment of your workplace due to work in different places. You travel a lot in this kind of business • individual perception of your own work environment 	attachment	Workplace Attachment




Appendix 3



Description of sectors in Kista ICT Hub

Sector	Bird view of a sector	Evaluation of physical access to greenery
Sector A		<p>Sector A has physical access to Kista Gård Park. The park belongs to residential area and unlikely used by employees working nearby because there are physical obstacles to access the park. Firstly, there is fence between park and buildings which makes it impossible for employees to directly reach the park. Secondly, because of the fence, workers need to walk around all buildings to get on the two roads which are on left and right sides which lead to the park. It takes some time to reach. During the observation time of this park, only families with kids were noticed.</p>
Sector B		<p>Sector B does not have physical access to green outdoor places.</p>
Sector C		<p>As it is seen on the map, the Sector B has inner court yards and they might be visited by employees. The sector is considered as having access to greenery.</p>

Sector D		<p>Sector D has the presence of greenery and has partial physical access to Grönlandsparken on the right corner of the current picture. As we see on the right side of the picture, we see the green corridor. This corridor is wild like nature and it follows the pedestrian way. Some part of the greenery belongs to the daycares.</p>
Sector E		<p>Sector E shares the border with Sector D and have the same green corridor on pedestrian way. Also, it has access to Grönlandsparken on the left corner of the current picture.</p>
Sector F		<p>Sector F is located on the edge of Kista ICT Hub. It has a huge parking lot on its right side and after it there is a busy high way -E4. The sector does not have physical access to greenery.</p>

Sector G		<p>Sector G is neighboring with previous sector and shares the same environment. The area is plane concrete environment. It also does not have access to greenery.</p>
Sector H		<p>Sector H is located next to the E18 highway. The road separates the sector from a wild like forest. There are pedestrian paths which connects two sides. It is considered as access to greenery.</p>
Sector I		<p>Sector I has access to greenery on its right side on the picture. The greenery there is wild like forest. The sector is located in the corner of Kista ICT Hub and the corner is intersection of two busy highways E4 and E18. It is quite loud in this area.</p>

Sector J		<p>Sector J has access to the wild like forest but also same as Sectors H and I is located next to the highway E18. There is a green place just in the middle of the sector and it has some benches and tables.</p>
Sector K		<p>Sector K has partial access to Grönlandsparken in the upper left corner. The area is very concrete with a lot of parking lots.</p>
Sector L		<p>Sector L has access to Grönlandsparken but it also - as Sector K - has huge parking lot.</p>

Sector M		<p>Sector M has an inner courtyard which is located for other building and does not have public use. That is why the sector is considered as without access to greenery.</p>
Sector N		<p>Sector N is the area of Kista Science Tower. It is located just next to metro line, under which there is a big parking lot. The entire area covered by buildings which are connected between each other and it makes them as a whole construction. Those connections look like breaches and have some planted trees. The sector is not considered having access to greenery.</p>